GUIDELINES DENTISTRY

S3 Guideline (long version)

Implant treatment for oral rehabilitation in connection with head and neck radiation

Association of the Scientific Medical Societies (AWMF)
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Leading scientific societies:

German Association of Oral Implantology (DGI)
German Society for Oral and Maxillofacial Surgery (DGMKG)
German Society of Dentistry and Oral Medicine (DGZMK)

Participation of further professional societies belonging to the Association of the Scientific Medical Societies (AWMF):

German Society of Orthodontics (DGKFO)
German Society of Periodontology (DG PARO)

Participation of other scientific societies/organisations:

Working Group for Maxillofacial Surgery (AGOKi)
Professional Association of German Oral Surgeons (BDO)
European Association of Dental Implantologists (BDIZ EDI)
Federal Dental Association (BZÄK)
German Society for Aesthetic Dentistry (DGÄZ)
German Society for Geriatric Dentistry (DGAZ)
German Society for Environmental Dentistry (DEGUZ)
German Society for Dental Implantology (DGZI)
National Association of Statutory Health Insurance Physicians (NASHIP)
Association of German Dental Technicians Guilds (VDZI)
Association of Medical Specialists (VMF)
Self-help Network for Head, Neck and Mouth Cancer Association (SHG Mundkrebs)
Federal Association for Laryngeal and Head and Neck Tumours (Bundesverband der Kehlkopfoperierten e.V.)

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1 What is new?

As part of the update, all recommendations were reviewed to ensure that they were up to date. For this purpose, systematic research regarding prioritised topics and interviews with participating experts were undertaken. The prioritised topics were the implant prognosis for patients with head and neck radiotherapy and the identification of risk factors in this patient group.

As a result of the updating process, 24 statements or recommendations were reviewed, modified, or added entirely.

Contents

2 Publishing

2.1 Leading scientific societies

- German Society for Oral and Maxillofacial Surgery (DGMKG)
- German Association of Oral Implantology (DGI)
- German Society of Dentistry and Oral Medicine (DGZMK)

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2.4 Editorial note

Exclusively for reasons of better readability, masculine, feminine and other forms of language are not used simultaneously. This in no way implies discrimination against different genders. All references to persons in this document are to be understood as gender-neutral.

3 Scope and purpose

3.1 Prioritisation reasons

Reasons for drafting a guideline for implant insertion in connection with head and neck radiotherapy are:

a) prevalence and indications of radiotherapy of the head and neck area
b) frequency of the coincidence of radiotherapy in the head and neck area and implant treatment
c) frequency and relevance of complications
d) uncertainty about treatment and the need for interdisciplinary communication
e) health economic importance

to a) Prevalence and indications of radiation in the head and neck area

Squamous cell carcinomas of the oral cavity and the oropharynx are among the 10 most prevalent malignancies worldwide. Furthermore, head and neck radiation is also indicated for less frequent malignancies (salivary gland malignancies, malignant lymphomas, etc.). According to the prognosis of the joint publication of the Robert Koch Institute and the Society of Epidemiological Cancer Registers in Germany (GEKID), the number of new illnesses for women is around 4497 in 2017 and 9653 for men. The mean age for disease onset for women is 63 years, 3 years lower than the average age of disease onset of 66 years in men. In terms of the relative 5-year survival rate, women have a more favourable prognosis at 63% compared to 47% for men. In the period between 1999 and 2011, the disease rate has increased for both sexes. In the further course of the disease, they are almost constant in women, whereas a declining progression is actually observed in men. Mortality rates are also slightly declining for men, while they are almost unchanged for women. Squamous cell carcinoma accounts for 87% of malignant tumours in the head and throat area, a further 4% are adenocarcinomas, mainly of the salivary glands.

For more than half of the patients, radiotherapy is an integral part of oncological treatment on its own or in combination with surgical procedures and/or chemotherapy *(Grötz 2001 [1])*. For this, the intention can be curative or palliative.

to b) Frequency of the coincidence of radiotherapy in the head and neck area and implant treatment

Radiotherapy and implant restoration may coincide due to the following points:

1. According to the current S2k Guideline, pre-radiotherapy is indicated to reduce the risk of infected osteoradionecrosis (IORN) by extracting avital, advanced PA-damaged, cariously destroyed or partially retained teeth with a risk of pericoronitis *(Krüger et al. 2018 [2])*. Therefore, the dental status at this point is already relatively reduced.
2. Important late effects of radiation (tooth loss due to radiation caries, prothesis intolerance due to radio-xerostomia) are rehabilitated by implant-supported restoration.
3. Implantation as a supportive measure for other oncological therapy effects (jaw defects, neuromuscular dysfunction) often affects patients who have also received radiotherapy.

4. Clinically acceptable fixation of prosthetic or defect prosthetic restorations with oncological patients who still receive radiotherapy after extensive tissue resection and prophylactic extraction of potential abutment teeth (for infected osteoradionecrosis (IORN) prevention) might not be possible without implants.
5. The increasing frequency of implant restorations in the overall population will, in future, lead to a growing number of patients who already had implants inserted before radiotherapy.

to c) Frequency and relevance of complications

A distinction is made between early, mostly reversible consequences of treatment, such as mucositis, and late, irreversible consequences, such as radio-xerostomia, radiation-induced fibrosis and infected osteoradionecrosis [IORN]) *(Grötz 2002 [3]; Bschorer et Schmelzle 1995 [4]; Grötz et al. 2001 [5]; Langendijk et al. 2008 [6])*. IORN is one of the most serious local complications of radiotherapy in the head and neck area. The prevalence of IORN ranges from 0.4% to 56% (Chronopoulos et al. 2018 [7]). On average, IORN prevalence is between 5% and 8% internationally and based on studies and meta-analyses over the last 10 to 20 years *(Grötz et al., 2020 [8])* and is being reduced through continuous periradiotherapeutic care *(Krüger et al. 2018 [2]; Grötz et al. 2020 [8]).* Modern intensity-modulated radiotherapy (IMRT) also leads to high IORN rates in long-term follow-up (*Foster et al. 2018 [9]; Grötz et al. 2020 [8])*. Therefore, a long-term clinical follow-up of irradiated patients (also with IMRT) is indicated. Implants in the irradiated bony implant bed tissue can theoretically lead to an IORN as well as reduce the risk of an IORN, e.g., by the avoidance of denture bruising. “Evidence-based” recommendations for complication management are required.

Increasing application of multimodal therapy concepts (radiochemotherapy) and the addition of new forms of therapy, such as the application of so-called biologics (“molecular targeting”), may result in increased or additional therapy effects. Oral mucositis, including peri-implant mucositis in particular, has a significantly higher prevalence with radiochemotherapy protocols than with radiotherapy alone *(Steingräber et al. 2006 [10]).* IMRT is currently the standard radiotherapy method for the head and neck area. In the meantime, the application of 3D techniques can be seen as obsolete due to the clear superiority of IMRT over the standard 3D computed radiography testing (CRT) in avoiding radio-xerostomia, the reduction of radiogenic caries as well as osteoradionecrosis (ORN) (Nutting et al. 2012 [11], Duarte et al. 2013 [12], Ben-David et al. 2007 [13], Gupta et al. 2012 [14]).

to d) Uncertainty about treatment and the need for interdisciplinary communication

Treatment uncertainties regarding implantation in irradiated patients are:

1. In situ effect on existing implants on the planning target volume of radiotherapy, including consideration of any scattered radiation.
2. Differential treatment considerations of local indication restrictions due to radiotherapy consequences (radiation-induced fibrosis, atrophy, latent bone damage) and other oncological treatments (osteoplasty, soft tissue transplants) as well as other general restrictions for

indications for implant insertion (functional masticatory rehabilitation, fixation of resection prostheses, reduction of IORN risk)

3. Differential therapeutic considerations of implant time (post radiationem), number and location of implants, type of implant, etc.

to e) Health economic importance

According to the German Social Code (SGB) V, the treatment of implants is currently excluded from the benefits of statutory health insurance funds. Exceptions are regulated by Sec. 28 German Social Code (SGB) V (see the statement of the National Association of Statutory Health Insurance Physicians (NASHIP) in the Appendix).

The fixation of cost-intensive dentures on implants compared to teeth with questionable prognosis can also be beneficial for health economic reasons.

When replacing a mucosal-supported prosthesis with a dental prothesis that is carried or supported by an implant, high follow-up costs can partially be avoided due to the increased follow-up care of radiotherapy patients (pressure sores, relining, etc.) *(Heymann et al. 2000 [15])*.

3.2 Objectives and research question

This Guideline is aimed at presenting the indicators and risk factors of an implant insertion after radiotherapy and the current scientifically proven methods of implant-supported restoration (for indication identification, see Table 1 in the Appendix*).* Practitioners, patients, and corporate bodies, as well as reimbursement bodies and experts on the issue of exceptional indications, should be supported in their decision-making. In addition, the specific features that result from implant insertion, which already took place before the indication for radiotherapy, should be outlined. The central concern is to highlight the special features of the radiotherapy patient that deviate from or go beyond the established concepts of implantological care and follow-up care *[e.g., Koeck et Wagner 2004 [16]]*.

3.3 Addressees of the Guideline

- Dentists, dentists who specialise in implantology
- Dentists for oral surgery
- Doctors for oral and maxillofacial surgery

It is intended to inform doctors of other special fields, in particular, doctors of radiotherapy and radiation oncology and ear, nose, and throat specialists.

3.4 Exceptions to the Guideline

see Guideline report

3.5 Patient target group

- Patients before, during or with the condition after head and neck radiation
- Patients with squamous cell carcinomas of the oral cavity and the oropharynx
- Patients with other malignancies (salivary gland malignancy, malignant lymphomas, etc.) of the head and neck area

3.6 Links to other guidelines

- Fluoridation measures for caries prophylaxis (Association of the Scientific Medical Societies (AWMF) registration number 083-001)
- Fissure and dimple sealing (Association of the Scientific Medical Societies (AWMF) registration number 083-002)
- Dental digital volume tomography (Association of the Scientific Medical Societies (AWMF) registration number 083-005)
- Dental trauma on permanent teeth, treatment (Association of the Scientific Medical Societies (AWMF) registration number 083-004)
- Fixed dentures for tooth-limited gaps (Association of the Scientific Medical Societies (AWMF) registration number 083-003)
- Implantological indications for the application of bone substitute materials (Association of the Scientific Medical Societies (AWMF) registration number 083-009)
- Implant prosthetic care of the edentulous maxilla (Association of the Scientific Medical Societies (AWMF) registration number 083-010)
- Indications for implantological 3D X-ray diagnosis and navigation-assisted implantology (Association of the Scientific Medical Societies (AWMF) registration number 083-011)
- All-ceramic crowns and bridges (Association of the Scientific Medical Societies (AWMF) registration number 083-012)
- Treatment of periodontitis stage 1 to 3 - the German implementation of the S3 Guideline “Treatment of stage 1 to 3 periodontitis” of the European Federation of Periodontology (EFP) (Association of the Scientific Medical Societies (AWMF) registration number 083-043)
- Instrumental dental functional analysis (Association of the Scientific Medical Societies (AWMF) registration number 083-017)
- Dental surgery under oral anticoagulation/inhibition of platelet aggregation inhibition (Association of the Scientific Medical Societies (AWMF) registration number 083-018)
- Fear of dental treatment in adults (Association of the Scientific Medical Societies (AWMF) registration number 083-020)
- Caries prophylaxis with permanent teeth – basic recommendations (Association of the Scientific Medical Societies (AWMF) registration number 083-021)

- Peri-implant infections on dental implants, treatment (Association of the Scientific Medical Societies (AWMF) registration number 083-023)
- Dental implant treatment for multiple tooth agenesis and syndromes (Association of the Scientific Medical Societies (AWMF) registration number 083-024)
- Dental implants with diabetes mellitus (Association of the Scientific Medical Societies (AWMF) registration number 083-025)
- Dental implants in medicinal treatment with bone antiresorptives (incl. bisphosphonates) (Association of the Scientific Medical Societies (AWMF) registration number 083-026)
- Diagnostics and treatment of bruxism (Association of the Scientific Medical Societies (AWMF) registration number 083-027)
- Composite restorations in the posterior region (Association of the Scientific Medical Societies (AWMF) registration number 083-028)
- Replacement of missing teeth with composite bridges (Association of the Scientific Medical Societies (AWMF) registration number 083-031)
- Dental implants in patients with immune deficiency (Association of the Scientific Medical Societies (AWMF) registration number 083-034)
- Ceramic implants (Association of the Scientific Medical Societies (AWMF) registration number 083-039)
- Time of implantation (Association of the Scientific Medical Societies (AWMF) registration number 083-040)
- Material incompatibilities with dental implants (Association of the Scientific Medical Societies (AWMF) registration number 007-089)
- Use of platelet-rich fibrin (PRF) in dental implantology (Association of the Scientific Medical Societies (AWMF) registration number 083-042)

4 Introduction

4.1 Definition of the clinical picture

An endosseous implant after radiotherapy in the oral and maxillofacial area is the introduction of alloplastic, xenogeneic or other material in the jaw and/or facial skull to create the conditions for a prosthetic or defect prosthetic restoration to improve rehabilitation functionally and physiognomically/aesthetically, to reduce physiological involution processes (resorption, function reduction) and to avoid, reduce and alleviate effects of oncological treatment (tissue defects, prothesis intolerance, tooth loss due to radiation caries, risk of infected osteoradionecrosis).

4.2 ICD 10 Codes

- C00-C14 Malignant neoplasms of the lip, oral cavity and pharynx
- K10.2 Inflammatory conditions of the jaws
- K12.3 Radiation-induced oral mucositis

4.3 Symptoms in patients with radiation in the head and neck area

From a clinical perspective, it makes sense to distinguish between early, mostly reversible consequences of radiation treatment (particularly mucositis) and late, irreversible consequences (radio-xerostomia, radiation caries, radiation-induced fibrosis, and the risk of infected osteoradionecrosis [IORN])) *(Grötz 2002 [3]; Bschorer et Schmelzle 1995 [4]; Grötz et al. 2001 [5]; Langendijk et al. 2008 [6]; Krüger et al. 2018 [2])*. The interaction of the different radiotherapy effects in the oral cavity leads to a relevant and permanent decline in the quality of life *(Al-Nawas et al. 2006, [17]; Hahn et Krüskemper 2007 [18]; Pace-Balzan et Rogers 2012 [19]; Krüger et al. 2018 [2]).* The relationship between the functional rehabilitation status and psychosocial reintegration is well established *(Müller et al. 2004 [20]).* These undesirable treatment consequences are indicated in the patient by the following symptoms:

Reduction of the masticatory function

- due to poor dental status prior to primary oncological therapy,
- prophylactic tooth extractions before radiotherapy for IORN prevention, tooth extractions after radiotherapy through due to rapidly progressive radiation caries, tooth extractions due to other dental indications (parodontopathy, etc.), independent of the oncological disease and treatment.

Reduction of prosthesis capacity through

- insufficient dental support (tooth loss),
- insufficient mucosa lubrication (radio-xerostomia),
- increased vulnerability of the mucosa (radiation atrophy and fibrosis, decreased sensitivity,

- insufficient alveolar ridge support due to alveolar ridge defects (a consequence of surgery, atrophy),
- insufficient prothesis stability due to impracticable adhesion mechanisms (e.g., valve rim, vacuum effect) due to resection-related tissue defect,
- insufficient soft tissue balances tegmental dentures through movement reduction of the oral and perioral muscles (consequences of surgery, radiation atrophy and fibrosis) and sensitivity disorders (consequences of surgery, radiotherapy effects).

Reduction of the swallowing and speech function through

- permanent loss of the tissue delimitation between the oral cavity and the jaw cavity (oral-antrum connection, etc.) or the nasal cavity (oral-nasal connection, etc.),
- reduced self-cleansing of the oral cavity (clearance) with food retention due to dryness,
- lack of sliding ability of food due to deficient saliva,
- taste disorders,
- permanent loss of the velopharyngeal function.

Reduction of the physiognomic function through

- loss of visible teeth with facial expressions (tooth loss),
- reduction of facial contours and/or prominence, as well as lip/cheek support (jaw defects, tooth loss),
- loss of vertical height in the lower third of the face.

Development of an infected osteoradionecrosis (IORN) through

- radiation-induced fibroses of the bone,
- latent radiation damage (hypocellularity, hypovascularity, hypoxia),
- increased incidence of denture bruising (radio-xerostomia, radiation atrophy and fibrosis),
- insufficient competence for secondary healing of soft tissue bone wounds (extraction alveoli, pressure sites),
- insufficient endosseous germ control with dentogenic contamination (periapical periodontitis, radicular cysts, pericoronitis, infected follicular cysts, marginal periodontitis, peri-implantitis).

Increased risk of a craniomandibular dysfunction/myoarthropathy through

- insufficient vertical jaw relationship and occlusal encryption during mastication and parafunctions

Increased risk for oral infections such as candidiasis

5 Diagnostics

5.1 Necessary examinations for treatment decision

5.1.1 Recommendations

Evidence-based recommendation 1 (reviewed, 2022)		
Patients* with a tumour in the head and neck area **should** receive an examination, documentation, and if necessary, treatment of the dental status before the start of oncological treatment. Vote: 47/0/1 (yes, no, abstention)	**strong consensus**	**A**
Literature: *Wolf et al. 2012, LoE IIIa [21], Grötz 2002 LoE IIIa [3], S3-Leitlinie Diagnostik und Therapie des Mundhöhlenkarzinoms 2021 [22]*		
Level of evidence: IIb A clinical guideline, a scientific opinion and an S3 Guideline deal with this research question.		
Quality of the evidence: moderate (⊕⊕⊕⊖)		

Evidence-based recommendation 2 (new, 2022)		
For planning and implementing surgical measures, a close interdisciplinary appointment with the radiation oncologist* or the family doctor* or the oncologist* **should** follow. Vote: 45/0/2 (yes, no, abstention)	**strong consensus**	**A**
Literature: *Wolf et al. 2012, LoE IIIa [21], Grötz 2002 LoE IIIa [3], S3-Leitlinie Diagnostik und Therapie des Mundhöhlenkarzinoms 2021 [22]*		
Level of evidence: IIb A clinical guideline, a scientific opinion and an S3 Guideline deal with this research question.		
Quality of the evidence: moderate (⊕⊕⊕⊖)		

Background text

Diagnostics, treatment planning and education are guided by the general requirements of implantological care in the oral health (ZMK) and the oral maxillofacial (MCG) area *(Koeck et Wagner 2004 [16]).* Regardless of the oncological disease and treatment, anamnestic, general medical, and local risk factors or high-risk factors must be identified and evaluated. A multidisciplinary approach here is recommended for optimal patient treatment *(Cawood et Stoelinga 2006 [23])* and can improve

patient survival significantly *(Friedland et al. 2011 [24])*. Between 58% and 97% of patients with a tumour in the head and neck area need dental treatment. In the majority of cases, extraction is required *(Jham et al. 2007 [25])*.

In Table 2, the pre-implantological, loco-regional examination is depicted in a flow chart. As part of treatment planning, options for conservative treatment by means of conservative dentures compared to the advantages and disadvantages of implant-supported dentures are assessed. Table 1 depicts a flow chart for indication identification. Consensus recommendations are not included in this Guideline as these are guidelines for general application. With positive indication for implants, the following data must be provided by the radiation oncologist:

- epicrisis with information on the underlying disease, reasons for the indication for curative or palliative radiotherapy,
- information about radiation procedures, e.g., IMRT, tomotherapy, brachytherapy, proton therapy,
- information about single dose (Gy), total dose (Gy), energy (MV),
- information about the type of radiation (incl. information for possible combined treatment),
- information about the time of radiotherapy, duration, complications, interruptions, oncological result,
- dose-volume histogram showing the dose (maximum dose, minimum dose, mean dose) in the volumes of risk organs such as the oral cavity, jaw, salivary glands and jaw head,
- presentation of the dose distribution in a representative CT section level in the maxilla and mandible,
- information about chemotherapy undertaken, biological treatments (molecular targeting), bone modifiers (bisphosphonates, Denosumab), etc.

With this information, the patient’s overall oncological prognosis can be estimated and assigned to an individual risk profile *(Sugerman et Barber 2002 [26])* as has already been established for the pre-radiotherapeutic dental rehabilitation *(Grötz 2002 [3])*.

The current S3 Guideline “Diagnostics and treatment of oral cavity carcinoma” [22] deals with a similar statement regarding the examination, documentation and treatment of the dental status before oncological therapy, which is connected to a “should” recommendation. Due to the pronounced, radiation-related compromise of the discussed patient group in the above Guideline, a “should” recommendation was agreed on regarding patient safety, aspects of prevention, and avoiding complications. The recommendation for planning and implementing the surgical measures and the close interdisciplinary agreement between radiation oncologists, the family doctor and the oncologists was amended to a “should recommendation” in consensus with the current S3 Guideline “Diagnostics and treatment of oral cavity carcinoma.” [22]

Table 1: Flow chart for indication identification

1. General treatment decision for implantological treatment
2. Special reasons for implants in radiotherapy patients
• Reduction or lack of residual teeth (pre-radiation rehabilitation, radiation caries)
• Jaw defects, gum defects
• Radio-xerostomia
• Uncontrollable, muscular malfunctions, scarred functional impairment, fibrosis
• Mucosal disorders, mucositis, mucosal fibrosis and atrophy
• Significant deviation of the jaw position due to lack of joint support
• Conventional dentures do not result in sufficient function and/or increase the IORN risk
3. Reasons which call into question the functional benefit of implant treatment:
• Swallowing function cannot be rehabilitated (independent from the masticatory function)
• Condition after ablatio linguae, permanent carrier of a percutaneous endoscopic gastrostomy (PEG)
• Pronounced jaw clamp, sufficient lower jaw mobility is not achievable
4. Reasons that generally qualify the indication:
• Patient prognosis for survival unfavourable in the short term
• Previous IORN
• Bisphosphonate treatment
• Very extensive primary tumour, tumour recurrence or metastasis without therapeutic remission approach (palliative oncological
• treatment situation)
• Extremely bad mouth hygiene without any recognisable compliance
• Additional general illnesses with known impairment for implants (e.g., uncontrolled diabetes mellitus)

Table 2: Flow chart for pre-implantological, loco-regional examination

1. Enoral inspection, palpation, and examination
• of the dental status, incl. orienting periodontitis (PAR) findings
• of the jaw (especially of the bony implant bed and relevant adjacent anatomic structures)
• of the mucosa and the remaining tegument (especially of the soft tissue implant beds)
• of the jaw joints, incl. functional analytical aspects
• of the salivary glands
• of the chewing and swallowing action
• of the speech function
• of the muscular balancing of the conventional denture
2. Survey of extraoral findings with profile assessment
3. Imaging examinations for planning before, for control immediately after, and at the time of successful osseointegration

5.2 Helpful further examinations in unique cases

The following further examinations are helpful for diagnostics in individual cases:

- multi-level imaging: diagnostic imaging (diagnosis of venous thromboembolism (DVT), computerised tomography (CT)), if necessary, 3D reconstructions, may be indicated to reduce surgical morbidity,
- periodontal status,
- biopsies with questionable pathological tissue changes, taking into account the necessary surgical precautions: mainly to exclude possible recurrence or an IORN,
- bone scintigraphy if there are reasonable grounds to suspect a relevant reduction in perfusion or latent osteoradionecrosis,
- haematological examinations in case relevant blood changes can be expected, for example, due to adjuvant chemotherapy,
- laboratory chemistry tests, in the case of concomitant diseases, particularly changes in the coagulation status,
- functional diagnostics to determine the swallowing function with radiological and endoscopic-functional procedures. (Speyer et al. 2010 [27]; Salinas 2010 [28])

6 Treatment

6.1 Treatment objectives

Treatment objectives for implant treatment for oral rehabilitation in connection with head and neck radiation are as follows:

- Restoration of the masticatory function by means of implant-carried or implant-supported dental prosthesis.
- Support of the oral components of the swallowing function and/or speech function through implant-supported prothesis or enoral defect prothesis.
- Prevention of IORN risk by reducing the tegmental transmitted force vector under prothesis function (avoidance of pressure ulcers).
- Prevention of functional jaw disease (craniomandibular disfunction) by maintaining or restoring the vertical jaw relation.
- Prevention of advancing jaw atrophy, particularly after restoration of jaw and/or facial skull deficits through bone augmentation by reducing the tegmental transmitted force vector under prosthesis function.
- Restoration of the oral and perioral components for psycho-social rehabilitation and reintegration.

