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Original Article

Peri implant bone resorption on microvascular free fibula flap: a radiographic retrospective study

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Abstract – Introduction: As the vascularization of the microvascular free fibula flap enables to maintain an osteogenic potential, osseointegrated implants have a 86% to 99% success rate. Thus, only few studies consider peri-implant bone resorption (PIBR). The aim of the study was to radiologically evaluate PIBR on fibula flaps. **Materials and methods**: Data were retrospectively collected. Gender, age, reason for interruptive mandibulectomy, previous radiotherapy, number of implants placed on the reconstruction, length and number of segments of the reconstruction, height of resorption were collected for each patient. Measurements were made on panoramic radiograph. **Results**: 85 clinical reports were reviewed for 39 retained. Peri-implant bone resorption was observed in 21 (53.9%) patients. The average age of the resorption group was 55.4 . All of the 5 patients with 4 or 5 implants on their reconstruction did not developed PIBR. 59.1% of patients with 1 segment reconstruction developed PIBR, 54.6% with 2 segments and 33.3% with 3 segments. **Discussion**: Age and poor oral hygiene appeared to be clearly more related to PIBR. An important number of implant (4 or 5) and a reconstruction with more than 1 segment seemed to decrease PIBR. Further studies are required to confirm these hypotheses.

Introduction

The microvascular free fibula flap followed by dental implants is a standard treatment for mandibular reconstruction [1–3]. The reconstruction of the mandible by microvascular free fibula flap (MFFF) is considered the gold standard technique. The vascularization of the free flap enables to maintain an osteogenic potential. The use of endosseous osseointegrated implants on these flaps has been described for more than 20 years and allows aesthetic and functional oral rehabilitation [4]. Implants have 86–99% success rate considering osseointegration on these flaps, but are frequently concerned by peri-implant bone resorption [5], which diagnosis is generally radiological. Several factors can influence this resorption, such as oral hygiene, quality of peri implant soft tissues, inflammation or traumatic occlusal forces. Radiation therapy has also been identified as an implant failure risk [6]. The aim of this retrospective series was to evaluate peri implant bone resorption on fibula flaps, and try to identify risk factors for peri-implant bone resorption, which may conduct in the future to develop a predictive model to anticipate bone resorption.

Materials and methods

Data

Data were retrospectively collected in medical observations with a hospital full-text research software dedicated to medical observation search from patients who were treated from January 2007 to January 2018 with microvascular free fibula flap (MFFF) and dental implants. Key words used for collecting data were: dental implants, free fibula flap, mandibular reconstruction. Inclusion criteria were: reconstructed mandible with MFFF, placement of dental implants on the flap. Exclusion criteria were: lack of saved data, patients who were lost to follow-up and patients who did not meet inclusion criteria. Collection of data was standardized thanks to a form, which was completed by 2 independent reviewers. Data recorded were: gender, age, reason for mandibulectomy and bone reconstruction, previous radiotherapy on the MFFFF, number of implants on the reconstruction, length and number of segments of the reconstruction, height of resorption, type of prosthetic rehabilitation (fixed or removable and implant connexion), quality of soft tissues, and follow up. Secondary data were also collected, such as metabolic disease which could influence bone resorption (*i.e.* diabetes), and toxic use (alcohol or tobacco).

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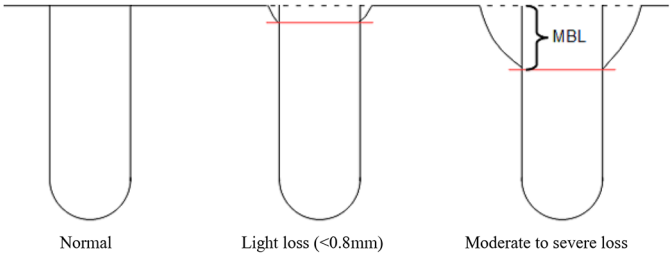

Fig. 1. Scale and scheme of PIBR. MBL= marginal bone loss.

Bone resorption measurements

Peri implant bone resorption was defined as the distance between the implant collar and the crestal level of the bone. The criteria "no resorption" was proposed when bone appeared at the implant collar (Fig. 1). Measurements were taken on panoramic radiograph, on the postoperative orthopantolomography and on a later control radiograph. Peri-implant bone resorption was considered from any visible crater-like shape. Measures were taken on the mesial and distal aspects of the implants with, as much as possible, an orthogonal incidence of the X-rays. They were performed by 2 different operators with the Image J® software. The software allows precise measurements on a 1/1 scale. Resorption was classified as light (<0.8 mm) to moderate (0.8–1.5 mm) or severe (>1.5 mm). PIBR on one implant classified the patient in the "resorption group" (R+), even if there were other implants without resorption.

