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Review Article
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Prevention of the Irradiated Patient in Dental Implantology

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Abstract

Patients with orofacial tumors who have received radiotherapy as basic or adjuvant treatment constitute the majority of patients treated in maxillofacial prosthodontics. But the use of implants for a better prosthetic balance and comfort for this type of patient remains a solution to be considered. Indeed, a benefit/risk assessment of the placement of an oral implant must be unavoidable in order to guarantee its integration and avoid treatment failure.

After several studies of the risk of osteoradionecrosis, which is the main cause of failure, the prognosis for implants has improved.

Nevertheless, before any implant therapy, a pre-implant file should be prepared containing additional information on the modality of radiotherapy in addition to the conventional information.

However, the introduction of preventive measures in the irradiated patient who is a candidate for implant prosthesis must be indispensable in order to improve the prognosis of this type of rehabilitation.

Keywords: Irradiated patient; Preventive measures; Dental implant

Introduction

In maxillofacial prosthodontics, clinical situations lead to many tissue disturbances which have an impact on the prosthetic balance, thus making conventional functional realization difficult. This is why, in the face of the failures of conventional prostheses, oral implantology must be taken into consideration in the therapeutic arsenal aimed at the oral rehabilitation of patients.

Cervicofacial radiotherapy has long been considered as an absolute contraindication to the placement of oral implants, since it seems to disturb the alveolar bone in its composition, leading to hypo-vascularization and increased bone resorption.

However, the need for dental rehabilitation in patients with orofacial cancer who have undergone radiotherapy has changed this position. For this reason, a benefit/risk assessment of the placement of an oral implant is essential to ensure its integration and avoid treatment failure.

Indeed, the main cause of implant failure in the irradiated patient is osteoradionecrosis. Some practitioners refuse to place implants in an irradiated area despite the advantages of such therapy for prosthetic rehabilitation.

Several teams have evaluated the risk of incidence of osteoradionecrosis. In their studies, Wagner et al. [1], described 1.6% cases of osteoradionecrosis with a loss of 5 implants. Granström [2], noted the occurrence of osteoradionecrosis in patients irradiated with high doses after combining pre- and post-radiation therapy. Therefore, implant surgery should be spaced from radiotherapy and the patient's dose to the implant site should be checked to decrease the risk of osteoradionecrosis.

Currently, the prognosis of implants has improved with recent radiotherapy techniques that use radiation converging on the target. This reduces the side effects on adjacent sites that may be future implant sites [3].

According to the different studies dealing with the possibility of placing implants in a patient who has received Cervicofacial radiotherapy, the percentage of implant success after 10 years varies from 56.5% to 90.8% [4].

The results of the study by Taylor et al. have shown that up to 100% implant success can be achieved. However, it should be noted that the implant sites were located at the symphyseal level, which is an area with little or no radiation [5].

Several studies have been conducted to compare irradiated and non-irradiated bone. These

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include Granström et al., published in 1994, 1999 and 2005, Nishimura et al. (1998), Brasseur et al., 2006 and Yerit et al., 2006. All showed significant reductions in the regenerative capacity and bone integration of implants in irradiated dogs and humans. The work of Brogniez et al. published in 2000 and 2002 found comparable Osseo integration of implants in the alveolar bone of non-irradiated and irradiated dogs [6].

Also, Ben Slama et al. reported a case of osteoradionecrosis, developed 3 months after the end of radiotherapy around implants that had been Osseo integrated for 10 years [7].

Although bone defect in early loaded implants was significantly higher in irradiated patients when compared with non-irradiated patients in the study by Landes and Kovacs et al., other non-comparative studies, such as Arcuri et al., Keller et al. and Visch et al., have reported fairly good survival results for implants in irradiated human alveolar bone, whether or not associated with hyperbaric oxygen therapy [5].

Preventive measures to be considered during dental implant rehabilitation

Based on the results of all these research studies, it is necessary to implement preventive measures to avoid implant loss and treatment failure.

This prevention can have several components, starting with the pre-implant assessment until the implant is loaded. It can go further through follow-up and maintenance.

Thus, before any implant therapy, it is necessary to prepare a pre-implant file which contains, in addition to the conventional file (general state, risk factors (tobacco and alcohol), exo- and endo-buccal assessment, the radiographic assessment, ...), other information are essential, since it is necessary to contact the oncologist and radiotherapist to collect certain information. This concerns the site of the irradiation, the dose received, the presence of surgical reconstruction or not, the associated chemotherapy or not, the treatment to improve the quality of the bone [hyperbaric oxygen therapy], etc.