- Improvement of oral health-related quality of life.

6.2 Conservative treatment

Consensus recommendations regarding conservative treatment measures were not included in this Guideline as these are not the focus of the Guideline.

- If the local conditions are sufficient, the fabrication and insertion of a conventional denture, obturator or defect prosthetic replacement for risk minimisation (IORN) is to be preferred.
- The fabrication and insertion of a provisional denture, obturator or defect prosthetic denture for the period until denture implant insertion and (afterwards) up to osseointegration is often independently needed due to functional reasons.

6.3 Surgical treatment

6.3.1 Implant planning

6.3.1.1 Interdisciplinary coordination and prosthetic-surgical conception

6.3.1.1.1 Recommendations

Evidence-based recommendation 3 (modified, 2022)		
Coordination between an implant surgeon* and an implant prosthetist* **should** take place with special consideration of oncological aspects. Vote: 49/0/1 (yes, no, abstention)	**strong consensus**	**B**
Literature: *Friedland et al. 2011, LoE IIb [24], S3-Leitlinie Diagnostik und Therapie des Mundhöhlenkarzinoms 2021 [22]*		
Level of evidence: IIb An S3 Guideline and a retrospective study are available on this research question.		
Quality of the evidence: moderate (⊕⊕⊕⊖)		

Statement 1 (new, 2022)	
The implant position shows the following increasing risk gradation in relation to the bony layer: 1. non-irradiated local bone 2. irradiated site-specific bone outside the target volume 3. non-irradiated augmented bone 4. irradiated local bone within the target volume	**strong consensus**

5. irradiated augmented bone Vote: 47/0/1 (yes, no, abstention)	

Literatur: *Neckel et al. 2021 LoE IV [29], Pieralli et al. 2021 LoE IIIb [30], Ettl et al. 2020 LoE IIb [31], Patel et al. 2020 LoE IIIb [32], Alberga et al. 2020 LoE IV [33], Sandoval et al. 2020 LoE IV [34], Di Carlo et al. 2019 LoE IV [35], Moore et al. 2019 LoE IV [36], Woods et al. 2019 LoE IV [37], Laverty et al. 2019 LoE IIIb [38], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Flores-Ruiz et al. 2018 LoE IV [41], Burgess et al. 2017 LoE IIIb [42], Rana et al. 2016 LoE IV [43], Ernst et al. 2016 LoE IIIb [44], Barber et al. 2016 LoE IIIb [45], Ch'ng et al. 2016 LoE IIIb [46], Pompa et al. 2015 LoE IIIb [47], Hessling et al. 2015 LoE IIIb [48], Nack et al. 2015 LoE IV [49], Doll et al. 2015 LoE IIIb [50], Hakim et al. 2015 LoE IIIb [51], Jacobsen et al. 2014 LoE IV [52], Korfage et al. 2014 LoE IIb [53], Gander et al. 2014 LoE IIIb [54], Dholam et al. 2013 LoE IV [55], Buurman et al. 2013 LoE IV [56], Fierz et al. 2013 LoE IIIb [57]*

Level of evidence: IIb

A total of 29 studies deal with this research question. These are 18 retrospective and 3 prospective cohort studies as well as 6 retrospective and 2 prospective case series.

Quality of the evidence: moderate (⊕⊕⊕⊖)

Evidence-based recommendation 4 (modified, 2022)		
The ideal prosthetic implant position **should** be weighed against a surgically less risky or prognostically more favourable position. If necessary, this may result in abandoning the ideal prosthetic position and giving preference to the ideal surgical position. Vote: 47/0/1 (yes, no, abstention)	**strong consensus**	**B**

Literature: *Neckel et al. 2021 LoE IV [29], Pieralli et al. 2021 LoE IIIb [30], Ettl et al. 2020 LoE IIb [31], Patel et al. 2020 LoE IIIb [32], Alberga et al. 2020 LoE IV [33], Sandoval et al. 2020 LoE IV [34], Di Carlo et al. 2019 LoE IV [35], Moore et al. 2019 LoE IV [36], Woods et al. 2019 LoE IV [37], Laverty et al. 2019 LoE IIIb [38], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Flores-Ruiz et al. 2018 LoE IV [41], Burgess et al. 2017 LoE IIIb [42], Rana et al. 2016 LoE IV [43], Ernst et al. 2016 LoE IIIb [44], Barber et al. 2016 LoE IIIb [45], Ch'ng et al. 2016 LoE IIIb [46], Pompa et al. 2015 LoE IIIb [47], Hessling et al. 2015 LoE IIIb [48], Nack et al. 2015 LoE IV [49], Doll et al. 2015 LoE IIIb [50], Hakim et al. 2015 LoE IIIb [51], Jacobsen et al. 2014 LoE IV [52], Korfage et al. 2014 LoE IIb [53], Gander et al. 2014 LoE IIIb [54], Dholam et al. 2013 LoE IV [55], Buurman et al. 2013 LoE IV [56], Fierz et al. 2013 LoE IIIb [57]*

Level of evidence: IIb

A total of 29 studies deal with this research question. These are 18 retrospective and 3 prospective cohort studies as well as 6 retrospective and 2 prospective case series.

Quality of the evidence: moderate (⊕⊕⊕⊖)

Background text

Fundamentally, the general concepts of prosthetic-surgical planning and treatment are available for irradiated patients in the oral maxillofacial area *(Koeck et Wagner 2004 [16])*. The same advantages and disadvantages of the different implant-prosthetic concepts as with non-irradiated patients should be weighed up here. With irradiated patients, specific aspects have to be considered, amongst which the following are of particular importance:

- Defect localisation and defect extension
- Mobility restrictions of the mandible and the tongue
- Condition of the soft tissue, particularly the availability of prosthetically usable and resilient mucosal areas, amount and quality of saliva
- Restrictions on oral hygiene options
- Jaw malpositions
- Value of retaining the residual teeth by taking into account radiation-induced impaired prognosis and implant strategy considerations
- Psycho-social aspects

In many cases, the specific local conditions in irradiated patients require an increase in the number of implants compared to non-irradiated patients. In addition to the diversity of findings, the special local conditions also cause the frequent need for an individual modification of standard implant prosthetic concepts. Often, surgical and prosthetic treatment do not go hand-in-hand. Coordination between the parties involved (the surgeon implanting the prosthesis and the prosthetist) is relevant for the overall result.

There is a controversial discussion regarding the relevance of avoiding a denture carried tegmentally as a special feature of the irradiated bone bed. The principle of the preference of a denture that is purely implant-supported to avoid pressure ulcers compared to the higher risk of IORN with a higher number of implants and a significant rise in costs need to be weighed up against each other *(Weischer et Mohr 1999 [58])*.

The positioning of the implants is subject to identical planning parameters as for non-irradiated patients, which are prioritised differently due to a special risk.

There are 29 studies from the period between 2013 and 2021 regarding the findings of implant treatment for oral rehabilitation of tumour patients in connection with head and neck radiation. These are 18 retrospective and 3 prospective cohort studies as well as 6 retrospective and 2 prospective case series. In 25 studies, implant survival was directly determined as an endpoint, whereas in 4 studies, the endpoint was only indirectly determined. Overall, the bias potential for these studies was considered as **high**.

On the research question regarding the bone implant bed, there are 20 studies that compare implants in irradiated and non-irradiated bone. These are 2 prospective and 17 retrospective studies cohort studies (LoE IIb (n=2), IIIb (n=13), IV (n=5)). Implant survival as an endpoint is determined directly in 17

studies and is determined indirectly in 1 study (Ernst et al. 2016 LoE IIIb [44]). 2 of the studies provide findings on the success of implants.

14 studies compare implants in local bone and osteoplasty. In 12 of these studies, implant survival was directly determined as an endpoint. These are 1 prospective and 11 retrospective cohort studies (LoE IIb (n=1), IIIb (n=7), IV (n=4)). In a further 2 studies, the implant survival rate is not the endpoint of the investigation. A retrospective cohort study outlines the success of implants (Ernst et al. 2016, LoE IIIb [44]), a further study provides information on the rate of osseointegration (Dholam et al. 2013, LoE IV [55]).

Furthermore, 7 of the retrospective cohort studies provide a comparison of irradiated and non-irradiated osteoplasty as well as irradiated and non-irradiated bone. (LoE IIIb (n=5), IV (n=2)).

In 4 studies, implant insertion is only undertaken in osteoplasties. Of these, 3 retrospective cohort studies compare implant survival with and without radiotherapy (LoE IIIb). One case series deals with implant survival in irradiated osteoplasties. In this case, however, the endpoint is not directly determined (Sandoval et al. 2020, LoE IV [34]).

Implants in local bone were assessed in 11 studies. In 4 studies, there is a comparison between irradiated and non-irradiated patients (2 retrospective and 2 prospective cohort studies). Seven studies investigated implants that were inserted into irradiated local bone. These are 5 studies with implant survival as the endpoint (4 retrospective and 1 prospective case series) and 2 case series (1 prospective and 1 retrospective) in which the endpoint was not assessed. (LoE IIb (n=1), IIIb (n=2), IV (n=8)).

Two studies found that the survival of implants in local bone is significantly higher than in osteoplasties (Ettl et al. 2020 LoE Iib [31], Laverty et al., 2019 LoE IIIb [38]). In 4 studies, a significantly lower survival of implants in osteoplasties in combination with radiotherapy was found. (Hessling et al. 2015 LoE IIIb [48], Ch’ng et al. 2016 [46], LoE IIIb, Fierz e al. 2013 LoE IIIb [57], Jacobsen et al. 2014 LoE IV [52]). In contrast, other studies only showed a small difference (Gander et al. 2014 LoE IIIb [54], Patel et al. 2020 LoE IIIb [32], Flores-Ruiz et al. 2018 LoE IV [41]) or showed comparable results for implants in different bone implant beds (Moore et al. 2019 LoE IV [36], Woods et al. 2019 LoE IV [37], Sandoval et al. 2020 LoE IV [34], Hakim et al. 2015 LoE IIIb [51]). In a prospective cohort study with 234 implants (Ettl et a. 2020, LoE IIb), a lower success rate was found for implants within the planned target volume (PTV) of radiotherapy than for implants outside the PTV. The difference, however, proved not to be significant (p=0.292). (Ettl et al. 2020, LoE IIb [31]).

6.3.2 Choice of the type of implant

6.3.2.1 Recommendations

Statement 2 (new, 2022)	
To date, the Guideline group has found that only data for titanium as an implant material is available.	**strong consensus**

• The treatment of irradiated patients* with zirconia dioxide ceramic implants is scientifically not researched. • Concerning implant sizes (diameter and length), there are no indications that different criteria should apply after radiation than without radiation. However, very thick, soft tissue layers after reconstruction measures must be considered.	

• No evaluative recommendation can be deducted from the literature or from clinical experience regarding the following decision alternatives: submucosal versus transmucosal healing, screw implant versus cylindrical implant Vote: 48/0/1 (yes, no, abstention)	
Literature: *Al-Nawas et Grötz 2011 [59], Neckel et al. 2021 LoE IV [29], Pieralli et al. 2021 LoE IIIb [30], Ettl et al. 2020 LoE IIb [31], Patel et al. 2020 LoE IIIb [32], Alberga et al. 2020 LoE IV [33], Sandoval et al. 2020 LoE IV [34], Di Carlo et al. 2019 LoE IV [35], Moore et al. 2019 LoE IV [36], Woods et al. 2019 LoE IV [37], Laverty et al. 2019 LoE IIIb [38], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Flores-Ruiz et al. 2018 LoE IV [41], Burgess et al. 2017 LoE IIIb [42], Rana et al. 2016 LoE IV [43], Ernst et al. 2016 LoE IIIb [44], Barber et al. 2016 LoE IIIb [45], Ch’ng et al. 2016 LoE IIIb [46], Pompa et al. 2015 LoE IIIb [47], Hessling et al. 2015 LoE IIIb [48], Nack et al. 2015 LoE IV [49], Doll et al. 2015 LoE IIIb [50], Hakim et al. 2015 LoE IIIb [51], Jacobsen et al. 2014 LoE IV [52], Korfage et al. 2014 LoE IIb [53], Gander et al. 2014 LoE IIIb [54], Dholam et al. 2013 LoE IV [55], Buurman et al. 2013 LoE IV [56], Fierz et al. 2013 LoE IIIb [57]*	
Level of evidence: IIb There are 29 studies (18 retrospective and 3 prospective cohort studies, 6 retrospective and 2 prospective case series) and one review dealing with this research question.	
Quality of the evidence: moderate (⊕⊕⊕⊖)	

Background text

There are few comparative studies regarding a possible advantage of chemically modified surfaces, which, however, point to an advantage of chemically modified surfaces (Heberer et al. 2011 [60]). Regarding the possible influence of the implant surface on the results of the restoration, a prospective case series and a prospective cohort study are available (LoE IIb). The endpoint of “implant survival” was directly determined in both studies. Regarding the comparison of different surfaces, the study design of the prospective case series is based on this endpoint. However, there is no non-irradiated control group. The 2 studies compare different surface-modified implant systems (SLA® vs. SLActive® or machined vs. Ti-Unite®). Overall, the bias potential of both studies is considered moderate.

A prospective case series (Nack et al. 2015 LoE IV [49]) presents the final results of a 5-year follow-up study by Heberer et.al. (2011) [60]. The preliminary findings published at the time indicated an

advantage of chemically modified surfaces. The final data, however, does not confirm this. However, no significant difference was found between the two groups. The 48 implants with non-modified surface (SLA) and the 49 implants with surface modification (SLActive) had 10 implant losses each at the end of the five-year follow-up. (p=0.926; survival rate SLA 79.2% vs. SLActive 79.6%).

A comparison between two different implant surfaces could be made in a prospective cohort study with 524 implants in the local mandible bone. It investigated implants that were inserted before 2003 and ones that had machined surfaces. Implants which were inserted after 2003, had a Ti-Unite® surface. In irradiated patients, no correlation was shown between the respective surfaces and the number of implant losses (with machined surface, there were 11/165, with Ti-Unite® surface 16/153).

Regarding the size of the implant (diameter and length), there are no indications that different criteria should be considered after radiation than without radiation (Yerit et al. 2006 [61]). However, very thick, soft tissue layers after reconstruction measures must be considered.

A prospective cohort study (Ettl et al. 2020, LoE IIb [31]) showed an overall lower success rate for implants with a length of more than 10 mm. This result was not significant (p=0.211) and referred to the overall population of irradiated and non-irradiated patients.

In a retrospective case series with 169 implants (Curi et al. 2018, LoE IV[40]) in irradiated jaw bones, no influence on success was shown either with product-specific differences or of their dimensions.

6.3.3 Choice of implantation time and loading time

6.3.3.1 Pre-radiation of already healed implants

6.3.3.1.1 Recommendations

Evidence-based recommendation 5 (modified, 2022)		
Before starting radiotherapy, at least a non-surgical treatment of a peri-implant infection **should** be performed. Vote: 48/0/1 (yes, no, abstention)	**Strong consensus**	**B**
Literature: *Al-Nawas et Grötz 2011, LoE IIIa [59]; Pieralli et al. 2021 LoE IIIb [30], Neckel et al. 2020 LoE IV [29], Hessling et al. 2015 LoE IIIb [48], Nack et al. 2015 LoE IV [49], Gander et al. 2014 LoE IIIb [54], Dholam et al. 2013 LoE IV [55], S3-Leitlinie „Die Behandlung periimplantärer Infektionen an Zahnimplantaten [62]*		
Level of evidence: IIb 8 studies deal with this research question. These are 1 review, 4 retrospective cohort studies, 2 prospective case series and 1 S3 Guideline.		
Quality of the evidence: moderate (⊕⊕⊕⊖)		

Background text

In principle, with implants that were already osseointegrated and treated before radiotherapy, no special features need to be observed. To minimise the risk of the development of osteoradionecrosis (IORN), treatment of an eventual peri-implant infection with peri-implantitis treatment is necessary before the start of radiotherapy.

In addition, it needs to be noted that conventional, fixed dental prosthesis (crowns and bridges) through dental alloys can lead to an undesirable, local dose increase of up to 180% on the mucous membrane of the mouth through scattered radiation *(Reitemeier et al. 2002 [63])*. This problem is counteracted with a radiation protection splint (“retractor”), which needs to be worn during radiation *(Grötz 2002 [3]; Reitemeier et al. 2002 [63])*.

In contrast, titanium implants in the target volume of the radiotherapy only cause a dose increase of approx. 25% through scattered radiation *(Ozen et al. 2005 [64])*. The peri-implant bony implant bed tissue is predominantly affected by this. There are no targeted measures to reduce the effect of scattered radiation. The possibility of reducing the occurrence of scattered radiation may result from reduced, higher compliant planning volumes. e.g., by means of multi-field techniques or intensity-modulated radiotherapy (IMRT), perspectively also through the application of innovative types of radiation such as, for example, protons.

There are 4 retrospective cohort studies (LoE IIIb n=3, LoE IV n=1) as well as 2 prospective case series (LoE IV) that provide information on the influence of the health of the peri-implant tissue. Findings of 1 case series (Nack et al. 2015 LoE IV [49]) contradict the results of the other 4 studies. The overall bias potential of the studies is rated as moderate.

In a retrospective study with 57 patients, a vestibuloplasty was undertaken with 14 tumour patients with and without radiotherapy respectively and with 6 patients in the healthy control group (Pieralli et al. 2021 LoE IIIb [30]). The study found that this intervention can stabilise the peri-implant soft tissue in irradiated patients. As part of the follow-up care, all patients had their teeth professionally cleaned at 3-month intervals. Overall implant survival proved to be high for the tumour group, with 98.2% (213/217) after an average follow-up of 81.2 months. Patients with systemic diseases such as diabetes, smokers who have been treated with radiotherapy, immunosuppressed patients, and patients with poor compliance were excluded from the study.

In a study with 272 implants (Hessling et al. 2015 LoE IIIb [48]) and a follow-up of 30.9 months, peri-implantitis and the presence of insufficient hard and soft tissue were indicated as factors associated with implant loss.

Similarly, in a retrospective cohort study (Gander et al. 2014 LoE IIIb [54]) with 136 implants and a success rate of 87.5% (119/136), peri-implantitis was indicated as the reason of implant failure in 16 of the 17 failures.

In a retrospective cohort study (Dholam et al. 2013 LoE IV [55]) with 85 implants, the most frequent reason for implant failure was lacking osseointegration and the presence of peri-implantitis, whereby peri-implantitis was the cause in 8 of a total of 20 failures (overall success rate 76.5% (65/85)). Patients with systemic diseases or tobacco consumers were not included in the study.

As part of a prospective case series with 15 patients (Neckel et al. 2020 LoE IV [29]), who had 81 implants inserted in irradiated local bone, the implant survival rate was 97.5% (79/81). Following the operation, the patients received professional implant cleaning every 3 months. After a follow-up of 3 years, bone loss averaged 1.5 mm mesially and distally in the mandible and 1.4 mm mesially and 1.3 mm distally in the maxilla. The radiotherapy dose hereby proved to be a significant factor influencing bone loss ($p < 0.001$). The study excluded patients with systemic diseases, smokers, immunosuppressed patents, and patients with implants inserted into transplanted or augmented bones.

In a prospective case series (Nack et al. 2015 LoE IV [49]), a loss of 20 implants in 97 patients was recorded after an average follow-up of 5 years (survival rate 79.4% (77/97). According to the recorded values of plaque index (mPII) and the modified sulcus bleeding index (mBI), no relevant peri-implantitis could be detected (SLA mPII 0.43 ± 0.62 mBI 0.81 ± 0.34; SLActive mPII 0.41 ± 0.62, mBI 0.79 ± 0.28). It should be noted, however, that strict exclusion criteria were also applied in this study concerning the patient collective. Therefore, patients with untreated periodontitis or systemic diseases such as diabetes, immunosuppressed patients, and smokers were excluded.

6.3.3.2 Implants inserted shortly before radiotherapy

6.3.3.2.1 Recommendations

Evidence-based recommendation 6 (new, 2022)		
Implant surgery treatment **can** also be performed shortly before radiotherapy. Vote: 47/0/1 (yes, no, abstention)	**strong consensus**	**0**
Literature: *Woods et al. 2019 [37] LoE IV, Patel et al. 2020 LoE IIIb (IV) [32], Korfage et al. (2014) LoE IV (IIb) [53], Alberga et al. 2020 [33] LoE IV*		
Level of evidence: IIb 4 studies deal with this research question. These are 2 retrospective and 1 prospective cohort study as well as 1 retrospective case series.		
Quality of the evidence: moderate (⊕⊕⊕⊖)		

Background text

Implant insertion as part of the primary tumour operation shortly before radiotherapy presupposes an agreed-upon operation concept (coordination between the tumour board and prosthetist/implantologist) so that the changes on the soft tissue due to the operation are healed at the time of radiotherapy *(Schoen et al. 2006 [65])*. The advantages are fast rehabilitation and simultaneous implant insertion in the case of tumour resection or pre-radiotherapeutic tooth rehabilitation, thus saving further surgical intervention. If necessary, fixation of obturator dentures in the maxilla may only be possible with this procedure. However, should there be an exceptional

indication within the meaning of Sec. 28 of the German Social Code (SGB) V and the Joint Federal Committee’s treatment guidelines for contractual dental care, this treatment concept is precluded by the necessity of a prior assessment within the framework of the expert procedure for implantological services agreed in the Federal Framework Agreement. This can hardly be realised preoperatively within the framework of a complex oncological treatment concept (*Al-Nawas et Grötz 2011 [59])*.

Regarding the implant prognosis of implants inserted during the tumour operation, no difference was shown in the localised anterior mandibular (regio interforaminalis) between irradiated and non-irradiated patients *(Schepers et al. 2006 [66])*. In a further study, edentulous patients with oral carcinoma for whom difficulties with the functional masticatory rehabilitation could be foreseen during tumour resection already and implantation was therefore carried out at the same time as the tumour surgery showed implant survival rates of 89% in irradiated bone and 99% in non-irradiated bone after 5 years. *(Korfage et al. 2010 [67])*.

A systematic review of n=4 comparative studies with n = 755 implants inserted in the site-specific jaw during an ablative tumour surgery shows a survival rate of 89.6% with postoperative radiotherapy versus 98.6 % in patients without additional radiation (Koudougou et al. 2020 [68]). Implants inserted after radiotherapy and implants inserted in a reconstructed jaw were excluded from the literature analysis.

In a prospective study of n = 20 head and neck tumour patients with 102 implants in which 39 immediate were compared to 63 late implantations, there was, on the one hand, no difference in implant survival with 7/102 overall losses (overall survival 93.1%), but, on the other hand, a significant reduction in time to final dental prosthesis insertion (321 ± 46.5 days versus 726 ± 45 days; $p < 0.0001$) (Woods et al. 2019 [37] LoE IV).

A retrospective study with 115 implants (including 14 zygomatic implants) and a follow-up of 46.9 months (Patel et al. 2020 LoE IIIb (IV) [32]) also showed that the insertion of implants during resection significantly shortened the time until rehabilitation (p=0.016).

A prospective cohort study with 164 patients who had 542 implants inserted into the local mandible straight after resection showed a survival rate of 93.1% (Korfage et al. (2014) LoE IV (IIb) [53]). In the case of radiotherapy, the insertion of implants was undertaken 6 weeks before the start of radiation. There was a significantly higher rate of implant loss in irradiated bone compared to implants in non-irradiated bone ($p < 0.001$; implant survival with radiotherapy 90.3% vs. 97.6% without radiotherapy).

In a prospective case series, n = 58 immediate implants were inserted in n = 29 patients after tooth extractions in the anterior mandible promptly before radiotherapy, either during the ablative tumour operation or during tooth extractions before radiotherapy (Alberga et al. 2020 [33] LoE IV). After an average follow-up of 18.5 months, n = 4 implants were lost (implant survival rate 93.1%). For n = 9 patients a functional overdenture could not be made. In Germany, the framework conditions of the exceptional indication, according to Sec. 28 German Social Code (SGB) V, significantly restrict the option of implant placement pre-radiation for the large group of Statutory Health Insurance (GKV)-insured persons. The high rate of 1/3 (n = 9/29 patients) of prosthetically unusable implants is sobering and questions the concept.

When evaluating the implant survival rate, it needs to be noted that this does not allow any information regarding the clinical condition of the peri-implant tissue structures, and the IORN risk can therefore not be assessed.

6.3.3.3 Post-irradiation inserted implants

6.3.3.3.1 Recommendations

Evidence-based recommendation 7 (reviewed, 2022)		
A 6- to 12-month waiting period **should** be given for post-radiation implantation after radiation to allow early and delayed radiation effects, particularly to the oral soft tissues, to subside. Vote: 47/0/1 (yes, no, abstention)	**strong consensus**	**A**
Literature: *Grötz et Schmidt 2013, LoE IIIa [69]; Dholam et Gurav 2012, LoE IIIa [70]; Werkmeister et al. 1999, LoE IIIb [71], Di Carlo (2019)[35] LoE IV, Neckel et al. 2021 LoE IV [29], Pieralli et al. 2021 LoE IIIb [30], Ettl et al. 2020 LoE IIb [31], Patel et al. 2020 LoE IIIb [32], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Burgess et al. 2017 LoE IIIb [42], Rana et al. 2016 LoE IV [43], Ernst et al. 2016 LoE IIIb [44], Pompa et al. 2015 LoE IIIb [47], Nack et al. 2015 LoE IV [49], Hakim et al. 2015 LoE IIIb [51], Doll et al. 2015 LoE IIIb [50], Gander et al. 2014 LoE IIIb [54], Korfage et al. 2014 LoE IIb [53], Dholam et al. 2013 LoE IV [55]*		
Level of evidence: IIb One review and 18 studies deal with this research question. These are 2 prospective and 10 retrospective cohort studies as well as 4 prospective and 2 retrospective case series.		
Quality of the evidence: low (⊕⊕⊕⊖)		

Statement 3 (new, 2022)		
There are no research findings in the literature regarding possible early or immediate loading of implants after radiotherapy. Vote: 47/0/1 (yes, no, abstention)	**strong consensus**	**A**

Evidence-based recommendation 8 (modified, 2022)		
The prosthetic loading with post-irradiated inserted implants **should** not be performed before 3 months. Vote: 45/0/2	**strong consensus**	**B**

Literature: *Dholam et Gurav 2012, LoE IIIa [70]; Ettl et al. 2020 LoE IIb [31] Alberga et al. 2020 LoE IV [33] Di Carlo et al. (2019) LoE IV [35], Pompa et al. (2015) LoE IIIb [47], Korfage et al. 2014 LoE IIb [53], Dholam et al. 2013 LoE IV [55]*
Level of evidence: IIb One review and 6 studies deal with this research question. These are 2 prospective and 2 retrospective cohort studies as well as 1 prospective and 1 retrospective case series.
Quality of the evidence: low (⊕⊕⊕⊖)

Background text

To date, implant treatment is mainly post-radiation and recent reviews also recommend this approach *(Grötz et Schmidt 2013 [69]; Dholam et Gurav 2012 [70])*. The period between radiotherapy and implant insertion does not influence the implant prognosis *(Yerit et al. 2006 [61])*. The international consensus is a 6- to 12-month waiting period after radiation to allow for the abatement of early and delayed radiation effects, particularly at the enoral soft tissue *(Grötz et Schmidt 2013, LoE IIIa [69]; Dholam et Gurav 2012, LoE IIIa [70]; Werkmeister et al. 1999, LoE IIIb [71]; consensus strength 10/10)*. There are no research findings in the literature regarding possible early or immediate loading of implants after radiotherapy. However, the general recommendation is that a longer period for implant healing of up to 6 months should be advised *(Dholam et Gurav 2012, LoE IIIa [70])*. There are 4 retrospective cohort studies (LoE IIIb (n=1), LoE IV (n=3) and 1 retrospective case series (LoE IV) that provide information on the influence of the time interval after radiotherapy on implant survival. Implant survival was directly determined as an endpoint. The overall bias potential of the studies is rated as moderate. In 1 retrospective case series, n = 84 titanium implants with a follow-up of at least 12 months in n = 17 patients with radiotherapy after oral cavity carcinoma showed the best implant survival with insertion more than 6 months after radiotherapy ($p < 0.01$) and treatment only at least 6 months after insertion ($p < 0.01$) (Di Carlo et al. 2019 LoE IV [35]). In a retrospective cohort study (Pompa et al. 2015 LoE IIIb [47]) with 34 patients, whose data appear to be at least partially consistent with those of the study by Du Carlo et al. 2019 [35], 168 implants were inserted in irradiated or non-irradiated jaw bones. In the case of radiotherapy, implantation took place at the earliest 12 months after the end of radiation. There were better results for implant survival when these were loaded at the earliest after 6 months. ($p < 0.01$).

A retrospective cohort study with 169 implants found after an average follow-up of 89.2 months that the timing of implant insertion did not significantly influence the implant survival rate (Curi et al. 2018 LoE IV [40]). Furthermore, in a retrospective study with 102 implants and a follow-up of 23 months (*Woods et al. 2019 LoE IV [37]*), no significant difference could be detected in the implant survival of immediate implants compared to delayed inserted implants (survival rate of immediate implants 97.4% vs. 90.5% with delayed insertion).

In a large number of studies which were published in the period between 2013 and 2021, implant insertion in irradiated patients was done at the earliest 6 months after the end of radiotherapy (*Neckel et al. 2021 LoE IV [29], Pieralli et al. 2021 LoE IIIb [30], Ettl et al. 2020 LoE IIb [31], Patel et al. 2020 LoE*

IIIb [32], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Burgess et al. 2017 LoE IIIb [42], Rana et al. 2016 LoE IV [43], Ernst et al. 2016 LoE IIIb [44], Pompa et al. 2015 LoE IIIb [47], Nack et al. 2015 LoE IV [49], Hakim et al. 2015 LoE IIIb [51], Doll et al. 2015 LoE IIIb [50], Gander et al. 2014 LoE IIIb [54], Korfage et al. 2014 LoE IIb [53], Dholam et al. 2013 LoE IV [55]).

6.3.4 Surgical procedure

6.3.4.1 Recommendations

Evidence-based recommendation 9 (reviewed, 2022)		
When creating access for implant insertion according to the least invasive O.R. technique principle in radiation-treated tissue, the bone surface **should** be exposed as little as possible through subperiosteal preparation. Vote: 46/0/1 (yes, no, abstention)	**strong consensus**	**B**
Literatur: *Wagner et al. 1986, LoE IIIb [72], Pieralli et al 2021 LoE IIIb [30]*		
Level of evidence: IIb One retrospective cohort study deals with this research question.		
Quality of the evidence: low (⊕⊕⊕⊖)		

Background text

When creating access for implant insertion according to the least invasive O.R. technique principle in radiation-treated tissue, it is recommended to expose the bone surface as little as possible through subperiosteal preparation *(Wagner et al. 1986, LoE IIIb [72])*. On the other hand, large enough access must be chosen to ensure safe three-dimensional positioning while protecting adjacent anatomical structures. There are no studies about 3-D data-assisted implantation in the irradiated jaw, but this approach may be advantageous due to its low invasiveness. When preparing the bony implant cavity, established precautions that cause minor trauma must be considered (sufficient cooling with, amongst others, sterile, physiological saline solution, sharp cutting rotating instruments, limited rotation rate, limited contact pressure, intermittent dabbing work) *(Bodard et al. 2006 [73])*. The insertion of an endosseous implant should take place while achieving high primary stability. To avoid bone exposure, a non-forced, careful wound closure should be aimed for. The opening or insertion of a healing abutment (sulcus former) is performed for modulation and epithelialisation of the peri-implant seam.

One retrospective cohort study (*Pieralli et al. 2021 LoE IIIb [30]*) which compares a group of 37 tumour patients with a healthy control group of 20 patients shows an implant survival rate of 98.2% (213/217) after an average 81.2-month follow-up in the tumour patient group. As part of the study, it was concluded that tumour patients can successfully be treated with implants. Among other things, minimally invasive surgery was mentioned as a prerequisite for this.

6.3.5 Bone bed augmentations

6.3.5.1 Recommendations

Statement 4 (new, 2022)	
Higher implant survival occurs in site-specific irradiated local bone bed tissue than in irradiated augmented bone bed tissue. Vote: 46/0/1 (yes, no, abstention)	**strong consensus**
Literature: *Yerit et al. 2006, LoE IIIb [61]; Salinas et al. 2010, LoE IIIb [74]; Fenlon et al. 2012, LoE IIIb [75]; Grötz et Schmidt 2013, LoE IIIa [69], Ettl et al. 2020 LoE IIb [31], Laverty et al. 2019 LoE IIIb [38], Hessling et al. 2015 LoE IIIb [48], Jacobsen et al. 2014 LoE IV [52], Fierz et al. 2013 LoE IIIb [57], Pieralli et al 2021 LoE IIIb [30], Patel et al. 2020 LoE IIIb [32], Flores-Ruiz et al. 2018 LoE IV [41], Ch’ng et al. 2016 LoE IIIb [46]*	
Level of evidence: IIb 12 studies deal with this research question. These are 1 cross-sectional study (renal cell carcinoma (RCC)), 10 retrospective and 1 prospective cohort study.	
Quality of the evidence: low (⊕⊕⊕⊖)	

Evidence-based recommendation 10 (reviewed, 2022)		
Bone-augmented measures **should** be avoided after radiotherapy. Vote: 44/0/1 (yes, no, abstention)	**strong consensus**	**B**
Literature: *Yerit et al. 2006, LoE IIIb [61]; Salinas et al. 2010, LoE IIIb [74]; Fenlon et al. 2012, LoE IIIb [75]; Grötz et Schmidt 2013, LoE IIIa [69], Pieralli et al 2021 LoE IIIb [30], Ettl et al. 2020 LoE IIb [31], Patel et al. 2020 LoE IIIb [32], Laverty et al. 2019 LoE IIIb [38], Flores-Ruiz et al. 2018 LoE IV [41], Burgess et al. 2017 LoE IIIb [42], Ch’ng et al. 2016 LoE IIIb [46], Barber et al. 2016 LoE IIIb [45], Hessling et al. 2015 LoE IIIb [48], Hakim et al. 2015 LoE IIIb [51], Jacobsen et al. 2014 LoE IV [52], Fierz et al. 2013 LoE IIIb [57]*		
Level of evidence: IIb 15 studies deal with this research question. These are 1 cross-sectional study, 1 prospective and 13 retrospective cohort studies.		
Quality of the evidence: low (⊕⊕⊕⊖)		

Background text

Irradiated local bone bed tissue leads to a more favourable implant prognosis than transplanted implant bed tissue in the radiation field *(Dholam et Ghurav 2012 [70]; Fenlon et al. 2012 [75]; Keller et al. 1997 [76]; Laverty et al. 2019 [38]; Shugaa-Addin et al. 2016 [77]; Cotic et al. 2017 [78],* Ettl et al. 2020 LoE IIb [31] LoE, Hessling et al. 2015 LoE IIIb [48], Jacobsen et al. 2014 LoE IV [52], Fierz et al. 2013 LoE IIIb [57]*)*. Therefore, there is a coincidence of both osteoplasty and radiotherapy (RT) being a cumulative negative prognosis factor related to implant success. In addition, implants placed simultaneously with osteoplasty surgery have a poorer prognosis for success, with the unfavourable outcome also being largely due to only questionable prosthetic restorability *(Fenlon et al. 2012* [75]). In 1 meta-analysis, the implant survival rate in microvascular anastomotic osteoplasties was investigated (Panchal et al. 2020 [79]. Implants without radiotherapy exposure with an average follow-up of 36 months had a better survival rate than the irradiated implants (95.3% vs. 84.6%; $p < 0.01$), and the radiation increased the risk of implant failure significantly (risk relationship (RR)): 4.74, $p < 0.01$). Therefore, this current meta-analysis also shows a clear survival rate of below 90% with the coincidence of osteoplasty as implant bed and radiation exposure.

In a retrospective study, 167 head and neck tumour patients with 779 implants from the observation period 2012 to 2017 showed implant survival of 95.7% (95% caries initiation (CI) 94.3-97.2%) at 3 years and 95.5% (95% CI 93.9-97.0%) at 5 years with an average follow-up of 38 months. Gender ($p = 0.09$), radiotherapy ($p = 0.16$), and chemotherapy ($p = 0.17$) had no significant effect on implant survival, whereas implant failure was significantly ($p < 0.01$) higher with insertion into grafted bone bed (osteoplasty) compared to site-specific bed (Laverty et al. 2019 LoE IIIb [38]).

There are 9 studies in the period from 2013 to 2021 that allow a comparison of the findings of implants in site-specific bone tissue and irradiated osteoplasties. 8 studies are retrospective cohort studies (LoE IIIb (n=6), LoE IV (n=2)). One is a prospective cohort study (LoE IIb). Implant survival was directly determined as an endpoint. The overall bias potential of the studies is rated as moderate (to high).

In addition, there are 3 retrospective cohort studies that compare implants in irradiated and non-irradiated osteoplasties but did not include implants in natural bone in the evaluation (LoE IIIb).

In a prospective cohort study with 39 patients (Ettl et al. 2020 LoE IIb [31]), findings for 234 implants in patients with and without radiotherapy in the head and neck area were recorded. Overall, an implant success rate of 92.3% was shown after 2 years. With the comparison of irradiated and non-irradiated bone, the information refers to the success of implants. Among other things, the insertion of implants in bone grafts had a negative influence on the result (p=0.021, the success rate in local bone 81.2% vs. 69.1% in osteoplasties). Implants placed within the intended target volume (PTV) also had a lower success rate than those placed outside the PTV, but this difference was not statistically significant (p=0.292).

As part of a retrospective study (Fierz et al. 2013 LoE IIIb [57]) with 104 implants, most implant losses occurred in irradiated osteoplasties (6 out of 14 implants, 30%) after a follow-up of 36-72 months. In the irradiated local bone, there were 8 losses from a total of 42 inserted implants (loss rate 19%).

In a retrospective cohort study (Ch’ng et al. 2016 LoE IIIb [46]) with 246 patients in which 1132 implants were included in the assessment, radiotherapy showed no negative impact on the survival of implants

in irradiated bone after an average follow-up of 33.7 months (RT 96.2% vs. NRT 96.4%; p=0.097). Implants in osteoplasties showed a slightly lower survival rate of 91.8% compared to implants inserted in local bone (survival rate 97.5%), but the difference was not significant, however (p>0.05). However, a significantly increased risk of implant loss was evident in implant placement in grafted bone associated with radiation (p<0.01; survival in irradiated osteoplasty 83.3% vs. 94.9% in osteoplasty without radiotherapy).

The finding of a retrospective study with 140 implants (Jacobsen et al. 2014, LoE IV [52]) was that the insertion of implants into an osteoplasty in combination with radiotherapy presents a risk factor for the implants. The implant survival in the irradiated osteoplasty was only 38.5% compared to 86% in the non-irradiated osteoplasty. However, the study only considered 13 implants in irradiated osteoplasties, of which 8 were losses. In comparison to this, there were 86 implants with 12 losses in osteoplasty without radiotherapy. The result is, therefore, only partially conclusive.

In a retrospective study (Burgess et al. 2017, LoE IIIb [42]) with an average follow-up of 24 months (6-60 months), all 199 implants were inserted into different osteoplasties. For implant survival after 5 years, it was shown that there was a difference in favour of the implants in non-irradiated bone. However, this was not significant (p=0.12).

Six further retrospective cohort studies could not detect a significant difference in the findings of the implants (Patel et al. 2020 LoE IIIb [32], Moore et al. 2019 LoE IV [36], Woods et al. 2019 LoE IV [37], Flores-Ruiz et al. 2018 LoE IV [41], Gander et al. 2014 LoE IIIb [54], Dholam et al. 2013 LoE IV [55]).

A current systematic literature review of relevant publications published between February 2013 and February 2021 provided the following findings about implant prognoses (Table 3):

- Implant bed site-specific, no RT performed: 85.7% to 100%
- Implant bed site-specific, RT performed: 67.9% to 98.9%
- Implant bed osteoplasty, no RT performed: 75% to 100%
- Implant bed site osteoplasty, RT performed: 38.5% to 95.2%

Table 3: Influence of radiotherapy and implant bed on implant survival (results of the systematic literature review between February 2013 and February 2021)

Treatment	Site-specific bed	Osteoplasty
Radiotherapy	Neckel (2021) 97.5% Pieralli (2021) 98.9% Patel (2020) 97.3% Alberga (2020) 90.5% Di Carlo (2019) 90.5% Papi (2019) 94.7% Curi (2018) 92.9% Flores-Ruiz (2018) 87.3% Rana (2016) 67.9% Ernst (2016) 96.6%	Pieralli (2021) 95.2% Patel (2020) 88.9% Sandoval (2020) 93.1% Flores-Ruiz (2018) 71.4% Burgess (2017) 84.4% Barber (2016) 84% Ch’ng (2016) 83.3% Hakim (2015) 89.6% Jacobsen (2014) 38.5% Fierz (2013) 70%

	Ch’ng (2016) 97.4% Pompa (2015) 76.5% Nack (2015) 79.4% Doll (2015) 89.7% Jacobsen (2014) 82.4% Korfage (2014) 90.3% Buurmann (2013) 97.3% Fierz (2013) 81%	
No radiotherapy (Control group)	Pieralli (2021) 97.4% Patel (2020) 98.6% Alberga (2020) 100% Flores-Ruiz (2018) 100% Ernst (2016) 98.9% Ch’ng (2016) 98.1% Pompa (2015) 96.6% Doll (2015) 93.5% Jacobsen (2014) 85.7% Korfage (2014) 97.6% Fierz (2013) 87.5%	Pieralli (2021) 100% Patel (2020) 94.1% Flores-Ruiz (2018) 75% Burgess (2018) 97.4% Ernst (2016) 100% Barber (2016) 89.5% Ch’ng (2016) 94.9% Hakim (2015) 94.4% Jacobsen (2014) 86% Fierz (2013) 92.3%

Concerning implant success (including prosthetic restorability), simultaneous implant placement with bony reconstruction is considered critical *(Grötz et Schmidt 2013 [69]; Fenlon et al. 2012 [75])*.

For extensive tissue replacement (e.g., elongated jaw replacement osteoplasties after continuity resection), pedicle or microvascular grafts show a good clinical outcome *(Zhang et al. 2004, LoE IIIa [80]; Salinas et al. 2010, LoE IIIb [74]; Anna-Gaelle et al. 2011, LoE IIIa [81])*.

In the period from 2013 to 2021, there are 5 retrospective cohort studies (LoE IIIb (n=4), LoE IV (n=1)) that provide information about the bone graft. Implant survival is determined as a direct endpoint in the 4 studies. However, the studies differ in terms of the type of osteoplasties found in each study. Only 1 study has the direct aim of comparing 2 different osteoplasty techniques. The overall bias potential of the studies is rated as high.

One retrospective cohort study with 136 implants and 1 follow-up after 20 months (Gander et al. 2014 LoE IIIb [54]) showed a slightly higher success rate for implants in free vascularised bone grafts (96.3%, 26/27) compared to free bone grafts (76.2%, 16/21). However, the difference did not reach statistical significance (p=0.308).

In a retrospective study (Burgess et al. 2017 LoE IIIb [42]) with an average follow-up of 24 (6-60) months, the results of 199 implants in different bone grafts (fibular graft n=96, anterior alveolar ridge lobe n=64, scapular graft n=37, radius lobe n=2) were evaluated. There was no significant difference between the two groups (survival rates FF 91.7%, deep circumflex iliac artery (DCIA) 96.9%, scapula 97.3%, radius 100%).

A retrospective cohort study (Hessling et al. 2015 LoE IIIb [48]) with 272 implants in local and transplanted bone and an average follow-up of 30.9 months showed the following survival rates for the implants in the different grafts after 5 years: Pelvic crest 96.6% (56/58), fibula 85.7% (18/21), scapula 100% (10/10), cranial vault 100% (4/4). The loss rate in fibular grafts was significantly higher (p=0.022) compared to the other types of reconstruction. Overall, the survival rate of implants in osteoplasties was 94.6% (88/93).

In a retrospective cohort study (Barber et al. 2016 LoE IIIb [45]), 114 patients were treated with osteoplasties. The aim of the study was to compare rehabilitation with free and bone-impaired fibular graft. In total, 82 implants were inserted in 30 patients. The 60-month follow-up showed significantly higher success rates for implants in bone-impaired fibular grafts (p=0.022, followed by p=0.006).

A retrospective cohort study (Jacobsen et al. 2014 LoE IV [52]) with an average follow-up of 67 months concluded that implants in microvascular fibular graft gave satisfying results. The implant survival rate was 82.9% (34/41) in local bone and 79.8% (77/99) in bone grafts.

6.4 Recommendations for the implementation of surgical measures

6.4.1 Recommendations

Evidence-based recommendation 11 (new, 2022)		
The implant insertion in the irradiated, site-specific tissue bed as well as circumscribed augmentative and corrective surgery **can** generally be carried out under local anaesthesia. Extensive, particularly peri-implantological measures (bone or soft tissue grafts) **can** necessitate further anaesthetic procedures. Vote: 45/0/1 (yes, no, abstention)	**strong consensus**	**0**
Literature: *Neckel et al. 2021, LoE IV, Ettl et al. 2020 LoE IIb, Moore et al. 2019 LoE IV*		
Level of evidence: IIb 3 studies deal with this research question. These are 1 prospective case series as well as 1 prospective and 1 retrospective cohort study.		
Quality of the evidence: low (⊕⊕⊕⊖)		

Evidence-based recommendation 12 (new, 2022)		
Stringent, long-term follow-up **should** be ensured for evaluation and support of the peri-implant tissue health. Reference is made here to the current Guideline “IORN and peri-implant infection”. Vote: 44/0/1 (yes, no, abstention)	**strong consensus**	**A**

Literature: *Neckel et al. 2021 LoE IV [29], S2k-Leitlinie „Infizierte Osteoradionekrose (IORN) der Kiefer" [2], S3-Leitlinie „Die Behandlung periimplantärer Infektionen an Zahnimplantaten" [62]*
Level of evidence: III One prospective case series deals with this research question.
Quality of the evidence: low (⊕⊕⊕⊖)

Background text

The implant insertion in the irradiated, site-specific implant bed tissue, as well as circumscribed augmentative and corrective surgeries, can generally be carried out under local anaesthesia. Extensive, peri-implantological measures, in particular (bone and soft tissue grafts), may necessitate further anaesthetic procedures. When planning further extensive anaesthetic procedures, the special features of the oncological patient must be considered according to individual aspects.

After implant insertion, sufficient intensity of care must be ensured promptly (e.g., follow-up checkups postoperatively, also on weekends) and also in emergencies (e.g., on-call).

Existing oral cavity obstruction or scarring limitation of movement and reduced ability to cooperate in some patients who have been pre-operated multiple times or the indication for accompanying corrective surgery may make treatment under inpatient care meaningful.

Furthermore, the necessity of regular and professional checkups and sufficient oral hygiene with repeated professional support (e.g., professional dental cleaning) needs to be pointed out to the patient.