Indeed, several studies indicate a certain number of factors to be taken into consideration in order to prevent implant treatment failure:

Associated treatment: reconstruction surgery/chemotherapy: The treatment of tumors of the orofacial sphere, in the majority of cases, is a combination of radiotherapy, resective surgery, and chemotherapy. The latter two may also influence the survival prognosis of the implants in the irradiated patient.

According to studies on animal models, chemotherapy has, in general, a negative effect on normal physiological bone turnover and in particular on osteoplastic activity. It also affects the healing and incorporation of allograft bone by the same mechanism [8].

On the contrary, surgical reconstruction is beneficial for implant survival, because it offers more bone volume as well as revascularization compared to the original residual bone [7].

Implant site: The choice of implant site should take into consideration the maxilla or mandible and the location of the implant (anterior or posterior).

According to the study by Hugentobler and Guyot [9], the success of an implant in the maxilla is slightly worse than that of a mandibular implant [8]. While Chrcanovic et al. [7], found that the side effects of radiotherapy seem to be more severe in the mandible than in the maxilla due to the lower blood supply from the old bone.

However, these results should be interpreted with caution, as the radiation field should be checked if it includes the implant site.

Dose received: With regard to the dose received during radiotherapy, implants inserted in locations that received an absorbed dose greater than 50 Gy have a lower survival rate than implants in areas that received a dose less than 50 Gy [8].

This conclusion was supported by the *in vitro* study of Ozen et al. which suggested that the 21% increase in radiation dose in the vicinity of titanium implants was an additional risk factor [9]. As for the French Society of Oral Surgery, it reports that during irradiation with a dose higher than 45 Gy, most often it is the absence or loss of Osseo integration and exceptionally osteoradionecrosis [10].

Local oral treatments: Before any prosthodontic treatment, the oral implant site must be prepared. This pre-prosthetic treatment includes the management of carious, periodontal, musculoarticular and osteo-mucosal pathologies, while taking into account the change in saliva and local flora as well as the nutritional deficiency caused by radiological.

Treatment for improvement: There are several ways to improve the survival rate of implants in the irradiated patient. These include Hyperbaric Oxygen therapy (HBO), BMP (Bone Morphogenic Protein) therapy and OGP (Osteogenic Growth Peptide) [8,11].

However, these techniques should be used with caution and with consideration of the advantages and limitations of each.

Prosthetics loading: The time to prosthetic loading after placement of an implant in healthy bone is often around three months. In a radiation-affected patient, Osseo integration occurs at a slower rate and the capacity for local healing is impaired.

For this reason, Taylor and Worthington et al. recommended a delay of six months before loading [6]. Wachter and Stoll et al., in their histomorphometric studies [8], indicate that implantation can be performed twelve to eighteen months after the end of irradiation. These results were supported by those of Jacobsson et al., who reported an improvement in bone healing capacity by a factor of almost 2.5 over a period of twelvemonths following irradiation. However, other studies have shown that there is no statistically significant difference in survival when implants are inserted before or after twelvemonths from the completion of radiation therapy [8].

Type of prosthesis: Implant-stabilized complete removable prosthesis or fixed prosthesis

Implant treatment is considered complete only after the implant has been loaded with prosthesis, whether fixed or removable. However, the choice of this prosthesis in the irradiated patient must take into consideration the fragility of the mucosal tissues and the risk of osteoradionecrosis which can occur in case of failure.

The complete removable prosthesis stabilized on implant is the most used type of implant prosthesis given its numerous advantages such as the ease of hygiene and handling, the reduced number of implants required or the implantation region which is most often anterior which favors the success, since it is an area with little or no radiation.

Regarding the attachment system, it is preferable to choose the

locator, since it seems to offer a better prognosis for implant success according to the work of Cordaro et al. [12], and Troeltzsch et al. [13], carried out in 2013.

However, it should be noted that removable prostheses cause continuous loads on the mucosa and can trigger osteoradionecrosis [14].

The fixed prosthesis, it is more complex. It requires more implants distributed over the entire arch, which is an additional risk of causing osteoradionecrosis, especially in the posterior regions. However, the use of fixed restorations reduces the risk of implant failure [14,15].

However, it is imperative that loading is done in the axis of the implant to allow optimal load distribution and thus avoid osteoradionecrosis [13].

Conclusion

In maxillofacial prosthodontics, there are no absolute contraindications to implant treatment. Each patient must be treated individually by a multidisciplinary team. This team must proceed according to a reliable treatment plan, respecting preventive measures and ensuring a rigorous follow-up schedule.

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