6.5 Additional measures

6.5.1 Obligatory, additional measures

6.5.1.1 Recommendations

Evidence-based recommendation 13 (modified, 2022)		
According to the IORN Guideline, systemic, anti-infective prophylaxis (e.g., Amoxicillin, Clindamycin) **should** follow as part of implantation in patients* after radiation. Vote: 44/0/1 (yes, no, abstention)	**strong consensus**	**A**
Literature: *Al-Nawas et al. 2002 LoE IIIa [82], Grötz 2002 LoE IIIa [3], Al-Nawas et Stein 2010 LoE IIIa [83], Neckel et al. 2021 LoE IV [29], Pieralli et al. 2021 LoE IIIb [30], Alberga et al. 2020 LoE IIb [33], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Ernst et al. 2016 LoE IIIb [44], Nack et al.*		

*2015 LoE IV [49], Doll et al. 2015 LoE IIIb [50], Hakim et al. 2015 LoE IIIb [51], Jacobsen et al. 2014 LoE IV[52], S*2k-Leitlinie „Infizierte Osteoradionekrose (IORN) der Kiefer“ [2]
Level of evidence: IIb One S2k Guideline, 3 scientific opinions and 10 studies deal with this research question. These are 2 prospective and 3 retrospective case series as well as 5 retrospective cohort studies.
Quality of the evidence: moderate (⊕⊕⊕⊖)

Background text

There is consensus in the international literature that a perioperative, systemic, anti-infective prophylaxis (e.g., Amoxicillin, Clindamycin) is performed with implant surgery (*Al-Nawas et al. 2002 LoE IIIa [82], Grötz 2002 LoE IIIa [3], Al-Nawas et Stein 2010 LoE IIIa [83], Neckel et al. 2021 LoE IV [29], Pieralli et al. 2021 LoE IIIb [30], Alberga et al. 2020 LoE IIb [33], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Ernst et al. 2016 LoE IIIb [44], Nack et al. 2015 LoE IV [49], Doll et al. 2015 LoE IIIb [50], Hakim et al. 2015 LoE IIIb [51], Jacobsen et al. 2014 LoE IV[52])*. The choice of oral or intravenous application is guided by the individual risk profile of the patient as well as the scope of surgery. Preoperative local measures for mucous membrane disinfection (e.g., chlorhexidine 0.12%) can lower the rate of early implant failures *(Lampert et al. 1997 [84])*.

In 10 reviewed studies from 2013 to 2021, which formed part of the systematic literature review, information on prophylactic antibiotic treatment of irradiated patients was found. This was the case in 7 retrospective (LoE IIIb (n=4), LoE IV (n=3)) and 1 prospective (LoE IV) cohort study, as well as in 2 prospective case series (LoE IV). In most cases, antibiotics were given over several days. A direct comparison of the results in patients with or without radiotherapy is not given in any of the available studies.

6.5.2 Optional, complementary measures

6.5.2.1 Change of diet

6.5.2.1.1 Recommendations

Evidence-based recommendation 14 (new, 2022)		
To ensure wound healing without inadequate stress on the surgical field, an adaptation of the type of diet as a step-by-step concept **can** be considered. Vote: 45/0/2 (yes, no, abstention)	**strong consensus**	**0**
Literature: *Ettl et al. 2020, LoE IIb [31]*		
Level of evidence: IIb		

There is 1 prospective cohort study dealing with this research question. The endpoint was indirectly determined.
Quality of the evidence: low (⊕⊕⊕⊖)

Background text

Oral liquid or pureed food is the treatment of choice for low-stress load reduction and cooperative patients. Temporary bypass of the oral food passage is possible by means of feeding tubes (e.g., nasogastric feeding tube). In a prospective cohort study (Ettl et al. 2020, LoE IV [31]) with 234 implants, patients who received radiotherapy were fed using a nasogastric feeding tube for 7 to 10 days.

6.5.2.2 Drilling template, navigation, robotics

6.5.2.2.1 Recommendations

Evidence-based recommendation 15 (new, 2022)		
A template-supported implantation based on sectional image data **can** be carried out. Vote: 45/0/1 (yes, no, abstention)	**strong consensus**	**0**
Literature: *Sandoval et al. 2020 LoE IV [34], S3 Leitlinie Indikationen zur implantologischen 3D-Röntgendiagnostik und navigationsgestützte Implantologie [85]*		
Level of evidence: IIb One S3 Guideline and 1 retrospective case series deals with this research question. The endpoint was indirectly determined.		
Quality of the evidence: low (⊕⊕⊕⊖)		

Background text

For risk minimisation, template-supported implantation based on sectional image data may be medically indicated in individual cases. This applies especially if it avoids critical augmentation *(Al-Nawas et Grötz 2011 [59])*. In addition to prosthetic aspects, the local soft/hard tissue conditions, including conditions after ablative tumour surgery (e.g., thick, extraoral distal lobes), should be considered in irradiated patients. The value of measures beyond this, such as the use of image data-supported navigation, can currently not be evaluated sufficiently.

6.5.2.3 Hyperbaric oxygen therapy

6.5.2.3.1 Recommendations

Evidence-based recommendation 16 (modified, 2022)		
Hyperbaric oxygen therapy (HBO) **should** not be recommended for implant treatment after radiotherapy. Vote: 44/0/3 (yes, no, abstention)	**strong consensus**	**B**
Literature: *Granstorm et al. 1999 [86], Curi et al. (2018), Woods et al. (2019)*		
Level of evidence: IIb 3 studies deal with this research question. These are 1 case control study, 1 retrospective case series and 1 retrospective cohort study.		
Quality of the evidence: low (⊕⊕⊕⊖)		

Background text

In the systematic Cochrane Review, only 1 randomised, controlled clinical study (RCT) between the groups “HBO therapy” and “no HBO therapy” for implant treatment after radiotherapy could be identified. *(Coulthard et al. 2008 [87], Espositio et al. 2008 [88])*. This study found no evidence that treatment with HBO therapy was advantageous. However, it must be noted that the missing statistical difference could arise from the low number of cases. Regarding the use of hyperbaric oxygen therapy, a retrospective case series (LoE IV) and a retrospective cohort study (LoE IV) are available from 2013 to 2021. As part of the retrospective cohort studies regarding the influence of HBO therapy on implant survival, however, (Woods et al. 2019 LoE IV) no opinion could be formed. One retrospective study shows a low implant survival in 35 head and neck cancer patients with 169 implants after HBO therapy compared to no HBO therapy. The difference was not statistically significant (88.2% vs. 94.1% p = 0.477) (Curi et al. 2018 LoE IV [40]). 14 articles were included in a systematic meta-analysis of the literature until April 2016 regarding the question of the efficacy of HBO therapy in the improvement of implant prognosis with radiotherapy patients. Although the result showed a lower implant loss rate in the HBO group (9.21%) versus the non-HBO group (22.44%), the authors point to further prognostic factors (type of implant, surgical protocol, time interval between RT and implant insertion, RT dose) that cannot be sufficiently separated as effects (Shah et al. 2017 [89]). Due to more data, a positive effect of HBO cannot be excluded *(Granstorm et al. 1999 [86])*.

6.5.2.4 Peri-implant soft tissue surgery

6.5.2.4.1 Recommendations

Evidence-based recommendation 17 (new, 2022)		
After tumour surgical reconstruction and/or head and neck radiation, mucosa/connective tissue as well as skin grafts **can** be used to optimise the hygiene of implant restoration and to reduce the risk of developing peri-implant infections. Vote: 45/0/1 (yes, no, abstention)	**strong consensus**	**0**
Literature: *Pellegrino et al. 2018 [90], Pieralli et al. (2021) [30], Neckel et al. 2020 LoE IV [29], Ernst et al 2016 LoE IIIb [44], Hessling et al. 2015 LoE IIIb [48], Nack et al. 2015 LoE IV [49], Doll et al. 2015 LoE IIIb [50], S3-Leitlinie „Die Behandlung periimplantärer Infektionen an Zahnimplantaten" [62]*		
Level of evidence: IIb One S3 Guideline and 7 studies deal with this research question. These are 2 prospective case series and 5 retrospective cohort studies.		
Quality of the evidence: low (⊕⊕⊕⊖)		

Background text

The site-specific soft tissue in the radiation field is affected by radiation atrophy or fibrosis and reduced vascularisation. After transplantation, the peri-implant soft tissue situation is even less favourable (flaps, split thickness skin graft, amongst others). Recurrent infections, particularly in areas of tumour-related loss of keratinised gingiva, are often described *(Al-Nawas et Grötz 2011 [59])*. Therefore, the soft tissue implant bed often represents the prognosis-limiting factor in the overall concept of rehabilitation. For the clinician, this situation presents a big challenge. There is hardly any data in the literature about handling the peri-implant soft tissue after radiation.

In 1 retrospective study, 21 patients and 108 osseointegrated implants in 21 microvascular fibula grafts showed overall survival rates of 97.2% at 12 months, 86.5% at 60 months and 79.3% at 120 months (Pellegrino et al. 2018 [90]. Implantation after radiotherapy had a higher rate of loss. At the 5- and 10-year follow-up, peri-implantitis was found in 14.8% and mucositis in 20.3% of surviving implants. The risk of peri-implantitis was increased by a factor of 1.5 when peri-implant connective tissue or skin grafts were not used (18.2 % vs. 9.5%).

Soft tissue-enhancing procedures include, amongst others, vestibular plastic surgery, detaching of the tongue, flap thinning and flap plasty *(Chan et al. 1997 [91]; Ali et al. 1997 [92]; Beumer et al. 1995 [93])*. Corrective peri-implant surgery is useful when there is deep ulcer formation or peri-implant symptoms due to fixed peri-implant tissue. Should peri-implant soft tissue procedures be necessary in irradiated patients, special precautions must be taken with surgery *(Grötz 2002 [3])*.

Five studies from the period between 2013 and 2021, which were part of the systematic literature review, are of interest regarding the research question of peri-implant soft tissue procedures. These are 3 retrospective (LoE IIIb) and 1 prospective (LoE IV) as well as one prospective case series (LoE IV). In the case of 1 retrospective cohort study (Ernst et al. (Ernst et al. 2016), the implant survival was indirectly determined as an endpoint. None of the studies directly compare results with or without connective tissue or skin grafts.

In a retrospective study with 57 patients, a vestibuloplasty was undertaken with 14 tumour patients with and without radiotherapy respectively and with 6 patients in the healthy control group (Pieralli et al. 2021 LoE IIIb [30]). The study found that this intervention can stabilise the peri-implant soft tissue in irradiated patients. Patients who have received vestibuloplasty had significantly lower pocket depths ($p < 0.011$) and significantly lower bleeding index (mBI) values ($p < 0.031$) compared to patients without vestibuloplasty. In addition, there was a gain of fixed gingiva (of approx. 1.7 mm on approx. 3.3 mm; $p > 0{,}001$). In general, patients who received radiotherapy showed significantly higher scores on plaque and bleeding indices (mPI, mBI) compared to the healthy control group ($p < 0.006$).

In a prospective case series with 20 patients (*Nack et al. 2015 LoE IV*), all patients with inadequate keratinised gingiva, received a vestibuloplasty. The implant survival after 60 months was 79.4% (77/97). None of the patients were diagnosed with peri-implantitis in the clinical trials.

One retrospective cohort study (*Ernst et al. 2016 LoE IIIb*) investigated the change of the marginal bone tissue in 35 patients with 194 implants. A modified vestibuloplasty was carried out in all patients. The average follow-up was 52.9 months. The implant survival overall was 97.9% (190/194). According to this study, the pre-prosthetic execution of a vestibuloplasty is necessary for stable long-term results regarding the health of the peri-implant tissue.

As part of a prospective case series with 15 patients (*Neckel et al. 2020 LoE IV* [29]), who had 81 implants inserted into irradiated local bone, there was an implant survival rate of 97.5 (79/81). All patients underwent vestibuloplasty using split-thickness skin grafts and received professional implant cleaning every 3 months following surgery. After a follow-up of 3 years, bone loss averaged 1.5 mm mesially and distally in the mandible and 1.4 mm mesially and 1.3 mm distally in the maxilla. The radiotherapy dose hereby proved to be a significant factor influencing bone loss ($p < 0.001$).

One retrospective cohort study (*Doll et al. 2015 LoE IIIb [50]*) with 157 patients and an average follow-up of 121 months showed overall implant survival of 92.2% (765/830). Of the 157 patients, 102 underwent vestibuloplasty.

In a retrospective cohort study with 272 implants (*Hessling et al. 2015 LoE IIIb [48]*) and a follow-up of 30.9 months, peri-implantitis and the presence of insufficient hard and soft tissue proved to be factors that were associated with implant loss. The study concluded that soft tissue management and an intensive oral hygiene programme are essential for long-term implant survival.

6.6 Complications

6.6.1 The infected osteoradionecrosis

6.6.1.1 Recommendations

Evidence-based recommendation 18 (reviewed, 2022)		
The advantages of implant insertion **should** be weighed up against the risks of an IORN during and after surgery as well as during follow-up care. Vote: 46/0/1 (yes, no, abstention)	**strong consensus**	**A**
Literature: *Moy et al. 2005, LoE IIIb [94], Alberga et al. 2020 LoE IIb [33], Laverty et al. 2019 LoE IIIb [38], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Flores-Ruiz et al. 2018 LoE IV [41], Ch'ng et al. 2016 LoE IIIb [46], Nack et al. 2015 LoE IV [49], Jacobsen et al. 2014 LoE IV [52], Korfage et al. 2014 LoE IIb [67], Fierz et al. 2013 LoE IIIb [57], Menapace et al. 2018 [95]*		
Level of evidence: IIb 12 studies deal with this research question. There are 2 prospective and 3 retrospective case series as well as 1 prospective and 6 retrospective cohort studies.		
Quality of the evidence: moderate (⊕⊕⊕⊖)		

Background text

Due to the effects of irradiation in the bone (reduction of vascularisation through vascular changes, reduction of cell density caused by primary and secondary osteocyte depletion, local hypoxia), each implantation in the irradiated bony implant bed tissue and the germ contamination associated with it carries the risk of an IORN. In addition, general post-implantological complications (fracture, osteomyelitis, etc.) have a higher clinical value in radiotherapy patients. It is therefore absolutely necessary to weigh up the advantages of implant insertion with the risks of an IORN during and after the operation as well as during the follow-up care *(Moy et al. 2005, LoE IIIb [94])*. In this regard, patient groups with systematically evaluated implant loss show triggered IORN in rare cases only *(Esser et Wagner 1997 [96]; Weischer et Mohr 1997 [97])*. Implant-related causes were also not found in relevant frequency in groups of follow-up patients with IORN *(Grötz 2001 [1])*. One retrospective case control study about implant survival in patients with the condition after IORN shows a low 5-year survival rate of 48%, so in this group of patients, an implantation has to be carefully considered (Mancha de la Plata et al. 2012 [98]). In a retrospective study, 121 implants were inserted in 23 patients with fibular grafts with the condition after ORN (n=18) or ON (n=5) (Menapace et al. 2018 [95]). The study aimed to compare primary and secondary implantation with a follow-up of at least 6 months, whereby the last follow-up after 80 weeks was done with the primary implantation or 126 weeks at the secondary implantation. There was an overall implant survival rate of 90.9% (110/121).

Of the studies evaluated as part of the systematic review of the publications from 2013 to 2021, 9 studies provide information on the presence of osteoradionecrosis. Amongst these studies, there are

4 retrospective (LoE IIIb (n=3), LoE IV (n=1)) and 1 prospective (LoE IIb) cohort study, as well as 2 prospective and 2 retrospective case series (LoE IV).

As part of a retrospective cohort study (Ch'ng et al. 2016 LoE IIIb [46]), 19 of the 246 patients developed osteoradionecrosis. Here, smoking was shown to be a significant risk factor (p=0.027). In 1 prospective cohort study (Korfage et al. 2014 LoE IIb [53]) with 164 patients, of which 5 developed ORN, no connection between smoking and the development of an osteonecrosis was shown. Osteoradionecrosis occurred in five other studies (Alberga et al. 2020 LoE IIb [33]: ORN in 1 of 29 patients, Laverty et al. 2019 LoE IIIb [38]: One patient with pathological fracture in bone graft osteonecrosis, Papi et al. 2019 LoE IV [39]: ORN in 1 patient with 3D conformal radiation therapy (3D-CRT) (6.25%), Flores-Ruiz et al. 2018 LoE IV [41]: 2 losses of 13 implants due to ORN, Fierz et al. 2013 [57]: 5 losses of 18 implants due to infection and ORN). In 2 studies, no patients developed irradiation-induced osteonecrosis during follow-up (Curi et al. 2018 LoE IV [40], Nack et al. 2015 LoE IV [49]).

6.6.2 The occurrence of secondary carcinoma

6.6.2.1 Recommendations

Evidence-based recommendation 19 (reviewed, 2022)		
In patients with oral cavity or oropharynx carcinomas, persistent peri-implant infections or findings in the mucous membrane where tumours are suspected **should** be clarified histologically regarding the presence of a recurring or secondary carcinoma. Vote: 46/0/1 (yes, no, abstention)	**strong consensus**	**A**
Literature: *Al-Nawas et al. 2006, LoE IIIa [59];* S3-Leitlinie Diagnostik und Therapie des Mundhöhlenkarzinoms 2021 [22], Korfage *et al. 2014 LoE IIb [53], S2k-Leitlinie Diagnostik und Management von Vorläuferläsionen des oralen Plattenepithelkarzinoms in der Zahn-, Mund- und Kieferheilkunde [99]*		
Level of evidence: IIb One S3 Guideline, 1 S2k Guideline, 1 review and 1 prospective cohort study deal with this research question.		
Quality of the evidence: moderate (⊕⊕⊕⊖)		

Background text

In the literature, there are reports about secondary carcinomas on implants in patients who already had head and neck cancer. *(Moergel et al. 2013 [100], Javed et al. 2012 [101]; De Ceulaer et al. 2010 [102]; Czerninski et al. 2006 [103])*. There are no systematic investigations regarding this. In patients with oral cavity or oropharynx carcinomas, persistent peri-implant infections or findings in the mucous

membrane where tumours are suspected should therefore be clarified histologically regarding the presence of a recurring or secondary carcinoma *(Al-Nawas et al. 2006, LoE IIIa [59]).*

6.7 Implant care for oral rehabilitation in connection with head and neck radiation

6.7.1 Recommendations

Evidence-based recommendation 20 (reviewed, 2022)		
Irradiated patients can be successfully treated with implants with good long-term results. Therefore, the implant prognosis for irradiated patients is predictably good so that no relevant indication limitation **should** result from radiotherapy alone. Vote: 45/0/1 (yes, no, abstention)	**strong consensus**	**A**
Literature: *Neckel et al. 2021 LoE IV [29], Pieralli et al. 2021 LoE IIIb [30], Ettl et al. 2020 LoE IIb [31], Patel et al. 2020 LoE IIIb [32], Alberga et al. 2020 LoE IV [33], Sandoval et al. 2020 LoE IV [34], Di Carlo et al. 2019 LoE IV [35], Moore et al. 2019 LoE IV [36], Woods et al. 2019 LoE IV [37], Laverty et al. 2019 LoE IIIb [38], Papi et al. 2019 LoE IV [39], Curi et al. 2018 LoE IV [40], Flores-Ruiz et al. 2018 LoE IV [41], Burgess et al. 2017 LoE IIIb [42], Rana et al. 2016 LoE IV [43], Ernst et al. 2016 LoE IIIb [44], Barber et al. 2016 LoE IIIb [45], Ch'ng et al. 2016 LoE IIIb [46], Pompa et al. 2015 LoE IIIb [47], Hessling et al. 2015 LoE IIIb [48], Nack et al. 2015 LoE IV [49], Doll et al. 2015 LoE IIIb [50], Hakim et al. 2015 LoE IIIb [51], Jacobsen et al. 2014 LoE IV [52], Korfage et al. 2014 LoE IIb [53], Gander et al. 2014 LoE IIIb [54], Dholam et al. 2013 LoE IV [55], Buurman et al. 2013 LoE IV [56], Fierz et al. 2013 LoE IIIb [57]*		
Level of evidence: IIb There are 29 studies dealing with this research question. These are 18 retrospective and 3 prospective cohort studies as well as 6 retrospective and 2 prospective case series.		
Quality of the evidence: moderate (⊕⊕⊕⊖)		

Background text

A systematic overview of all studies from the period between 2013 and 2021, which investigated implant survival for oral rehabilitation in connection with head and neck radiation is provided in the Guideline report. There are 29 studies that deal with the research question of oral rehabilitation of tumour patients in connection with head and neck radiation. These are 18 retrospective and 3 prospective cohort studies as well as 6 retrospective and 2 prospective case series. In 25 studies, implant survival was directly determined as an endpoint, whereas in 4 studies, the endpoint was only indirectly determined. The overall bias potential (internal validity) for these studies was rated as (moderate to) high. The survival rate of implants after radiotherapy for all listed studies is between 67.9% (Rana et al. LoE IV (2016) [43]) and 98.9% (Pieralli et al. (2021) LoE IIIb [30]).

Current reviews also show that there are sufficient implant survival rates in irradiated bone *(Colella et al. 2007 [87]; Javed et al. 2010 [100]; Javed et al. 2012 [70]; Anderson et al. 2013 [83]; Schiegnitz et al. 2013 [104]; Nooh et al. 2013 [105]; Nobrega et al. (2016) [106], Chrcanovic et al. (2016) [107], Zen Filho EV et al. (2016) [108], Shugaa-Addin et al.(2016) [77], Koudougou et al. (2020) [68]*).

This data points to the fact that implant treatment of irradiated patients is a safe and successful concept nowadays. Possible causes for an improved implant prognosis in the irradiated jaw can be due to advances and improvements in radiation techniques, implant materials and implant techniques.

Regarding implant survival in the maxilla compared to the mandible, some studies show a less favourable prognosis for the irradiated maxilla. *(Jisander et al. 1997 [101]; Niimi et al. 1998 [109]; Sammartino et al. 2011 [110]; Buddula et al. 2012 [111]; Schiegnitz et al. 2013 [104]; Nack et al. 2015 LoE IV [49]; Shugaa-Addin et al. 2016 [77]; Rana et al. 2016 LoE IV [43]; Flores-Ruiz et al. 2018 LoE IV [41])*. However, there are also studies that show a minor (*Patel et al. 2020 LoE IIIb [32]*) or no difference in the implant survival between the irradiated maxilla and mandible (*Curi et al. 2018 LoE IV [40], Di Carlo et al. 2019 LoE IV [35], Doll et al. 2015 LoE IIIb [50]*).

The dependence of the implant prognosis on the radiation dose has been proven by systematic animal studies *(Asikainen et al. 1998 [112])*. Clinically, there is contradictory data for tumour therapeutic doses *(Grötz et al. 1999 [113]; Klein et al. 2009 [114]; Dholam et Gurav 2012 [70]; Schiegnitz et al. 2013 [104])*. Based on the known radiation biological changes, such as fibrosation, hypoxia, etc., a dose-response relationship must however be assumed. In clinical studies, a poorer implant survival with dosages of > 50 Gy on the jaw could be detected.*(Klein et al. 2009 [114], Sammartino et al. 2011 [115], Rana et al. 2016 LoE IV [43], Di Carlo 2019 LoE IV [35])*. A prospective cohort study found that a radiation dose of over 60 Gray had a significantly negative influence on implant survival (p=0.025; *Ettl et al. 2020, LoE IIb [31]*). In 1 review, the high radiation dose ≥ 70 Gy was discussed as a negative risk factor for implant survival (*Shugaa-Addin et al. 2016 [77]).* A prospective case series *Neckel et al. 2021 LoE IV* [29]) showed an influence of the radiation dose on the peri-implant bone degradation. In a retrospective cohort study (*Dholam et al. 2013 LoE IV* [55]), most failures occurred with implants that were inserted in the patient group with radiation of between 56 to 66 Gray.

In the literature, the discussion regarding the advantages of implant survival after intensity-modulated radiotherapy (IMRT) compared to conventional conformal radiotherapy is controversial. A retrospective study shows a significantly higher implant survival after IMRT in 35 head and neck cancer patients with 169 implants compared to conventional conformal radiotherapy. (96.1% vs. 74.3%, p = 0.005) (*Curi et al. 2018 LoE IV* [40]). In a prospective cohort study, the comparison between 3D CRT (three-dimensional conformal radiotherapy) and IMRT regarding the crestal bone loss in 32 radiotherapy patients with 113 implants showed a difference only after 6 months (p=0.028) and no difference at all other points of measure (3,12,24 months) (*Papi et al. 2019 LoE IV* [39]). The implant survival was the same in both groups (p = 0.111).

In a retrospective study with 33 patients (*Gander et al. 2014 LoE IIIb [54]*), an intensity-modulated radiotherapy was carried out in 19 of a total of 21 irradiated patients. In the 2 patients who were treated with conventional radiotherapy, 6 implant failures occurred of a total of 12 implants. Due to the small number of patients that received conventional radiation in this study, a significant difference could not be found.

Tissue substitutes, especially thick flap reconstructions with a negative alveolar ridge profile, have an unfavourable effect on implant prognosis compared with the local irradiated soft tissue *(Yerit et al. 2006 [61]; Grötz et al. 1999 [113])*. Clinically one sees chronic stimulus hyperplasia with treatment-resistant peri-implant inflammation.

Chemotherapy with cisplatin, carboplatin, and 5FU does not seem to influence implant survival over 10 years compared to tumour patients treated surgically. *(Kovacs et al. 2001 [116])*. Adjuvant chemotherapy (cisplatin, carboplatin and 5FU) under radiation does not lead to a worse prognosis *(Grötz et al. 1999 [113])*. Statements can currently not be made about other types of chemotherapy or the application of so-called biologics (molecular targeting).

In a retrospective cohort study (*Laverty et al. 2019 LoE IIIb [38]*) with 779 implants, 382 implants were inserted in patients who had received radiotherapy and 143 implants in patients with radiochemotherapy. The average follow-up was 43 months. The implant survival rate in the irradiated bone for the total of all irradiated implants (RT and RCT) was 95% (499/525). With implants in connection with radiotherapy, the survival was 96.1% (367/382), and in connection with radiochemotherapy, it was 92.3% (132/143). Statistically, this did not present a significant difference.

A retrospective cohort study with 59 patients (*Hessling et al. 2015 LoE IIIb [48]*) with an average follow-up of 30.9 months found that adjuvant radiochemotherapy presented a significant risk factor for implant loss (p=0.024). Implants in non-irradiated bone showed a survival rate of 100% after 5 years (49/49). In comparison, the survival rate of implants in patients with adjuvant radiochemotherapy was 95.3% (122/128) and 97.9% (93/95) in patients with neoadjuvant RCT. All patients who received radiotherapy received radiochemotherapy. It was, therefore, impossible to compare radiotherapy alone with radiochemotherapy regarding implant prognosis. Overall, the implants in patients with RCT showed satisfactory results with a survival rate of 96.2% (765/795) after 5 years.

In a retrospective cohort study with 157 patients and a follow-up of 121 months on average (*Doll et al. 2015 LoE IIIb [50]*), 292 implants were inserted into irradiated bone and 538 in non-irradiated bone. The radiotherapy also consisted exclusively of a combination of radio- and chemotherapy. Patients who received an RCT had a 1.9-fold higher risk of implant loss compared to non-irradiated patients (p=0.011, loss rate RCT 10.3% (30/292), NRT 6.5% (35/538).

There are 21 studies on this statement. These are 4 prospective and 3 retrospective case series (LoE IV) as well as 1 prospective (LoE IIb) and 13 retrospective (LoE IIIb (n=10), LoE IV (n=3)) cohort studies. The implant survival was indirectly determined in 4 cases.

7 Indication

(see also statement of the National Association of Statutory Health Insurance Physicians (NASHIP) in the Appendix)

For patients receiving radiotherapy in the maxillofacial area, the same decision-making principles for the indication for implant treatment apply to patients not receiving radiotherapy. As with patients who have not undergone radiotherapy, the advantages and disadvantages of implant treatment compared

to conventional dental prosthesis treatment must be considered. In radiotherapy patients, specific risks (IORN, infections, etc.) should be taken into account when considering the indications. An indication for radiotherapy patients in the field of MCG results from the following findings in particular:

- extensive jaw and facial defects,
- reduction of the soft tissue resistance (pressure points with the risk of IORN),
- existing prothesis intolerance due to dry mouth (radio-xerostomia),
- non-controllable muscular malfunctions, e.g., due to scars and resections of the tongue,
- significant deviation of the jaw position e.g., due to lack of joint support,
- reduced dental status and reduced value of the residual teeth (rehabilitation before irradiation, radiation caries).

The fact of the less favourable implant prognosis in patients treated with radiotherapy (compared to non-irradiated) is relativised by the proven poor prognosis of naturally healthy teeth due to radiation *(Grötz et al. 2001 [5]; Wöstmann et Rasche 1995 [117])*.

8 Limitation of indication

The following conditions have a marked indication limitation (see also Table 1):

1. If no functional improvement can be achieved with the implant-supported denture (e.g., condition after ablatio linguae).
2. After an IORN.
3. In cases of an extensive primary tumour, tumour recurrence or metastases in a palliative treatment situation and limited life expectancy due to the stage of the tumour. In unique cases, however, rehabilitation is possible, e.g., in patients in a stable condition of the illness. Furthermore, treatment should be considered in patients with recurrent tumours receiving ongoing chemotherapy if improvement in quality of life is possible with oral rehabilitation and there is an appropriate prognosis (*Lazarus 2009 [118]*).
4. In cases of extremely poor oral hygiene and/or no apparent compliance.
5. In the presence of general diseases with known prognosis limitation for implants (e.g., uncontrolled diabetes mellitus).
6. With concurrent bisphosphonate therapy.

9 Summary

Irradiated patients can be successfully treated with implants with good long-term results. Quality of life regarding oral health can thereby be improved through implant treatment. Therefore, the indication for implant treatment should be examined in all patients with head and neck radiation.

In principle, with implants that were already osseointegrated and treated before radiotherapy, no special features need to be observed. However, treatment of a possible peri-implant inflammation before the start of radiotherapy should be undertaken.

The following applies to implantation after radiotherapy: According to the literature, the time interval between radiotherapy and implant insertion does not influence the implant prognosis. Nevertheless, there is international consensus that there should be a 6- to 12-month waiting period to allow for early and delayed effects of radiation to subside, especially on the enoral soft tissue (mucositis).

If the decision for implant prosthetic treatment is made, specific surgical precautions must be observed. These include, amongst others, peri-operative, systemic, anti-infective prophylaxis (e.g., Amoxicillin, Clindamycin) according to the joint statement of the German Society of Dentistry and Oral Medicine (DGZMK) and the German Society for Radiation Oncology (DEGRO) and a conservative protocol with late implantation and late loading (prosthetic loading with implants inserted post radiation at the earliest after 3 months). Bone-augmented measures after radiotherapy should be avoided or limited.

10 Information about this Guideline

10.1 Structure of the Guideline group

10.1.1 Coordination and contact address

- Lead author: PD Dr Eik Schiegnitz, M.Sc.
- Guideline coordinator: Prof. Dr Knut A. Grötz

10.1.2 Authors

- PD Dr Eik Schiegnitz, M.Sc.
- Katrin Reinicke
- Dr Jochem König
- Prof. Dr Bilal Al-Nawas
- Prof. Dr Knut A. Grötz

10.1.3 Participating scientific societies and organisations

The listed scientific societies and organisations as well as their mandated representatives or experts (plenary) listed in the table below, participated in the drafting of the Guideline and, were necessary, in the consensus conference.

Scientific societies/organisations	Abbreviation	Mandate holder	Declaration of interest exists
Working Group for Maxillofacial Surgery	AGOKi	**Prof. Dr Fouad Khoury**	yes
European Association of Dental Implantologists	BDIZ EDI	**Dr Stefan Liepe**	yes
		Dr Wolfgang Neumann	yes
Professional Association of German Oral Surgeons	BDO	**Dr Markus Blume**	yes
		Dr Wolfgang Jakobs	yes
		Dr Mathias Sommer, M.Sc.	yes
		Dr Martin Ullner	yes
Federal Association for Laryngeal and Head and Neck Tumours (Bundesverband der Kehlkopfoperierten e.V.)		**Karin Dick**	yes
Federal Dental Association	BZÄK	**Dr Jens Nagaba**	yes
German Society for Geriatric Dentistry	DGAZ	**Dr Jörg Munack, MSc, MSc**	yes
German Society for Aesthetic Dentistry	DGÄZ	**Dr Torsten Conrad**	yes
		Dr Sarah Al-Maawi	yes
		PD Dr Jonas Lorenz	yes
		Dr Karina Obreja	yes
German Society of Oral Implantology	DGI	**Prof. Dr Florian Beuer MME**	yes
		PD Dr Kristian Kniha	yes
		Dr Daniel Thiem	yes
		Prof. Dr Knut A. Grötz	yes
		Dr Christian Hammächer	yes
		PD Dr Keyvan Sagheb	yes
		Dr Lena Katharina Müller-Heupt	yes
		Prof. Dr Bilal Al-Nawas	yes
		Dr Anette Strunz	yes

		Prof. Dr Shahram Ghanaati	yes
		Prof. Dr Robert Sader	yes
		Prof. Dr Frank Schwarz	yes
		Prof. Dr Hendrik Terheyden	yes
		Dr Jan Tetsch, MSc, MSc	yes
		PD Dr Hendrik Naujokat	yes
		Prof. Dr Jörg Wiltfang	yes
		Prof. Dr Christian Walter	yes
		PD Dr Eik Schiegnitz	yes
		Katrin Reinicke	yes
		Dr Jochem König	yes
		Dr Juliane Wagner	yes
		Prof. Dr h.c. mult. Anton Sculean	yes
		Dr Ausra Ramanauskaite	yes
		Prof. Dr Tobias Fretwurst	yes
		Dr Carla Schliephake	yes
		Prof. Dr Michael Stimmelmayr	yes
		Lorena Cascant Ortolano	yes
		Prof. Dr Benedikt Spies	yes
		PD Dr Kathrin Becker, MSc	yes
		Prof. Dr Ralf Kohal	yes
		Prof. Dr Robert Nölken	yes
		PD Dr Stefan Wentaschek	yes
		Dr Kawe Sagheb	yes
German Society for Orthodontics	DGKFO	**Prof. Dr Christoph Bourauel**	yes
		Prof. Dr Sebastian Zingler	yes
		Prof. Dr Christopher Lux	yes
German Society for Oral and Maxillofacial Surgery	DGMKG	**Dr Martin Bonsmann**	yes
		Dr Martin Keweloh	yes
		Dr Jörg Wiegner	yes
		Prof. Dr Henning Schliephake	yes
		Prof. Dr Jürgen Hoffmann	yes

German Society for Periodontology	DG PARO	**PD Dr Raluca Cosgarea**	yes
		Prof. Dr Henrik Dommisch	yes
German Society for Environmental Dentistry Medicine	DEGUZ	**Lutz Höhne**	yes
German Society of Dentistry and Oral Medicine	DGZMK	**Dr Eleonore Behrens**	yes
		Dr Mohamed Sad Chaar	yes
		Prof. Dr Anne Wolowski	yes
		PD Dr Aydin Gülses	yes
German Society for Dental Implantology	DGZI	**Prof. Dr Michael Gahlert**	yes
		PD Dr Stefan Röhling	yes
		Dr Navid Salehi	yes
		Dr Elisabeth Jacobi-Gresser	yes
		Dr Arzu Tuna	yes
		PD Dr Pit Voss	yes
National Association of Statutory Health Insurance Dentists	KZBV	**Dr Jörg Beck**	yes
Self-help Network for Head, Neck and Mouth Cancer Association (Selbsthilfenetzwerk Kopf-Hals-M.U.N.D-Krebs e.V.)	SHG Mundkrebs	**Thomas Müller**	yes
Association of German Dental Technicians Guilds	Association of German Dental Technicians Guilds (VDZI)	**Rainer Struck**	yes
Association of Medical Specialists	VFM	**Sylvia Gabel**	yes
		Karola Will	yes

The following scientific societies were consulted in the process. There was no feedback regarding participation.

- German Society for Prosthetic Dentistry and Biomaterials (DGPro)
- German Society for Allergology and Clinical Immunology (DGAKI)
- German Society for Immunology (DGfI)
- German Society for Computer-Assisted Dentistry (DGCZ)
- Sichtbar
- Free Association of German Dentists
- Austrian Society for Implantology (ÖGI)

This Guideline was drafted in a working group. The members of this working group were:

Scientific societies/organisations	Abbreviation	Mandate holder	Conflict of interest exists
German Society of Oral Implantology	DGI	**Prof. Dr Frank Schwarz**	yes
German Society for Aesthetic Dentistry	DGÄZ	**PD Dr Jonas Lorenz**	yes
Federal Association for Laryngeal and Head and Neck Tumours (Bundesverband der Kehlkopfoperierten e.V.)		**Karin-Annette Dick**	yes
Self-help Network for Head, Neck and Mouth Cancer Association (Selbsthilfenetzwerk Kopf-Hals-M.U.N.D-Krebs e.V.)	SHG Mundkrebs	**Thomas Müller**	yes
Professional Association of German Oral Surgeons	BDO	**Dr Martin Ullner**	yes
German Society for Aesthetic Dentistry	DGÄZ	**Dr Karina Obreja**	yes
German Society of Oral Implantology	DGI	**PD Dr Eik Schiegnitz**	yes
German Society of Oral Implantology	DGI	**Katrin Reinicke**	yes
National Association of Statutory Health Insurance Dentists	KZBV	**Dr Jörg Beck**	yes

10.1.4 Patient participation

The Guideline was drafted with direct participation of patients. Both patient representatives listed below were fully entitled to vote.

Scientific societies/organisations	Abbreviation	Mandate holder	Declaration of interest exists
Federal Association for Laryngeal and Head and Neck Tumours (Bundesverband der Kehlkopfoperierten e.V.)		**Karin Dick**	yes
Self-help Network for Head, Neck and Mouth Cancer Association (Selbsthilfenetzwerk Kopf-Hals-M.U.N.D-Krebs e.V.)	SHG Mundkrebs	**Thomas Müller**	yes

10.1.5 Methodology

- Prof. Dr Ina Kopp (Association of the Scientific Medical Societies (AWMF))
- Dr Monika Nothacker (Association of the Scientific Medical Societies (AWMF))
- Dr Cathleen Muche-Borowski (Association of the Scientific Medical Societies (AWMF) Certified Guideline Consultant)
- PD Dr Eik Schiegnitz, M.Sc. (German Association of Oral Implantology(DGI), Guideline officer)
- Dr Silke Auras (German Society of Dentistry and Oral Medicine (DGZMK), Guideline officer)
- Dr Birgit Marré (German Society of Dentistry and Oral Medicine (DGZMK), Guideline officer)
- Dr Anke Weber, M.Sc. (German Society of Dentistry and Oral Medicine (DGZMK), Guideline officer)

10.2 Fundamentals of the methodology

The methodology for drafting this Guideline was guided by the Association of the Scientific Medical Societies (AWMF) regulatory framework (version 2.0 of 19/11/2020). Source: Association of the Scientific Medical Societies (AWMF) - Standing Committee Guidelines. Association of the Scientific Medical Societies (AWMF) regulatory framework “Guidelines”. 2. 2020 edition. (http://www.awmf.org/leitlinien/awmf-regelwerk.html).

For the exact methodology, please refer to the Guideline report.

11 Editorial independence

11.1 Funding of the Guideline

The drafting of this Guideline was independent and neutral.

The German Association of Oral Implantology (DGI e.V.) funded the work to draft and update the Guideline. The funding organisation had no nominal influence on the content of the Guideline apart from the right to vote.

The Guideline conference's venues, hotel accommodations and catering were funded by the German Association of Oral Implantology (DGI e.V.). The travelling costs of the Guideline authors and the Guideline coordinators were provided by the German Association of Oral Implantology (DGI e.V.). The travel expenses of the mandate holders were borne by the respective scientific society that sent them. The external consultation and moderation by Association of the Scientific Medical Societies (AWMF) certified Guideline consultants was supported by the German Association of Oral Implantology (DGI e.V.).

11.2 Disclosure and handling of secondary interests

All members of the Guideline groups (authors, participants of the Guideline conference) use the Association of the Scientific Medical Societies (AWMF) form (as of 01/11/2020) to declare secondary interests and submitted these in advance to the 5th German Association of Oral Implantology (DGI) Guideline conference. The originals are kept at the German Association of Oral Implantology (DGI e.V.) office. The declaration of interest was evaluated by third parties (Prof. Kopp and PD Dr Schiegnitz) concerning topical relevance to the Guideline and degree of relevance (low, moderate, high) who also suggested measures for handling conflicts of interest. The evaluation and the suggested measures were presented in the plenary session at the beginning of the 5th German Association of Oral Implantology (DGI) Guideline conference. Given the thematic relevance to the Guideline, the following evaluation was made:

- **Low conflict of interests** was defined as: less than 10 presentations/conference contributions with direct thematic relevance to the Guideline topic, indirect interest through engagement in an implantology-oriented scientific society/foundation as well as the clinical and scientific focus in the field of implantology

- **Moderate conflict of interest** was defined as more than 10 presentations/conference contributions or advisory board/consultant activities with direct topical relevance to the Guideline topic

- **High conflict of interest** was defined as: Ownership interest in medicinal products/medical devices (e.g., patent, copyright, sales licence), ownership of shares, equities, and funds with participation in companies in the healthcare sector

Persons with a moderate conflict of interest abstained from voting. The coordinator of the Guideline abstained in principle. A tabular summary of the declarations, the evaluation, and the management of conflicts of interest is appended to this Guideline.

In order to minimise possible secondary influences of low secondary interests, the Guideline was drafted by a core team in close cooperation:

- Prof. Dr Knut A. Grötz
- PD Dr Eik Schiegnitz, M.Sc.
- Prof. Dr Bilal Al-Nawas
- Dr Jochem König
- Katrin Reinicke

The coordinator, Prof. Dr Knut A. Grötz abstained from all votes.

12 External evaluation and adoption

12.1 Adoption by the Boards of the editing scientific societies/organisations

The Boards of the participating scientific societies approved the Guideline between 10/06/2022 and 10/08/2022. Finally, the Boards of the leading scientific societies approved the publication from 21/03/2023 to 27/03/2023.

13 Dissemination and implementation

13.1 Exploitation rights

Participants of the Guideline group as the authors of scientific work were informed in writing about the transfer of the right of use for the publication of the Guideline on the websites of the Association of the Scientific Medical Societies (AWMF), German Society of Dentistry and Oral Medicine (DGZMK) and other scientific societies as well as the publication in scientific journals of the scientific societies, Dental Bulletins (zm), chamber journals, etc. The consent of all participants is available at the Guideline office of the German Society of Dentistry and Oral Medicine (DGZMK). The free use of the contents of the Guideline by the addressees corresponds with the statutory purpose of the scientific societies.

13.2 Dissemination and implementation approach

The Guideline and the supplementary documents are available from the following sources:

- Publication on the homepage of the German Association of Oral Implantology (DGI), German Society for Oral and Maxillofacial Surgery (DGMKG), German Society of Dentistry and Oral Medicine (DGZMK)
- Publication in the Guideline register of the Association of the Scientific Medical Societies (AWMF)
- Publications in the German Dental Journal (DZZ), German Dental Journal International (DZZ International) and Dental Bulletins (zm)
- Scientific publications in the IJID

14 Period of validity and updating procedure

Guideline status as of: 02/12/2022
Valid until: 01/12/2027

This Guideline represents the updated Guideline from May 2015. The Guideline is valid from 02 December 2022 until the next update. The validity period is estimated to be 5 years. Regular updates are planned; if changes are urgently needed, these will be published separately. Comments and notes for the updating process are expressly welcome and can be sent to the lead author, PD Dr Eik Schiegnitz - eik.schiegnitz@unimedizin-mainz.de.

15 Literature

1. Grötz, K.A., *Prophylaxe und Therapie der Folgen therapeutischer Tumor-Bestrahlung im Mund-Kiefer-Gesichtsbereich*. 2001, Berlin: Quintessenz.

2. Krüger, M., et al., *S2k-Leitlinie: Infizierte Osteoradionekrose (IORN) der Kiefer (007/04).* 2018.

3. Grötz, K.A., *Zahnärztliche Betreuung von Patienten mit tumortherapeutischer Kopf-Hals-Bestrahlung.* Stellungnahme der DGZMK und DEGRO, 2002. **57**: p. 509-511.

4. Bschorer, R. and R. Schmelzle, *Der RTOG- Score (Radiation Therapy Oncology Group) als Leitfaden zur Behandlung im vorbestrahlten Gebiet.* Fortschr Kiefer Gesichtschir, 1995. **40**: p. 162–166

5. Grötz, K., et al., *Chronische Strahlenfolgen an den Zahnhartgeweben (“Strahlenkaries”) Klassifikation und Behandlungsansätze.* Strahlenther Onkol, 2001. **177**: p. 96-104.

6. Langendijk, J.A., et al., *Impact of late treatment-related toxicity on quality of life among patients with head and neck cancer treated with radiotherapy.* J Clin Oncol, 2008. **26**(22): p. 3770-6.

7. Chronopoulos, A., et al., *Osteoradionecrosis of the jaws: definition, epidemiology, staging and clinical and radiological findings. A concise review.* Int Dent J, 2018. **68**(1): p. 22-30.

8. Grötz, K.A., E. Schiegnitz, and T.F. Wolff, *Kompromittierte Patienten - MKG UPDATE 2020.* 2020.

9. Foster, C.C., et al., *Definitive chemoradiation for locally-advanced oral cavity cancer: A 20-year experience.* Oral Oncol, 2018. **80**: p. 16-22.

10. Steingräber, M., P. Feyer, and P. Ortner, *MASCC Guidelines 2006 zur Prophylaxeund Therapie der Mukositis bei Tumortherapie.* 2006.

11. Nutting, C.M., et al., *Parotid-sparing intensity modulated versus conventional radiotherapy in head and neck cancer (PARSPORT): a phase 3 multicentre randomised controlled trial.* Lancet Oncol, 2011. **12**(2): p. 127-36.

12. Duarte, V.M., et al., *Comparison of dental health of patients with head and neck cancer receiving IMRT vs conventional radiation.* Otolaryngol Head Neck Surg, 2014. **150**(1): p. 81-6.

13. Ben-David, M.A., et al., *Lack of osteoradionecrosis of the mandible after intensity-modulated radiotherapy for head and neck cancer: likely contributions of both dental care and improved dose distributions.* Int J Radiat Oncol Biol Phys, 2007. **68**(2): p. 396-402.

14. Gupta, T., et al., *Three-dimensional conformal radiotherapy (3D-CRT) versus intensity modulated radiation therapy (IMRT) in squamous cell carcinoma of the head and neck: a randomized controlled trial.* Radiother Oncol, 2012. **104**(3): p. 343-8.

15. Heymann, C., et al., *Implantatprothetik versus konventionelle Prothetik bei Freiendsituationen.* Z Zahnärztl Implantol, 2000. **16**: p. 190-195.

16. Koeck, B. and W. Wagner, *Implantologie. Praxis der Zahnheilkunde Band 13*, ed. U. Fischer. 2004, München.

17. Al-Nawas, B., et al., *Quantifying radioxerostomia: salivary flow rate, examiner's score, and quality of life questionnaire.* Strahlenther Onkol, 2006. **182**(6): p. 336-41.

18. Hahn, T.R. and G. Krüskemper, *Auswirkungen der Strahlentherapie auf die Lebensqualität. .* Mund Kiefer GesichtsChir, 2007. **11**: p. 99-106.

19. Pace-Balzan, A. and S.N. Rogers, *Dental rehabilitation after surgery for oral cancer.* Curr Opin Otolaryngol Head Neck Surg, 2012. **20**(2): p. 109-13.

20. Muller, F., et al., *The use of implant-supported prostheses in the functional and psychosocial rehabilitation of tumor patients.* Int J Prosthodont, 2004. **17**(5): p. 512-7.

21. Wolff, K.D., M. Follmann, and A. Nast, *The diagnosis and treatment of oral cavity cancer.* Dtsch Arztebl Int, 2012. **109**(48): p. 829-35.

22. *Leitlinienprogramm Onkologie (Deutsche Krebsgesellschaft, Deutsche Krebshilfe, AWMF): S3-Leitlinie Diagnostik und Therapie des Mundh hlenkarzinoms, Langversion 3.0, 2021, AWMF Registernummer: 007/100OL.* 2021.

23. Cawood, J.I. and P.J. Stoelinga, *International academy for oral and facial rehabilitation--Consensus Report.* Int J Oral Maxillofac Surg, 2006. **35**(3): p. 195-8.

24. Friedland, P.L., et al., *Impact of multidisciplinary team management in head and neck cancer patients.* Br J Cancer, 2011. **104**(8): p. 1246-8.

25. Jham, B.C., et al., *Oral health status of 207 head and neck cancer patients before, during and after radiotherapy.* Clin Oral Investig, 2008. **12**(1): p. 19-24.

26. Sugerman, P.B. and M.T. Barber, *Patient selection for endosseous dental implants: oral and systemic considerations.* Int J Oral Maxillofac Implants, 2002. **17**(2): p. 191-201.

27. Speyer, R., et al., *Effects of therapy in oropharyngeal dysphagia by speech and language therapists: a systematic review.* Dysphagia, 2010. **25**(1): p. 40-65.

28. Salinas, T.J., *Prosthetic rehabilitation of defects of the head and neck.* Semin Plast Surg, 2010. **24**(3): p. 299-308.

29. Neckel, N., et al., *Influence of implant-specific radiation doses on peri-implant hard and soft tissue: An observational pilot study.* Clin Oral Implants Res, 2020.

30. Pieralli, S., et al., *Retrospective long-term clinical evaluation of implant-prosthetic rehabilitations after head and neck cancer therapy.* Clin Oral Implants Res, 2021.

31. Ettl, T., et al., *Implant survival or implant success? Evaluation of implant-based prosthetic rehabilitation in head and neck cancer patients-a prospective observational study.* Clin Oral Investig, 2020. **24**(9): p. 3039-3047.

32. Patel, J., H. Antov, and P. Nixon, *Implant-supported oral rehabilitation in oncology patients: a retrospective cohort study.* Br J Oral Maxillofac Surg, 2020. **58**(8): p. 1003-1007.

33. Alberga, J.M., et al., *Mandibular dental implant placement immediately after teeth removal in head and neck cancer patients.* Support Care Cancer, 2020. **28**(12): p. 5911-5918.

34. Sandoval, M.L., et al., *Immediate dental implants in fibula free flaps to reconstruct the mandible: A pilot study of the short-term effects on radiotherapy for patients with head and neck cancer.* Clin Implant Dent Relat Res, 2020. **22**(1): p. 91-95.

35. Di Carlo, S., et al., *Timing for implant placement in patients treated with radiotherapy of head and neck.* Clin Ter, 2019. **170**(5): p. e345-e351.

36. Moore, P., et al., *Outcomes of dental and craniofacial osseointegrated implantation in head and neck cancer patients.* Head Neck, 2019. **41**(9): p. 3290-3298.

37. Woods, B., M. Schenberg, and A. Chandu, *A Comparison of Immediate and Delayed Dental Implant Placement in Head and Neck Surgery Patients.* J Oral Maxillofac Surg, 2019. **77**(6): p. 1156-1164.

38. Laverty, D.P., et al., *Outcomes of implant-based oral rehabilitation in head and neck oncology patients-a retrospective evaluation of a large, single regional service cohort.* Int J Implant Dent, 2019. **5**(1): p. 8.

39. Papi, P., et al., *Crestal bone loss around dental implants placed in head and neck cancer patients treated with different radiotherapy techniques: a prospective cohort study.* Int J Oral Maxillofac Surg, 2019. **48**(5): p. 691-696.

40. Curi, M.M., et al., *Long-term success of dental implants in patients with head and neck cancer after radiation therapy.* Int J Oral Maxillofac Surg, 2018. **47**(6): p. 783-788.

41. Flores-Ruiz, R., et al., *Implant survival in patients with oral cancer: A 5-year follow-up.* J Clin Exp Dent, 2018. **10**(6): p. e603-e609.

42. Burgess, M., et al., *Osseointegrated implants into a variety of composite free flaps: A comparative analysis.* Head Neck, 2017. **39**(3): p. 443-447.

43. Rana, M.C., et al., *Assessment of the Survival of Dental Implants in Irradiated Jaws Following Treatment of Oral Cancer: A Retrospective Study.* Niger J Surg, 2016. **22**(2): p. 81-85.

44. Ernst, N., et al., *Changes in Peri-Implant Bone Level and Effect of Potential Influential Factors on Dental Implants in Irradiated and Nonirradiated Patients Following Multimodal Therapy Due to Head and Neck Cancer: A Retrospective Study.* J Oral Maxillofac Surg, 2016. **74**(10): p. 1965-73.

45. Barber, B.R., et al., *Bone-impacted fibular free flap: Long-term dental implant success and complications compared to traditional fibular free tissue transfer.* Head Neck, 2016. **38 Suppl 1**: p. E1783-7.

46. Ch'ng, S., et al., *Osseointegrated implant-based dental rehabilitation in head and neck reconstruction patients.* Head Neck, 2016. **38 Suppl 1**: p. E321-7.

47. Pompa, G., et al., *Survival of dental implants in patients with oral cancer treated by surgery and radiotherapy: a retrospective study.* BMC Oral Health, 2015. **15**: p. 5.

48. Hessling, S.A., et al., *Implant-based rehabilitation in oncology patients can be performed with high long-term success.* J Oral Maxillofac Surg, 2015. **73**(5): p. 889-96.

49. Nack, C., et al., *Rehabilitation of irradiated patients with chemically modified and conventional SLA implants: five-year follow-up.* J Oral Rehabil, 2015. **42**(1): p. 57-64.

50. Doll, C., et al., *Survival analysis of dental implants and implant-retained prostheses in oral cancer patients up to 20 years.* Clin Oral Investig, 2015. **19**(6): p. 1347-52.

51. Hakim, S.G., et al., *Masticatory rehabilitation following upper and lower jaw reconstruction using vascularised free fibula flap and enossal implants-19 years of experience with a comprehensive concept.* Clin Oral Investig, 2015. **19**(2): p. 525-34.

52. Jacobsen, C., et al., *Is mandibular reconstruction using vascularized fibula flaps and dental implants a reasonable treatment?* Clin Implant Dent Relat Res, 2014. **16**(3): p. 419-28.

53. Korfage, A., et al., *Overdentures on primary mandibular implants in patients with oral cancer: a follow-up study over 14 years.* Br J Oral Maxillofac Surg, 2014. **52**(9): p. 798-805.

54. Gander, T., et al., *Medium-term outcome of Astra Tech implants in head and neck oncology patients.* Int J Oral Maxillofac Surg, 2014. **43**(11): p. 1381-5.

55. Dholam, K.P., et al., *Implant-retained dental rehabilitation in head and neck cancer patients: an assessment of success and failure.* Implant Dent, 2013. **22**(6): p. 604-9.

56. Buurman, D.J., et al., *Prosthetic rehabilitation of head and neck cancer patients focusing on mandibular dentures in irradiated patients.* Int J Prosthodont, 2013. **26**(6): p. 557-62.

57. Fierz, J., W. Hallermann, and R. Mericske-Stern, *Patients with oral tumors. Part 1: Prosthetic rehabilitation following tumor resection.* Schweiz Monatsschr Zahnmed, 2013. **123**(2): p. 91-105.

58. Weischer, T. and C. Mohr, *Ten-year experience in oral implant rehabilitation of cancer patients: treatment concept and proposed criteria for success.* Int J Oral Maxillofac Implants, 1999. **14**(4): p. 521-8.

59. Al-Nawas, B. and K.A. Grötz, *Implant based rehabilitation in connection with head neck and radiation therapie.* Dtsch Zahnärztl Z 2011. **66**: p. 818–826.

60. Heberer, S., et al., *Rehabilitation of irradiated patients with modified and conventional sandblasted acid-etched implants: preliminary results of a split-mouth study.* Clin Oral Implants Res, 2011. **22**(5): p. 546-51.

61. Yerit, K.C., et al., *Implant survival in mandibles of irradiated oral cancer patients.* Clin Oral Implants Res, 2006. **17**(3): p. 337-44.

62. Schwarz, F. and J. Becker, *S3-Leitlinie Die Behandlung periimplantärer Infektionen an Zahnimplantaten.* 2016.

63. Reitemeier, B., et al., *Evaluation of a device for attenuation of electron release from dental restorations in a therapeutic radiation field.* J Prosthet Dent, 2002. **87**(3): p. 323-7.

64. Ozen, J., et al., *Dosimetric evaluation of the effect of dental implants in head and neck radiotherapy.* Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2005. **99**(6): p. 743-7.

65. Schoen, P.J., et al., *Mandibulotomy and implant insertion.* Head Neck, 2003. **25**(9): p. 748-53.

66. Schepers, R.H., et al., *Effect of postoperative radiotherapy on the functional result of implants placed during ablative surgery for oral cancer.* Int J Oral Maxillofac Surg, 2006. **35**(9): p. 803-8.

67. Korfage, A., et al., *Benefits of dental implants installed during ablative tumour surgery in oral cancer patients: a prospective 5-year clinical trial.* Clin Oral Implants Res, 2010. **21**(9): p. 971-9.

68. Koudougou, C., et al., *Postimplantation radiation therapy in head and neck cancer patients: Literature review.* Head Neck, 2020. **42**(4): p. 794-802.

69. Grötz, K.A. and B.L.J. Schmidt, *Handbuch MKG Update.* 2013.

70. Dholam, K.P. and S.V. Gurav, *Dental implants in irradiated jaws: a literature review.* J Cancer Res Ther, 2012. **8 Suppl 1**: p. S85-93.

71. Werkmeister, R., et al., *Rehabilitation with dental implants of oral cancer patients.* J Craniomaxillofac Surg, 1999. **27**(1): p. 38-41.

72. Wagner, W., H. Kuffner, and U. Hartmann, *Der bestrahlte Patient als Risikopatient bei zahnärztlich-chirurgischen Eingriffen.* Dtsch Zahnärztl Z., 1986. **41**: p. 440-443.

73. Bodard, A.G., et al., *[Dental implants in irradiated areas: a series of 33 patients].* Rev Stomatol Chir Maxillofac, 2006. **107**(3): p. 137-42; discussion 143-4.

74. Salinas, T.J., et al., *Clinical evaluation of implants in radiated fibula flaps.* J Oral Maxillofac Surg, 2010. **68**(3): p. 524-9.

75. Fenlon, M.R., et al., *Factors affecting survival and usefulness of implants placed in vascularized free composite grafts used in post-head and neck cancer reconstruction.* Clin Implant Dent Relat Res, 2012. **14**(2): p. 266-72.

76. Keller, E.E., et al., *Mandibular endosseous implants and autogenous bone grafting in irradiated tissue: a 10-year retrospective study.* Int J Oral Maxillofac Implants, 1997. **12**(6): p. 800-13.

77. Shugaa-Addin, B., et al., *The effect of radiotherapy on survival of dental implants in head and neck cancer patients.* J Clin Exp Dent, 2016. **8**(2): p. e194-200.

78. Cotic, J., et al., *Implant-prosthetic rehabilitation after radiation treatment in head and neck cancer patients: a case-series report of outcome.* Radiol Oncol, 2017. **51**(1): p. 94-100.

79. Panchal, H., et al., *Dental Implant Survival in Vascularized Bone Flaps: A Systematic Review and Meta-Analysis.* Plast Reconstr Surg, 2020. **146**(3): p. 637-648.

80. Zhang, F., et al., *Mandibular reconstruction with microsurgical bone flap and dental implants.* J Long Term Eff Med Implants, 2004. **14**(4): p. 305-16.

81. Anne-Gaelle, B., et al., *Dental implant placement after mandibular reconstruction by microvascular free fibula flap: current knowledge and remaining questions.* Oral Oncol, 2011. **47**(12): p. 1099-104.

82. Al-Nawas, B., W. Wagner, and P.M. Shah, *Einsatz von Antibiotika in der zahnärztlichen Praxis.* DGZMK-Stellungnahme, 2002.

83. Anderson, L., et al., *The influence of radiation therapy on dental implantology.* Implant Dent, 2013. **22**(1): p. 31-8.

84. Lambert, P.M., H.F. Morris, and S. Ochi, *The influence of 0.12% chlorhexidine digluconate rinses on the incidence of infectious complications and implant success.* J Oral Maxillofac Surg, 1997. **55**(12 Suppl 5): p. 25-30.

85. *Indikationen zur implantologischen 3D-Röntgendiagnostik und navigationsgestützte Implantologie* 2011.

86. Granstrom, G., A. Tjellstrom, and P.I. Branemark, *Osseointegrated implants in irradiated bone: a case-controlled study using adjunctive hyperbaric oxygen therapy.* J Oral Maxillofac Surg, 1999. **57**(5): p. 493-9.

87. Colella, G., et al., *Oral implants in radiated patients: a systematic review.* Int J Oral Maxillofac Implants, 2007. **22**(4): p. 616-22.

88. Esposito, M., et al., *Interventions for replacing missing teeth: hyperbaric oxygen therapy for irradiated patients who require dental implants.* Cochrane Database Syst Rev, 2008(1): p. CD003603.

89. Shah, D.N., C.J. Chauhan, and J.S. Solanki, *Effectiveness of hyperbaric oxygen therapy in irradiated maxillofacial dental implant patients: A systematic review with meta-analysis.* J Indian Prosthodont Soc, 2017. **17**(2): p. 109-119.

90. Pellegrino, G., et al., *Long-term results of osseointegrated implant-based dental rehabilitation in oncology patients reconstructed with a fibula free flap.* Clin Implant Dent Relat Res, 2018. **20**(5): p. 852-859.

91. Chan, M.F., et al., *Oral rehabilitation with implant-retained prostheses following ablative surgery and reconstruction with free flaps.* Int J Oral Maxillofac Implants, 1997. **12**(6): p. 820-7.

92. Ali, A., et al., *Implant rehabilitation of irradiated jaws: a preliminary report.* Int J Oral Maxillofac Implants, 1997. **12**(4): p. 523-6.

93. Beumer, J., 3rd, E. Roumanas, and R. Nishimura, *Advances in osseointegrated implants for dental and facial rehabilitation following major head and neck surgery.* Semin Surg Oncol, 1995. **11**(3): p. 200-7.

94. Moy, P.K., et al., *Dental implant failure rates and associated risk factors.* Int J Oral Maxillofac Implants, 2005. **20**(4): p. 569-77.

95. Menapace, D.C., et al., *Primary vs Secondary Endosseous Implantation After Fibular Free Tissue Reconstruction of the Mandible for Osteoradionecrosis.* JAMA Facial Plast Surg, 2018. **20**(5): p. 401-408.

96. Esser, E. and W. Wagner, *Dental implants following radical oral cancer surgery and adjuvant radiotherapy.* Int J Oral Maxillofac Implants, 1997. **12**(4): p. 552-7.

97. Weischer, T. and C. Mohr, *[Early detection of threatened implant loss in tumor patients].* Mund Kiefer Gesichtschir, 1997. **1**(5): p. 294-9.

98. Mancha de la Plata, M., et al., *Osseointegrated implant rehabilitation of irradiated oral cancer patients.* J Oral Maxillofac Surg, 2012. **70**(5): p. 1052-63.

99. Hertrampf, K. and M. Kunkel, *S2k-Leitlinie Diagnostik und Management von Vorläuferläsionen des oralen Plattenepithelkarzinoms in der Zahn-, Mund- und Kieferheilkunde* 2019.

100. Javed, F., et al., *Implant survival rate after oral cancer therapy: a review.* Oral Oncol, 2010. **46**(12): p. 854-9.

101. Jisander, S., B. Grenthe, and P. Alberius, *Dental implant survival in the irradiated jaw: a preliminary report.* Int J Oral Maxillofac Implants, 1997. **12**(5): p. 643-8.

102. De Ceulaer, J., et al., *Squamous cell carcinoma recurrence around dental implants.* J Oral Maxillofac Surg, 2010. **68**(10): p. 2507-12.

103. Czerninski, R., et al., *Oral squamous cell carcinoma around dental implants.* Quintessence Int, 2006. **37**(9): p. 707-11.

104. Schiegnitz, E., et al., *Oral rehabilitation with dental implants in irradiated patients: a meta-analysis on implant survival.* Clin Oral Investig, 2014. **18**(3): p. 687-98.

105. Nooh, N., *Dental implant survival in irradiated oral cancer patients: a systematic review of the literature.* Int J Oral Maxillofac Implants, 2013. **28**(5): p. 1233-42.

106. Smith Nobrega, A., et al., *Irradiated patients and survival rate of dental implants: A systematic review and meta-analysis.* J Prosthet Dent, 2016. **116**(6): p. 858-866.

107. Chrcanovic, B.R., T. Albrektsson, and A. Wennerberg, *Dental implants in irradiated versus nonirradiated patients: A meta-analysis.* Head Neck, 2016. **38**(3): p. 448-81.

108. Zen Filho, E.V., S. Tolentino Ede, and P.S. Santos, *Viability of dental implants in head and neck irradiated patients: A systematic review.* Head Neck, 2016. **38 Suppl 1**: p. E2229-40.

109. Niimi, A., et al., *Experience with osseointegrated implants placed in irradiated tissues in Japan and the United States.* Int J Oral Maxillofac Implants, 1998. **13**(3): p. 407-11.

110. Buddula, A., et al., *Survival of dental implants in irradiated head and neck cancer patients: a retrospective analysis.* Clin Implant Dent Relat Res, 2012. **14**(5): p. 716-22.

111. Buddula, A., et al., *Survival of turned and roughened dental implants in irradiated head and neck cancer patients: a retrospective analysis.* J Prosthet Dent, 2011. **106**(5): p. 290-6.

112. Asikainen, P., et al., *Osseointegration of dental implants in bone irradiated with 40, 50 or 60 gy doses. An experimental study with beagle dogs.* Clin Oral Implants Res, 1998. **9**(1): p. 20-5.

113. Grötz, K.A., et al., *[Prognosis and prognostic factors of endosseous implants in the irradiated jaw].* Mund Kiefer Gesichtschir, 1999. **3 Suppl 1**: p. S117-24.

114. Klein, M.O., et al., *Functional rehabilitation of mandibular continuity defects using autologous bone and dental implants - prognostic value of bone origin, radiation therapy and implant dimensions.* Eur Surg Res, 2009. **43**(3): p. 269-75.

115. Sammartino, G., et al., *Implant therapy in irradiated patients.* J Craniofac Surg, 2011. **22**(2): p. 443-5.

116. Kovacs, A.F., *Influence of chemotherapy on endosteal implant survival and success in oral cancer patients.* Int J Oral Maxillofac Surg, 2001. **30**(2): p. 144-7.

117. Wöstmann, B. and K.R. Rasche, *Einfluß einer Radiotherapie auf die Überlebenszeit von Zähnen und Zahnersatz.* Zahnärztl Welt, 1995. **104**: p. 627-633.

118. Lazarus, C.L., *Effects of chemoradiotherapy on voice and swallowing.* Curr Opin Otolaryngol Head Neck Surg, 2009. **17**(3): p. 172-8.

Appendix 1 - Statement of the National Association of Statutory Health Insurance Physicians (NASHIP)

Statement of the National Association of Statutory Health Insurance Physicians (NASHIP) regarding the health economic importance and the indication status for statutory insured patients (as of 08/04/2022)

Implants are excluded from obligatory benefits of the statutory health insurance funds according to the German Social Code (SGB) V unless there are exceptional indications for particularly severe cases to be defined by the Federal Joint Committee (G-BA)(until 2004: Federal Committee of Dentists and Health Insurance Funds) in guidelines according to Sec. 92 para. 1 of the German Social Code (SGB) V.

The exceptional indications classified as particularly severe cases by the Federal Joint Committee in Section VII of the Guidelines for adequate, appropriate, and economical statutory dental care (treatment guidelines) include in detail:

a) larger jaw and facial defects which originate

- from tumour surgery,
- inflammation of the jaw,
- in surgery as a result of cysts (e.g., large follicular cysts or keratocysts),
- in surgery following osteopathy if there is no contraindication for implant treatment,
- in congenital malformations of the jaw (lip, jaw, and cleft palate, ectodermal dysplasias) or
- in accidents,

b) existing permanent xerostomia, particularly as part of tumour treatment,

c) generalised congenital dental agenesis,

d) unintentional muscular dysfunctions of the mouth and face (e.g., spasticity).

A precondition for classifying a case as particularly severe is that treatment is part of overall medical treatment. This concept will be explained in more detail below.

The examples mentioned in the indication “surgery for cysts” make it clear that a claim for benefits only exists for larger defects such as keratocysts or large follicular cysts.

If defects result from surgery due to osteopathies, implant treatments are often contra-indicated and need to be examined for individual cases.

It must be noted for the exceptional indication “congenital malformations of the jaw” that the list is not exhaustive. Malformations of a similar extent can also be seen as an exceptional indication. However, the jaw malformation must be the reason for the need for implantological treatment.

If xerostomia (dry mouth) is not only temporary, for example, due to temporary intake of medication, and cannot be remedied through therapeutic measures, it can be classified as permanent extreme xerostomia.

This can be due to tumour treatment, for example. In such cases, dry mouth is often experienced when the large salivary glands are in the radiation field. Radiation with a dose of 50 Gy, in particular, can cause irreversible damage to the salivary glands.

“Generalised congenital dental agenesis” does not only mean complete edentulism but also the congenital absence of the majority of teeth. To distinguish this from complete edentulism, it must be at a stage close to complete edentulism, and when looking at each jaw separately, the majority of the teeth typically found in a person must be missing. It is thus clear that this exceptional indication, apart from other conditions, can only be present if more than 8 teeth are not present in each jaw.

Muscular dysfunction in the mouth and facial area, according to b) require that they cannot be influenced voluntarily. In these cases, the mucosa-supported total prostheses in the patient’s mouth have no support, and there is thus an exceptional indication as there is the risk that these patients could, for example, swallow or aspirate their prosthesis, as can occur with epilepsy. The prerequisite is that the patient is also undergoing regular medical treatment, and there is, thus, an overall medical treatment present. To this end, the underlying disease must be proven by means of medical reports. These patients are cared for at the expense of statutory health insurance companies if conventional prosthetic treatment is not possible, regardless of the load capacity of the prosthesis site.

With extra-oral defects in the facial area after tumour operations or accidents or as a result of congenital agenesis, the primary objective is to cover the defects surgically according to the treatment guidelines. If purely surgical rehabilitation is not possible and the fixation of epitheses for defect closure by other fixation options is ruled out, fixation of epitheses by implants is indicated.

The catalogue of exceptions came into force on 22 September 1998 and was last amended by a decision of the Federal Joint Committee on 01/03/2006 with validity from 18/06/2006.

In addition, the treatment guidelines state that health insurance funds must obtain an expert opinion for all treatment cases with an exceptional indication according to the treatment guidelines. The National Association of Statutory Health Insurance Physicians (NASHIP) and the umbrella organisations of health insurance funds have outlined the details of how the expert opinion should be drafted in binding regulations of the Federal Framework Agreement. The agreement on the expert procedure for implantological services came into force on 01/01/2000 and was last amended by the agreement from 21/12/2021 with entry into force on 01/01/2022.

The health insurance funds cover 100% of the expenses for implantological services including epitheses and/or superstructures as a benefit in kind if the following cumulative prerequisites are met (Sec. 28 para. 2 sentence 9 of the German Social Code (SGB) V in conjunction with the treatment guidelines):

- presence of a “rare exceptional indication for particularly severe cases”
- provision of implantological services "within the framework of an overall medical treatment[1]".

[1] In its judgement of 07/05/2013, the Federal Social Court (BSG) decided that an overall medical treatment in the meaning of Sec. 28 para 2 German Social Code (SGB) V must consist of different medical and dental components without being exhaustive in one of these parts. Rather than merely covering the restoration of the masticatory function, it must have an overall medical objective that characterises the treatment as a whole. The necessity for implant treatment alone will not be sufficient for this. It must rather have an overall medical treatment objective and must not be the main treatment objective of this overall treatment. According to this, cases in which the aim of the implantological treatment does not go beyond the mere provision of dental prostheses to restore the masticatory function are excluded from the outset.

- Conventional prosthetic treatment is not possible without implants

The latter only applies in the above-listed exceptional indication a) to c) of the treatment guideline if the reconstructed prothesis site is not resilient due to a dental prosthesis bearing on the mucous membrane. The resilience of the prosthesis site is only irrelevant in a particularly severe case of muscular dysfunction (Paragraph VII No. 2 d of the Treatment Guideline).

Overall, the stringent requirements of the legislator and the directives of the Joint Federal Committee result in 4 conditions which must be met in order to establish the insured person’s entitlement to benefits:

- A “rare exceptional indication for particularly severe cases” is present.
- Conventional prosthetic treatment is not possible without implants.
- The implantological services are provided “within the framework of an overall medical treatment”.
- The proposed treatment is sufficient, appropriate, and economical and does not go beyond what is necessary.

In 2020, approx. 1,850 implantological assessments were carried out within the Statutory Health Insurance (GKV) framework. In approx. 1,330 cases, the planned treatment complied wholly or partially, so that in these cases, the exceptional indication within the meaning of Sec. 28 para. 2 sentence 9 of the German Social Code (SGB) V was present, which had to be provided at the expense of the statutory health insurance. Treatment is provided either as outpatient or inpatient care. In these cases, outpatient services are invoiced to health insurance funds in accordance with the Private Fee Regulations for Dentists (GOZ) or for Fee Regulations for Doctors (GOÄ).

If the prerequisites for entitlement to benefits of the insured person pursuant to Sec. 28 para. 2 sentence 9 of the German Social Code (SGB) V in connection with the treatment guidelines are not met, the implant restorations are considered purely private services. The insured person is then only entitled to a fixed amount from the health insurance fund according to the prosthetic condition to be treated.

However, in certain exceptional cases, superstructures (implant-supported dentures) are part of the standard treatment of the Statutory Health Insurance (GKV), namely

a) in the case of single-tooth gaps, if there is no need for periodontal treatment, if the adjacent teeth are free of caries and do not need to be crowned or are crowned, and

b) in the case of atrophied edentulous jaws.

The entitlement within the framework of standard treatment is limited to the provision of single crowns in the case of tooth-limited single-tooth gaps according to letter a) and to the provision of complete dentures as contractual dental services in the case of atrophied edentulous jaws according to letter b).

According to this, the need for any further dental treatment measures, such as bone implantation to enable the insertion of a dental implant, should also be irrelevant.

All services related to the implants, such as the implants themselves, the implant abutments and the implant-related connecting elements, are not part of the standard superstructure treatment.

The health insurance fund may forward the submitted treatment plan to an expert to clarify whether a corresponding exceptional case exists. The expert procedure agreed between the National Association of Statutory Health Insurance Physicians (NASHIP) and the Statutory Health Insurance (GKV) umbrella body for the provision of dental prostheses and crowns applies accordingly. The partners of the Federal Framework Agreements regulate further details.

Attachment 2 - Declaration of conflict of interest: Tabular summary

The following is a tabular summary of the declarations of interest, as well as the results of the inspection, evaluation and actions that were decided by the Guideline Group after discussion of the issues and implemented during the consensus conference.

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Prof. Dr Bilal Al-Nawas	aQua Institute	none	Straumann, Camlog, Dentsply, Geistlich, Mectron, German Association of Oral Implantology (DGI), International Team for Implantology (ITI), Osteology	none	Straumann	none	Memberships: German Association of Oral Implantology (DGI), ITI, International Federation of Dental Educators (IFDAE) Focus of scientific/clinical activity: Infections, implantology, oncology, biomaterials, reconstructive surgery Congress of the German Society for Oral and Maxillofacial Surgery (DGMKG)/Professional Association of German Oral Surgeons (BDO), 3D Print Congress	Low, to minimise influences, drafting of the Guideline in a team
Prof. Dr Knut Grötz	none	none	Training institutes of the State Dental Associations: State Dental Association of Hesse (LZKH)/Dental Training Academy Hesse (FAZH), Dental Training Centre Stuttgart (ZFZ Stuttgart), State Dental Association Saxony-Anhalt (ZÄK Sachsen-Anhalt), Advanced Training Forum for	none	none	none	Memberships: President of the German Association of Oral Implantology (DGI), ITI Fellow, German Society for Oral and Maxillofacial Surgery (DGMKG), Professional Association of German Oral Surgeons (BDO) Focus of scientific/clinical activity: Treatment of risk patients Congress presidencies	Low, due to the role as Guideline coordinator abstinence from all votes to minimise any influence, drafting of the Guideline as part of a team

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			Dentists Freiburg (FFZ Freiburg) Training institutes of the university: Münster University Hospital Companies/businesses: Straumann GmbH, Dentsply, Mectron GmbH, Cellpharm GmbH, Meisinger Publishers/service providers for congress organisation: Oemus Media AG, Med-Update GmbH, Boeld GmbH, Deutscher Ärzte-Verlag, Rosenberg Zürich scientific and professional societies: German Association of Oral Implantology (DGI) and regional associations (LVs)/quality circles (QZs) of the German Association of Oral Implantology (DGI), ITI, German Society for Oral and Maxillofacial Surgery (DGMKG), Professional Association of German Oral Surgeons (BDO),					

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			German Association of Oral Implantology(DGOI), Dental Society Hesse (ZGH), Administrative Centre Stuttgart (VWZ Stuttgart)					
PD Dr Eik Schiegnitz	none	none	State Dental Association Rhineland-Palatinate Companies: Straumann, Septodont, Geistlich, Dentsply, Sanofi, Mectron Congress organisation: Oemus Media AG, Boeld GmbH, scientific and professional societies: German Association of Oral Implantology (DGI) and regional associations (LVs)/quality circles (QZs) of the German Association of Oral Implantology (DGI), ITI, German Society for Oral and Maxillofacial Surgery (DGMKG), German Association of	none	Straumann, Botiss, Geistlich, Dentsply, ITI	none	Memberships: German Association of Oral Implantology (DGI), German Society for Oral and Maxillofacial Surgery (DGMKG), ITI Focus of scientific/clinical activity: Implantology, jaw necrosis, oncology, biomaterials, reconstructive surgery	Low, to minimise influences, drafting of the Guideline in a team

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			Oral Implantology(DGOI)					
Dr Lena Katharina Müller-Heupt	none	Farmako GmbH (medical cannabis)	none	Springer, Spitta, MVG Verlag	Profil GmbH (metabolic disorders)	none	Memberships: 1. Chair DEVELOpmed. aid e.V. Focus of scientific/clinical activity: Oral microbiology, periodontitis, peri-implantitis, tissue engineering, metabolic disorders, cranio-maxillofacial surgery (MCG) research physician	No topical relevance, no consequence
Prof. Dr Robert Sader	German Research Foundation (DFG)	German Society for MCG Surgery (DGMKG), Int. Fed. of Esthetic Dentistry, Int. Foundation for Cleft Lip and Palate, Oral Reconstruction Found., Int. Fed. of Esthetic Dentistry, Intern. Congress of Oral Implantology, Osteo Science Foundation	Oral Reconstruction Found., Intern. Congress of Oral Implantology, German Society of Oral Implantology, Academy for Practice and Science (APW) of the German Society of Dentistry and Oral Medicine (DGZMK), Goethe University Frankfurt, Company Bien-Air, Camlog, Henry Schein, Geistlich, Straumann, Mectron	none	Camlog, Nobelbiocare, Straumann, Mectron, Geistlich, Bien-Air, Megagen	none	Scientific focus Replacement and regeneration of oral hard and soft tissues, cleft lip and palate surgery, oncological MCG surgery Clinical focus Cleft lip and palate, oncological MCG surgery, dental implantology Memberships: President of the German Society for Aesthetic Dentistry, German Society for MCG Surgery (scientific Advisory Board), German Society of Dentistry and Oral Medicine (DGZMK) (extended Board), Int. Federation Esthetic Dentistry (Board), Int. Cleft Lip and Palate Foundation (extended Board), German Association of Oral Implantology (DGI) (Board Hesse Section), German Society for Surgery (DGCH), Austrian Society for Surgery (OEGCH), Swiss Society for Maxillofacial Surgery (SGMKG), Europ. Society for MCG Surgery, Intern. Society for MCG Surgery, Working Group for Maxillofacial Surgery (AGKi) of the German Society of Dentistry and Oral Medicine (DGZMK), Austrian Society for	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							Cleft Lip and Palate, American Cleft Palate Association, German Society of Plastic/Reconstructive Surgery, German Association of Oral Implantology(DGOI), International Congress of Oral Implantologists (ICOI) (Board), German Society for Ultrasound in Medicine (DEGUM), Pierre Fouchard Academy, Association for Medical Education, Dentista, Association of the Study of Internal Fixation (AO), Int. Bone Research Association (IBRA), German Society for Military Medicine and Military Pharmacy (DGWMP)	
PD Dr Keyvan Sagheb	none	none	Straumann, Geistlich, Nobel, Camlog	none	Camlog	none	Focus of scientific/clinical activity: Augmentations, implantology, oncology Memberships: German Society of Dentistry and Oral Medicine (DGZMK), German Association of Oral Implantology (DGI), German Society for Oral and Maxillofacial Surgery (DGMKG), German Society for Ultrasound in Medicine (DEGUM), Working Group for Maxillofacial Surgery (AGKi), Working Group for Radiology (ARö), International Association for Dental Research (IADR), Association of Oral Pathology and Oral Medicine (AKOPOM), Free Association of German Dentists (FVDZ), German-Austrian-Swiss Working Group for Tumours in the Maxillofacial Region (DÖSAK), ITI, Camlog Connect, FOR	Low, no consequence since no leadership role
Prof. Dr Christian Walter	none	none	Straumann	none	Straumann, Pluradent	none	Focus of scientific/clinical activity: Osteonecrosis associated with medicinal products, implantology, dentoalveolar surgery, implantology, periodontology, dermatosurgery	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							Memberships: German Society of Dentistry and Oral Medicine (DGZMK), German Association of Oral Implantology (DGI), German Society for Oral and Maxillofacial Surgery (DGMKG), German Society for Ultrasound in Medicine (DEGUM), Working Group for Maxillofacial Surgery (AGKi), Working Group for Radiology (ARö), International Association for Dental Research (IADR), Association of Oral Pathology and Oral Medicine (AKOPOM), Free Association of German Dentists (FVDZ), German-Austrian-Swiss Working Group for Tumours in the Maxillofacial Region (DÖSAK), ITI, Camlog Connect, FOR	
Prof. Dr Shahram Ghanaati	none	none	Geistlich, Mectron, Camlog	none	Geistlich	none	Focus of scientific/clinical activity: Biomaterials research, biologisation of biomaterials, onco-surgery and reconstruction, platelet-rich-fibrin (PRF) Memberships: DGMKG	No topical relevance to the Guideline, no consequence
Prof. Dr rer.nat. Dipl.-Phys. Christoph Bourauel	none	none	Society for Orthodontics of Berlin and Brandenburg, State Dental Association Saxony (ZÄK Sachsen), State Dental Association Hesse (ZÄK Hessen), German Centre for Oral Implantology (DZOI e.V.), Dr Lentrodt, University of Zurich, State Dental Association Rhineland Palatine (LZK Rheinland-Pfalz), Al	none	none	none	Work focused in the field of dental biomechanics, materials science, corrosion, biocompatibility, fatigue loading Not clinically active Memberships: German Institute for Standardisation (DIN), Obmann, Working Committee for Orthodontic Products, Conventor ISO 106, WG 17, orthodontic anchors (until 2018)	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			Wehda Medical Center, Company Work4smile					
Rainer Struck	none	none	none	none	none	none	Focus: none Memberships: Association of German Dental Technicians Guilds (VDZI)	none
PD Dr Aydin Gülses	none	none	none	none	none	none	Focus: none Memberships: none	none
Dr Jörg Beck	none	none	none	none	none	none	Focus: none Memberships: Employee of the National Association of Statutory Health Insurance Physicians (NASHIP)	none
Prof. Dr Henning Schliephake	none	none	none	none	none	none	Scientific focus: Oncological reconstructive surgery/regenerative medicine Clinical focus: Oncological reconstructive surgery/malformation surgery Memberships: European Association for Osseointegration (EAO)/President 2018-2020	none
Thomas Müller	none	none	none	none	none	none	Focus: none Memberships: none	none
Karola Will	none	none	none	none	none	none	Focus: none Memberships: none	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Dr Jens Nagaba	none	none	none	none	none	none	Focus: none Memberships: Employee of the Federal Dental Association (BZÄK)	none
Dr Mohamed Sad Chaar	none	none	none	none	none	none	Focus: Dental prosthetics, materials science, implant prosthetics Memberships: none	none
Sylvia Gabel	none	none	none	none	none	none	Focus: none Memberships: none	none
Dr Christian Hammächer	none	none	Camlog	Scientific publications and book projects (Teamwork-media)	none	none	Scientific focus: Lectureship at the Clinic for Dental Prosthetics at the Rhine-Westphalia Technical University of Aachen (RWTH Aachen), lectureship at the Academy for Practice and Science (APW) and master’s degree programmes, publications in the fields of implantology/periodontology Clinical focus: Implantology, periodontology, prosthetics, in particular in the aesthetic field Memberships: Member of the Board of the German Association of Oral Implantology (DGI) Lead participation in further training: German Association of Oral Implantology (DGI), Academy for Practice and Science (APW), congresses, workshops	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
PD Dr Jonas Lorenz	Various courts	none	Geistlich Vertriebsgesellschaft mbH, Camlog, German Association of Oral Implantology (DGI), State Dental Association Hesse (LZÄK Hessen), German Society for Aesthetic Dentistry (DGÄZ)	Independent	Third-party funding Geistlich, Camlog, Straumann, Oral Reconstruction Foundation	none	Scientific focus: Implantology, biomaterials research Clinical focus: Implantology, oral surgery Memberships: German Association of Oral Implantology (DGI), German Society of Dentistry and Oral Medicine (DGZMK), German Society for Aesthetic Dentistry (DGÄZ), Board of the Hesse National Association of the German Association of Oral Implantology (DGI)	Low, no consequence since no leadership role
PD Dr Hendrik Naujokat	none	none	Osteology Foundation	none	Dentsply Sirona, Osteology Foundation	none	Focus: none Memberships: none	Low, no consequence since no leadership role
PD Dr Kristian Kniha	none	none	none	none	Working Group Start of the RWTH Aachen University, German Federal Ministry for Economic Affairs and Energy (BMWI) (Working Group of Industrial Research Associations (AIF)), ITI Large Grand	none	Scientific focus: Dental implants, ceramic implants, explantation with biophysical methods Clinical focus: Implantology Memberships: ITI, Professional Association of German Oral Surgeons (BDO)	No topical relevance to the Guideline, no consequence
Prof. Dr Jürgen Hoffmann	MSD	MSD	MSD, KLS Martin, Straumann, Geistlich	none	none	none	Clinical focus: The treatment of patients with sarcoma diseases is part of the treatment spectrum of our clinic Memberships: German Society for Oral and Maxillofacial Surgery (DGMKG), Working Group	MSD: bears no reference. Other: Low, no consequence

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							for Maxillofacial Surgery (AGKi), Germany Society of Surgery (DGCh) Lead participation in further training/training institutions: Medical Director of the Clinic and Polyclinic for MCG Surgery	since no leadership role
Dr Elisabeth Jacobi-Gresser	none	none	Dentalpoint/CH	Research group Olmedo	Olmedo et al, University of Buenos Aires, Argentina	none	Focus points: none Memberships: none	Low, no consequence since no leadership role
Karin-Annette Dick	none	none	none	none	none	none	Focus point: none Memberships: none	none
Prof. Dr Fouad Khoury	Dentsply, Sirona, Stoma, International Medical Center (IMC), Meisinger	Dentsply, Sirona	Dentsply, Sirona, Meisinger, German Association of Oral Implantology (DGI), Working Group for Osteosynthesis (AO USA), Individuals with Disabilities Education Act USA (IDEA USA), American Association of Oral and Maxillofacial Surgeons (AAOMS USA), New York University College of Dentistry (NYU USA), Santa Monica, Spain, EAO, ICOI, Spanish Society of Periodontics and Osseointegration	none	FDI, peri-implantitis study	none	Scientific focus: Bone augmentation with autogenous bone, soft tissue management/soft tissue augmentation, peri-implantitis treatment Clinical focus: Implantology, oral surgery, bone augmentation with autogenous bone, soft tissue management/soft tissue augmentation, tooth transplantation, peri-implantitis treatment Memberships: Working Group for Maxillofacial Surgery (AGKi), Professional Association of German Oral Surgeons (BDO) Lead participation in further training/training institutions: Private Clinic Schloss Schellenstein	Low, no consequence since no leadership role (consultant/expert activity and advisory board, not relevant to the topic)

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			(SEPA), Professional Association of German Oral Surgeons (BDO), Health AG, Quintessenz, NW, Urban Regeneration Institute Budapest, German Society for Implant Dentists (BDIZ), Catholic University of Murcia Spain (UCAM) Study group for restorative dentistry, Spanish Society of Dental Implantology (SCOI Spain), ITI, Portuguese Dental Association, Czech Society for Oral Surgery, World Dental Federation (FDI)					
Dr Arzu Tuna	none	none	none	none	none	none	Focus: none Memberships: none	none
Dr Wolfgang Jakobs, MSc	none	none	German Association of Oral Implantology (DGI), German Association of Oral Implantology(DGOI), German Society of Dentistry and Oral Medicine (DGZMK),	Sedation, alveolaris inferior (LA), dental anaesthesia, implantology	Implantology, local anaesthesia, dental anaesthesia	none	Scientific focus: Dental anaesthesia Clinical focus: Implantology, oral surgery Memberships: BDO Lead participation in further training/training institutions: Private dental clinic IZI GmbH	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			Professional Association of German Oral Surgeons (BDO), German Society for Oral and Maxillofacial Surgery (DGMKG), University for Digital Technologies in Medicine and Dentistry (DTMD), University Luxembourg, etc.	, sedation procedures				
PD Dr Raluca Cosgarea	none	none	New Working Group for Periodontology (NAgP), DTMD, State Dental Association Rhineland Palatine (ZÄK Rheinland-Pfalz), District Dental Association (BZK), German Society of Periodontology (DG Paro)	none	Bredent, Periotabs, Geistlich, Botiss	none	Scientific focus: Anti-infectious and anti-inflammatory therapies in the treatment of periodontitis, microbiological and immunological aspects in periodontitis/peri-implantitis, biomaterials for the regeneration of vertical intrabony defects and the surgical treatment of gingival recessions, periodontitis and rheumatoid diseases, treatments for oral lichen planus and other bullous diseases with oral manifestations Clinical focus: Surgical and non-surgical treatment of periodontitis, mucogingival periodontal surgery, surgical and non-surgical treatment of peri-implantitis Memberships: German Society of Periodontology (DG Paro), International Academy of Periodontology (IAP)	Low, no consequence since no leadership role
Dr Jörg-Ulf Wiegner	none	none	Camlog, Geistlich, Dentsply	none	Camlog	none	Scientific focus: Implantology Clinical focus: Implantology	Low, no consequence

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							Membership: German Society for Oral and Maxillofacial Surgery (DGMKG), German Society of Dentistry and Oral Medicine (DGZMK), Germany Society of Surgery (DGCh), German Association of Oral Implantology (DGI), ICOI, European Centres for Dental Implantology (ECDI), Federal Association of Company Health Insurance Funds (BdB), British Association of Otolaryngologists (BAO), Belfast Dental Care (BDC) Lead participation in further training/training institutions: German Society for Oral and Maxillofacial Surgery (DGMKG) Professional Association (BV)	since no leadership role
Lutz Höhne	none	none	DEGUZ	University Medicine Göttingen (UMG) Professional journals of the environmental medical associations	none	none	Scientific focus: none Clinical focus: Practising dentist until the beginning of 2021, now working for the German Society for Environmental Dentistry (DEGUZ) and giving lectures Memberships: German Society for Environmental Dentistry (DEGUZ), Guideline officer, advisor, German Professional Association of Environmental Physicians (dbu), European Academy for Environmental Medicine (Europaem) Lead participation in further training/training institutions German Society for Environmental Dentistry (DEGUZ), Head for the curriculum on environmental dentistry	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Dr Torsten Conrad, MSc	District Dental Association for Rhenish Hesse (BZK Rheinhessen)	none	Mectron, Camlog, District Dental Association for Rhenish Hesse (BZK Rheinhessen), State Dental Association Rhineland Palatine (LZK Rheinland-Pfalz), Oemus, German Association of Oral Implantology (DGI)	Multidisciplinary Digital Publishing Institute (MDPI)	Nanotechnology/Bioengineering Centre (NIBEC), University Hospital Frankfurt Clinic for Maxillofacial and Plastic Surgery (MKPG Frankfurt)	none	Scientific focus: none Clinical focus: none Memberships: DGI	Low, no consequence since no leadership role
Prof. Dr Anne Wolowski	none	Dentsply	none	none	none	none	Scientific focus: Psychosomatics, dentistry for the elderly, functional disorders Clinical focus: Prosthetics, psychosomatic, geriatric dentistry, functional disorders Memberships: German Society of Dentistry and Oral Medicine (DGZMK), German Society for Prosthetic Dentistry and Biomaterials (DG Pro), German Society for Functional Diagnostics and Therapy (DGFDT), Working Group for Psychology and Psychosomatics (AKPP), Konrad-Morgenroth Förderergesellschaft (KMFG) Lead participation in further training/training institutions: Teaching at the University of Münster, curriculum psychosomatic basic competence of the Working Group for Psychology and Psychosomatics (AKPP)/Academy for Practice and Science (APW)	Low, no consequence since no leadership role (advisory board not relevant to the topic)

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Dr Mathias Sommer, MSc	State Dental Association North Rhine-Westphalia (ZÄK NRW)	none	Dentsply, Academy for Practice and Science (APW) of the German Association of Oral Implantology (DGI)	none	none	none	Scientific focus: Implantological case studies Clinical focus: General dental, oral surgery and implantological activities Memberships: Professional Association of German Oral Surgeons (BDO), German Association of Oral Implantology (DGI)	Low, no consequence since no leadership role
Prof. Dr Jörg Wiltfang	Courts	DGMKG	German Association of Oral Implantology (DGI)/Academy for Practice and Science (APW), State Dental Association Kiel (ZÄK Kiel), Academy of Karlsruhe (Akademie Karlsruhe)	Multiple publications	Multiple studies	none	Scientific focus: Bone regeneration, malformations, implantology Focus clinical tumour surgery, malformation surgery, implantology, traumatology, dysgnathia surgery Memberships: German Society for Oral and Maxillofacial Surgery (DGMKG), German Society of Dentistry and Oral Medicine (DGZMK), Schleswig-Holstein Society for Dental, Oral and Maxillofacial Medicine (SHGMZK), German Association of Oral Implantology (DGI), European Academy for Advanced Training in Medicine and Dentistry (EFMZ) Lead participation in further training/training institutions: State Dental Association Kiel (ZÄK Kiel) - curriculum for implantology/periodontology	Low, no consequence since no leadership role
Dr Martin Keweloh	none	none	Humantech/Steinenbronn	Prof. Mertens, University of Heidelberg	Geistlich	none	Scientific focus: Socket preservation, peri-implant soft tissue replacement Clinical focus: see above Memberships: none	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							Lead participation in further training/training institutions: Curriculum for implantology, German Society for Oral and Maxillofacial Surgery (DGMKG)	
Prof. Dr Pit Voss	KLS Martin	none	none	none	none	none	Scientific focus: Medication related osteonecrosis of the jaw (MRONJ) Clinical focus: Medication related osteonecrosis of the jaw (MRONJ) Memberships: none	Low, no consequence since no leadership role
Prof. Dr Frank Schwarz	none	Osteology Foundation, Lucerne, Switzerland, Executive Board Member	Geistlich Pharma AG, Osteology Foundation	International journals	Osteology Foundation, Lucerne, Switzerland	none	Scientific focus: Research focus: Aetiology, pathogenesis, diagnostics and treatment of peri-implant infections Clinical focus: Treatment peri-implant infections Memberships: none	Low or not relevant to the topic, no consequence since no leadership role
Dr Jan Tetsch, MSc, MSc	none	none	German Association of Oral Implantology (DGI), Academy for Practice and Science (APW), State Dental Association (ZÄK)	none	none	none	Scientific focus: Implantology/surgery and prosthetics/implants in the adolescent jaw Clinical focus: Implantology/surgery and prosthetics/implants in the adolescent jaw Memberships: German Association of Oral Implantology (DGI), German Society for Implant Dentists (BDIZ), German Society of Dentistry and Oral Medicine (DGZMK) Lead participation in further training/training institutions: Training courses German Association of Oral Implantology (DGI)/Academy for Practice	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							and Science (APW) and State Dental Association (ZÄK)	
Dr Sarah Al-Maawi	none	none	none	none	none	none	Scientific focus: Biomaterials research, biologisation of biomaterials Clinical focus: Regenerative medicine and biomaterials research Memberships: none	none
Dr Anette Strunz	Camlog	none	Camlog, Geistlich, Sirona, Philipp Pfaff Institute	none	none	none	Scientific focus: none Clinical focus: Implantology, navigation Memberships: Press spokesperson for the German Association of Oral Implantology (DGI) Lead participation in further training/training institutions: Curriculum for implantology, Philipp Pfaff Institute Berlin	Low, no consequence since no leadership role
Prof. Dr h.c. (mult.), MS, PhD Anton Sculean	none	Osteology Foundation, Lucerne, Switzerland, Board Member	Geistlich Pharma AG; Osteology Foundation, Straumann AG, Basel, Switzerland; Camlog, Wimsheim, Germany	International journals	none	none	Scientific focus: Reconstructive periodontal surgery, management of soft tissue defects of the tooth and implant, treatment of peri-implant infections Clinical focus: Reconstructive periodontal surgery, management of soft tissue defects of the tooth and implant Memberships: none	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Prof. Dr Hendrik Terheyden	none	none	Dentaurum, Meisinger, Geistlich	none	none	none	Scientific focus: Augmentation surgery Clinical focus: General jaw surgery at the Clinic, implant surgery in private practice Memberships: German Association of Oral Implantology (DGI), German Society of Dentistry and Oral Medicine (DGZMK), Association of University Teachers for Dentistry, Oral Medicine and Maxillofacial Medicine (VHZMK), EAO, International Association of Oral and Maxillofacial Surgeons (IAOMS), European Association for Cranio-Maxillofacial Surgery (EACMFS), Working Group for Maxillofacial Surgery (AGKi) Lead participation in further training/training institutions: Strasbourg Osteosynthesis Research Group (SORG) (Board member of the Section Preprothetic), International Academy for Oral and Facial Rehabilitation (IAOFR) (Board member of the Section Preprothetic)	Low, no consequence since no leadership role
Dr Jörg Munack, MSc, MSc	none	none	none	none	none	none	none	none
Prof. (adj.) Dr Sebastian Zingler	none	none	none	none	none	none	Scientific focus: none Clinical focus: none Memberships: none	none
Dr Stefan Liepe	none	none	none	none	none	none	Scientific focus: none Clinical focus: none	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							Memberships: European Association of Dental Implantologists (BDIZ EDI), Board	
Dr Markus Blume	none	none	Cranium GbR	none	none	none	Scientific focus: Dental transplantation, implantology, oral surgery Clinical focus: Dental transplantation, implantology, oral surgery Memberships: German Association of Oral Implantology (DGI), Professional Association of German Internists (BDI) training advisor Lead participation in further training/training institutions: Dental volume tomography (DVT) diagnostics, further education	Low, no consequence since no leadership role
Dr Martin Ullner	Association of Statutory Health Insurance Dentists of Hesse (KZVH) Board officer for Oral Surgery Member of the Joint Complaints Committee and scaling and root planting (SRP) State Dental Association of Hesse (LZKH)	none	none	none	none	none	Scientific focus: none Clinical focus: none Memberships: Professional Association of German Oral Surgeons (BDO), 2. federal chair	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
	Further Education Committee for Oral Surgery Delegate Association of Statutory Health Insurance Dentists of Hesse (KZVH), State Dental Association of Hesse (LZKH) Delegate for Federal Dental Association (BZÄK)							
Dr Martin Bonsmann	none	none	German Association of Oral Implantology (DGI), German Society for Oral and Maxillofacial Surgery (DGMKG), State Dental Association North Rhine (ZÄK Nordrhein), State Dental Association Westphalia/Lippe (ZÄK Westfalen/Lippe), numerous firms such as: Camlog, Nobel, Geistlich, Hager +	Springer Verlag	none	none	Scientific focus: none Clinical focus: none Memberships: German Society for Oral and Maxillofacial Surgery (DGMKG), German Association of Oral Implantology (DGI)	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			Meisinger, Straumann, Dental Ratio					
Dr Eleonore Behrens	none	none	none	none	none	none	Scientific focus: none Clinical focus: none Memberships: none	none
Prof. Dr Florian Beuer, MME	none	Henry Schein, Prosec	Academy for Practice and Science (APW), IvoclarVivadent, German Association of Oral Implantology (DGI), Nobel Biocare, Oral Reconstruction Foundation (ORF)	none	IvoclarVivadent, ORF, German Association of Oral Implantology (DGI), Bego	Mitsui	Scientific focus: Implantology, implant prosthetics, digital dentistry Clinical focus: Implantology, implant prosthetics, digital dentistry Memberships: German Association of Oral Implantology (DGI), Prosec Scientific Board, ITI Lead participation in further training/training institutions: Head of Dentistry Charité University Medicine Berlin, Steinbeis University of Applied Sciences	Low, no consequence since no leadership role (advisory board not relevant to the topic), no consequence
Prof. Dr Michael Gahlert	none	Journal Ceramic Implants and European Society of Ceramic Implants	Straumann Group Basel	Pre-reviewed journals	ITI	none	Scientific focus: Research regarding ceramic implants with diverse scientific publications Clinical focus: Oral surgery, implantology Memberships: ITI, German Association of Oral Implantology (DGI), European Society of Ceramic Implantology	Low, no consequence since no leadership role
Dr Karina Obreja	none	none	Dental Training Academy Hesse (FAZH)/State Dental	National and international journals	none	none	Scientific focus: Oral surgery, implantology, peri-implant infections	Low, no consequence

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			Association of Hesse (LZKH)				Clinical focus: Oral surgery, implantology, peri-implant infections Memberships: none	since no leadership role
Katrin Reinicke	none	none	none	none	none	none	Scientific focus: none Clinical focus: none Memberships: none	none
PD Dr, Stefan Röhling	none	European Society for Ceramic Implantology, vice president	Straumann Group	none	International Team for Implantology	none	Scientific focus: Ceramic implants Clinical focus: Implantology Memberships: ITI, European Society for Ceramic Implantology, vice president, German Association of Oral Implantology (DGI), German Society of Dentistry and Oral Medicine (DGZMK)	Low, no consequence since no leadership role
Dr Navid Salehi	none	none	none	none	none	none	Scientific focus: none Clinical focus: none Memberships: Board member German Society for Dental Implantology (DGZI)	none
Prof. Dr Henrik Dommisch	District Court Berlin, Regional Court Berlin, CP-GABA GABA Prevention Award, German Cancer Aid, expert opinions for national and	Charité Research Commission, Journal of Periodontology, Quintessenz Verlag, Journal ZM	State Dental Association Hesse (Zahnärztekammer Hessen), Further Education Institute, German Society for Endodontology and Dental Traumatology (Deutsche Gesellschaft	J Periodontal Res., J Dent Res., Hum Mol Genet, J Clin Periodontol, J. Periodontol, Eur J Hum	Company Kreussler Pharmaceutics Company Novartis Charité Foundation (Stiftung Charité) German Research Foundation	none	Scientific focus: Genetic risk factors of periodontitis, innate immune response of oral cells and tissues, nanocarriers in the context of anti-inflammatory treatment of oral inflammatory diseases Clinical focus: Treatment of periodontal and peri-implant diseases and conditions (resective and regenerative surgical treatment),	Low, no consequence since no leadership role

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
	international journals (Journal of Clinical Periodontology, Journal of Periodontology, Journal of Periodontal Research, German Dental Journal (DZZ), PLOS One, Connective Tissue, Journal of Dental Research, Periodontology, Junger Zahnarzt, wissen kompakt)	(Dental Bulletins) up-2-date, Thieme Verlag, German Dental Journal (DZZ), Deutscher Ärzte-Verlag (German Medical Publishers)	für Endodontologie und Zahnärztliche Traumatologie), State Dental Association Hamburg (Zahnärztekammer Hamburg), State Dental Association Freiburg (Zahnärztekammer Freiburg), Association of German Dental Hygienists (Bund Deutscher Dentalhygieniker), German Society for Prosthetic Dentistry and Biomaterials (DGPro), European Membrane Society (EMS) Webinar, University of Freiburg PPI, State Dental Association Berlin (Zahnärztekammer Berlin), PPI, State Dental Association Berlin (Zahnärztekammer Berlin), Zeiss, German Association of Oral Implantology (DGI) curriculum, Professional Association of German Oral Surgeons (BDO), German Society for Oral and Maxillofacial Surgery (DGMKG), PPI,	Genet, Periodontol 2000, Sci Rep., Clin Oral Investig, Clin Epigenetics, Cells Tissues Organs, Tissue Barriers, Hypertension, Int. Endod J., German Physician’s Insurance (DÄV), Quintessenz Verlage	(Deutsche Forschungsgemeinschaft)		endodontological treatment of pulpal and periapical diseases Memberships: German Society of Periodontology (DG Paro), Berlin Society of Periodontology (DG Paro), EFP, German Society of Dentistry and Oral Medicine (DGZMK), Working Group for Basic Research (AfG), IADR, German Society for Endodontology and Dental Traumatology (DGET) Lead participation in further training/training institutions: Clinical Director of Advanced Training for Dental Hygienists, Philipp Pfaff Institute, State Dental Association Berlin (Zahnärztekammer Berlin)	

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
			State Dental Association Berlin (Zahnärztekammer Berlin), PPI, State Dental Association Berlin (Zahnärztekammer Berlin), State Dental Association Hamburg (Zahnärztekammer Hamburg), State Dental Association Lower Saxony (Zahnärztekammer Niedersachsen), State Dental Association Upper Palatine (Zahnärztekammer Oberpfalz), State Dental Association Schleswig-Holstein (Zahnärztekammer Schleswig-Holstein), Neue Gruppe, Med Update, European Federation of Periodontology (EFP), State Dental Association Berlin (Zahnärztekammer Berlin), German Society of Periodontology (DG Paro), Academy for Practice and Science (APW)					

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Dr Juliane Wagner	none	none	none	none	none	none	Scientific focus: Inflammation research, peri-implantitis, periodontitis Memberships: none	none
Dr Jochem König	none	none	none	none	none	none	Scientific focus: Biometric-methodological publications (network meta-analysis), participation in clinical studies and healthcare research projects as a methodologist Clinical focus: none Memberships: Work Group German Society for Medical Informatics, Biometry and Epidemiology (FG GMDS), German Region of the International Biometric Society (IBS-DR), Classification Society (Gesellschaft für Klassifikation), International Society for Computational Biology (ISCB)	none
Dr Daniel Thiem	none	none	Sanofi	none	none	none	Memberships: BDO Focus of scientific/clinical activity: Reconstructive surgery, dysgnathia surgery, implantology	No topical relevance, no consequence
Dr Ausra Ramanauskaite, PhD	none	none	none	International journals	Osteology Foundation, Lucerne, Switzerland	none	Scientific focus: Aetiology, pathogenesis, diagnostics and treatment of peri-implant infections Clinical focus: Treatment peri-implant infections Memberships: none	No topical relevance, no consequence
Dr Weber, Anke	none	none	none	none	none	none	Member: German Society of Dentistry and Oral Medicine (DGZMK), Guideline officer	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							Member: German Society of Dentistry and Oral Medicine (DGZMK), member Research activities: none Clinical activities: none Participation in continuous training/training: none Personal relationship: none	
Dr Birgit Marré	Certified expert for forensic dental age assessment	none	none	none	Randomised Shortened Dental Arch (RaSDA) study	none	Member: German Society of Dentistry and Oral Medicine (DGZMK) - Guideline officer Member: German Society of Dentistry and Oral Medicine (DGZMK), Working Circle for Forensic Odontostomatology (AKFOS), German Society for Functional Diagnostics and Therapy (DGFDT), German Society for Prosthetic Dentistry and Biomaterials (DGPro), Working Group for the Further Development of Teaching in Dentistry (AKWLZ) - member Scientific activity: dental prosthetics Participation in continuous training/training: yes Personal relationship: none	none
Dr Wolfgang Neumann	none	none	none	none	none	none	Scientific focus: none Clinical focus: none Membership: Treasurer for European Association of Dental Implantologists (BDIZ EDI)	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Prof. Dr Tobias Fretwurst	none	National Osteology Group Germany	Camlog Germany, ITI, Medentis, Osteology Foundation, Geistlich	none	Oral Reconstruction Foundation	none	Scientific focus: Peri-implantitis treatment, complex augmentation Clinical focus: Peri-implantitis treatment, complex augmentation Memberships: German Association of Oral Implantology (DGI) (not a mandate holder), German Society of Dentistry and Oral Medicine (DGZMK) (no mandate holder), Dental Association Upper Rhine (Oberrheinische Zahnärztegesellschaft) (scientific advisory board)	No topical relevance, no consequence
Dr Carla Schliephake	none	none	none	none	none	none	none	none
Prof. Dr Ina Kopp	German Accreditation Body (DakkS)	aQua Institute (aQua-Institut), Scientific Advisory Board for the Institute for Quality and Transparency in Healthcare (IQTIG), German Agency for Quality in Medicine (ÄZQ), Austrian	German Association of Oral Implantology (DGI), German Digital Healthcare Act (DVG), 32nd German Cancer Congress (Deutscher Krebskongress), Foundation for Health Knowledge (Stiftung Gesundheitswissen), State Medical Association Hesse (LÄK), Academy of Public Health (Akademie Öffentliches Gesundheitswesen), German Pain Congress (Deutscher	Schattauer Verlag	German Cancer Aid (DKH), German Federal Ministry of Health (BMG), German Research Foundation (DFG)	none	Scientific focus: Guidelines, quality management, healthcare research Memberships: Association of the Scientific Medical Societies (AWMF), Clinical Cancer Register, Extended Planning Group for the Programme for National Health Services of the Federal Dental Association (BZÄK), National Association of Statutory Health Insurance Physicians (NASHIP) and Association of the Scientific Medical Societies (AWMF), Steering Committee for the Guideline programme Oncology of the German Cancer Society, German Cancer Aid and Association of the Scientific Medical Societies (AWMF), Steering Committee of the Cooperation Network for Quality Assurance through Clinical Cancer Registers, Standing Committee for the Guidelines for the Association	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
		Society for Dermatology and Venereology (ÖGDV),	Schmerzkongress), Evidence-based medicine Frankfurt (EBM Frankfurt), 33rd German Cancer Congress (Deutscher Krebskongress), European Union Member State Exit (EUMSE) coordination, Institute for Medical Biostatistics, Epidemiology and Informatics (IMBEI), 34th Annual Meeting of the Working Group of the Ltd. (Jahrestagung AG der Ltd.) Hospital Doctors				of the Scientific Medical Societies (AWMF) (Vice-Chair) Guidelines International Network, German Evidence-Based Medicine Network, German Society for Surgery, Expert Advisory Board for the National Healthcare Guidelines Programme of the Federal Dental Association (BZÄK), National Association of Statutory Health Insurance Physicians (NASHIP) and Association of the Scientific Medical Societies (AWMF) Lead participation in further training/training institutions: Guideline seminars of the Association of the Scientific Medical Societies (AWMF) for guideline developers and the curriculum for guideline consultants, advanced seminars of the guidelines of the Association of the Scientific Medical Societies (AWMF) for guideline developers, workshops of the guideline programme oncology	
Dr Cathleen Muche-Borowski	none	none	Antibiotic Stewardship (ABS) course Bonn of the Westphalia-Lippe Pharmacy Foundation (Apothekerkammer Westfalen-Lippe), Berlin University of Mainz	none	German Research Foundation (DFG), German Federal Ministry of Education and Research (BMBF), Federal Joint Committee (G-BA) (Innovation Fund), Institute for Quality and Efficiency in Healthcare (IQWiG), Central Institute (Zi), Association of Statutory Health Insurance Physicians	none	Scientific focus: Co-author Multimorbidity Guideline, lead author publication on Multimorbidity Guideline, co-author Association of the Scientific Medical Societies (AWMF) rulebook, publications on Allergy Prevention Guidelines, author Protection from Over- and Underuse Guideline, lead author publication on Protection from Over- and Underuse Guideline Clinical focus: none Memberships: German Network for Evidence-based Medicine (DNEbM), German Society for Epidemiology (DGEpi), German Health Literacy Network (DNGK), Westphalia-Lippe Pharmacy	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
					Hesse (KVH), Association of Statutory Health Insurance Physicians Schleswig-Holstein (KV-SH), National Association of Statutory Health Insurance Physicians (KBV), Authority for Labour, Social Affairs, Family and Integration (BASFI) Hamburg, German Society for General Practice/Family Medicine (DEGAM), Unna Foundation (Unna-Stiftung)		Foundation (Apothekerkammer Westfalen-Lipp), Berlin	
Dr Monika Nothacker, MPH	none	1. Healthcare research project "ZWEIT" (relevance of second opinions) no remuneration 2. Healthcare research project INDiQ (Measureme	Berlin School of Public Health	none	German Cancer Society (DKG) 1. Network University Medicine German Federal Ministry of Health (BMG) 2. Network University Medicine Federal Joint Committee (G-BA) Innovation Fund	none	Scientific focus: Guidelines and guideline methodology Prioritisation of guideline recommendations (Making smart decisions together), quality indicators, topic-related reviews Clinical focus: none Memberships: German Network for Evidence-based Medicine (Deutsches Netzwerk Evidenzbasierte Medizin) (member) German Cancer Society (Deutsche Krebsgesellschaft) (member until Dec 2020)	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
		nt of Indication Quality from Routine Data) – remuneration 5000 euros institutional 3. Steering Committee National Cancer Plan no remuneration IQTIG					Guidelines International Network/GRADE Working Group (member) Lead participation in further training/training institutions: Guideline seminar for guideline developers/consultants as part of the curriculum for guideline consultants of the Association of the Scientific Medical Societies (AWMF) 1 – 3/Year	
Prof. Dr Michael Stimmelmayr	Geriatric Oral Research Group (GORG)	ORF Board	Camlog, Geistlich	none	none	none	Scientific focus: Implant surgery, augmentation surgery, implant prosthetics, plastic PA surgery Clinical focus: Implantology, periodontology, implant prosthetics Memberships: German Association of Oral Implantology (DGI), German Society of Dentistry and Oral Medicine (DGZMK), Dental Working Group Kempten (ZAK Kempten), Professional Association of German Oral Surgeons (BDO), Neue Gruppe	No topical relevance, no consequence
Lorena Cascant Ortolano	none	none	none	none	none	none	none	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Prof. Dr Benedikt Spies	none	none	none	None, industrial	Oral Reconstruction Foundation	none	none	none
PD Dr MSc Kathrin Becker	Osteology Foundation (Scientific Review Board)	Osteology Foundation (Expert Council)	Osteology Foundation (Osteology Research Academy)	none	Straumann AG, Dentaid AG, Dentsply Sirona AG	none	Scientific focus: Skeletal anchorage, 3D imaging, micro-CT Clinical focus: Orthodontics, treatment of patients with oral and craniofacial dysfunctions, skeletal anchorage Memberships: EAO, EAO Congress Committee, EAO Junior Committee, German Association of Oral Implantology (DGI), Stakeholder EAO for the European Society of Endodontology (ESE) Consensus Conference January 2023, Statistician Consensus Conference of German Association of Oral Implantology (DGI)/Osteology/Spanish Society of Periodontics and Osseointegration (SEPA) 2022 Lead participation in further training/training institutions Committee for Curriculum Development for Licensing Regulations (University of Düsseldorf) Personal relationships (as partner or first-degree relatives) with representatives of a healthcare company: My husband owns shares/equities in the company Easy Radiology GmbH/Smart in Media AG	No topical relevance, no consequence

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
Prof. Dr Christopher Lux	Member of the Board of Directors of the Academy for Further Dental Education in Karlsruhe (Akademie für zahnärztliche Fortbildung Karlsruhe) and of the Orthodontics Further Education Committee (both belong to the State Dental Association (LZK) Baden-Württemberg) Attendance fees no relevance to the Guideline	Advisory board of the journal Oral Prophylaxis and Paediatric Dentistry (Oralprophylaxe und Kinderzahnheilkunde) no relevance to the Guideline	Lectures for diverse state dental associations (Landeszahnärztekammer) and scientific societies (e.g., German Society for Paediatric Dentistry (DGKiZ), German Society for Aesthetic Dentistry (DGÄZ)) Lecture remuneration according to the state dental association (Landeszahnärztekammer) or the scientific society no direct relevance to the Guideline – topics of the Guideline (e.g., appropriate time of treatment, aplasia, etc.) are partly included in lectures	none	none	none	Membership of the German Society of Orthodontics (DGKFO) and Association of University Teachers for Dentistry, Oral Medicine and Maxillofacial Medicine (VHZMK) scientific activity: Studies about the effectiveness of certain orthodontic (KFO) appliances clinical activity: incl. functional orthodontics and dental trauma topic could be relevant to the Guideline	none
Dr Silke Auras	none	none	none	none	none	none	Guideline officer of the German Society of Dentistry and Oral Medicine (DGZMK), Research activities: none Participation in continuous training/training: none	none

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							Personal relationship: none	
PD Dr Stefan Wentaschek	District courts Koblenz, Marburg, Zweibrücken	Reviewer for professional dentistry journals	25th Greifswald Symposium 2022, State Dental Association (LZÄK) Rhineland-Palatine, Implant Royally Seminar (Fürstlich Implantieren Seminar) 2020 – 2022, Study group Hofheim 2021, ITI Congress 2021, Straumann SMART 2.0, German Association of Oral Implantology (DGI) Online Event and Quality Circle 2020, Association of Democratic Dentistry (VDZM)/German Working Group on Dentistry (DAZ) 2019, Free Association of German Dentists (FVDZ) 2019, Academy for Practice and Science (APW) 2019	none	In vitro trials hybrid implant crowns In vitro trials implant-abutment connections Patient studies immediate loading	none	Clinical focus: Planning and implementation of tooth- and implant-supported dentures	No topical relevance, no consequence
Prof. Dr Robert Nölken	none	none	Dentsply Sirona, ITI	none	Dentsply Sirona	none	Scientific focus: Immediate implantation Clinical focus: Immediate implantation and immediate restoration	No topical relevance, no consequence

	Consultant/expert activity	Participation in a scientific advisory board	Paid lecturing/or training activity	Paid author/-co-authorship	Research projects/ conducting clinical studies	Ownership interests (patent, copyright, shareholdings)	Indirect interests	Topics of the Guideline relating to conflicts of interest (COI), assessment regarding their relevance, consequence
							Memberships: none Lead participation in further training/training institutions: Courses with Dentsply + ITI	
Prof. Dr Ralf Kohal	none	none	Zahngipfel (summit on dentistry), SIC invent AG	none	none	none	Scientific focus: Ceramic implants: preclinical and clinical studies – some publications on ceramic implants Clinical focus: prosthetic dentistry – care of edentulous and partially edentulous patients; care of (ceramic) implants Memberships: German Society of Dentistry and Oral Medicine (DGZMK), German Society of Periodontology (DG Paro), German Association of Oral Implantology (DGI), IADR, EAO, European Society for Ceramic Implant Dentistry (ESCI) Lead participation in further training/training institutions: Clinic for Dental Prosthetics, University of Freiburg, senior consultant	none
Dr Dipl.-Inf. Kawe Sagheb	none	none	none	none	none	none	Scientific focus: dental prosthetics Clinical focus: dental prosthetics Memberships: German Society of Dentistry and Oral Medicine (DGZMK), German Society for Prosthetic Dentistry and Biomaterials (DGPro), German Society for Computer-Assisted Dentistry (DGCZ)	none

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