Analyses

Statistical analyses were performed using SSPS (IBM, Armonk, USA); subgroup analyses were performed regarding the age of the patients, the number of segments on the flap and length of the flap, the follow up, the circumstances of the reconstruction (primary versus secondary reconstruction), etiology, and implantation in an irradiated flap or not.

Results

85 clinical reports were reviewed for 39 retained; the reasons for exclusion were missing data (panoramic radiograph or missing clinical reports). 21 patients presented with PIBR, and 18 without.

Patients

13 women and 26 men were included, aged from 26 to 77 (mean: 55.97). Ninety-eight implants were placed on the fibula flaps, ranging from 1 to 5 (mean: 2.51). Reasons for mandibular reconstruction were malignant tumor, *i.e.* epidermoid carcinoma or sarcoma for 21 patients (53.8%), benign tumor *i.e.* ameloblastoma, fibroma or chronic osteitis for 7 patients (17.9%), osteoradionecrosis for 7 patients (17.9%), trauma for 4 patients (10.3%).

Implants

All implants were placed at bone level. Peri-implant bone resorption was observed in 21 patients (53.9%). The resorption group (R+) consisted of 18 men and 3 women and the non-resorption group (R–) 9 men and 9 women. In the R+ group, resorption was light for 3 women and 7 men, moderate for 5 men and severe for 6 men. The average age of the R+ group was 55.4 years compared to 47.6 years in R– group. 69.2% (9 patients) of patients over 60 years old presented with PIBR, including 3 light losses.

Radiation therapy

Of the 6 patients irradiated on the fibula flap (*i.e.* patients who underwent primary reconstruction), 3 patients presented with PIBR. In the R+ group, of these 3 patients with implants in irradiated bone, 2 presented with light resorption and 1 with severe resorption and implant loss.

Follow up

Mean follow up for the R+ group was 16.4 months, and 22.0 months in the non-resorption group (Tab. I). Follow up was over 36 months for 6 patients of the R+ group, of which 1 with severe and 1 with moderate PIBR.

Etiology

Looking at the 4 patients with a traumatic history (3 ballistics and 1 road traffic accident), all peri-implant resorptions were moderate to severe and the one that did not presented resorption was young (25 years old). The 3 presenting with an ameloblastoma in the resorption group had light losses.

Number of segments

Looking at the number of segments of the reconstruction (Tab. II), most of the patients presented with a one-segment reconstruction. 59.1% of patients with a 1 segment reconstruction developed a peri-implant bone resorption, 54.5% for 2 segments and 33.3% for 3 segments. All of the 5 patients with 4 or 5 implants on their reconstruction did not develop peri-implant bone resorption.

Type of prosthesis

In the R+ group, 9 patients were rehabilitated with fixed screwed dentures, 3 with a removable denture and individual attachments (Locator® or balls) and 8 with bar-retained removable dentures. One patient could not receive his prosthesis due to early death (brain hemorrhage).

Oral hygiene, quality of soft tissues and toxic use

Oral hygiene and quality of soft tissues were retrospectively collected in medical observations. Oral hygiene was good for

Table I. Details of the patients presenting with PIBR, regarding age, sex, length and number of segments of the flap, previous radiotherapy on the flap, number of implants, etiology of the reconstruction, measurement of PIBR, time interval for recording, oral hygiene and type of prosthesis.

Age	Sex	Length of the flap (cm)	Number of segments	Number of implants (+ out of the flap)	Etiology of the reconstruction	Previous radiotherapy on the flap (Yes/No)	PIBR measurement (mm)	Postoperative observation time interval (months)	Type of prosthesis and attachment	Oral hygiene	Tobacco use or other disease
24	F	9.55	2	3	Sarcoma	Yes	<0.8	4	Fixed	Good	No
26	M	7.34	1	3	Osteosarcoma	Yes	<0.8	5	Partial denture (individual attachment)	Good	No
38	M	9.41	2	3	Balistic trauma	No	1	5	Total denture (bar)	Good	No
38	F	7.55	1	2	Ameloblastoma	No	<0.8	1	Fixed	Good	No
52	M	12.48	2	3 + 1	Epidermoid carcinoma	Yes	2.2 + loss of 2 implants	3	Total denture (individual attachment)	Poor	Tobacco (5 cig/day)
52	F	11.49	2	2	Epidermoid carcinoma	No (secondary reconstruction)	<0.8	1	Total denture (individual attachment)	Good	No
52	M	NA	1	3	Ameloblastoma	No	0.8	18	Fixed	Good	No
54	M	10.14	1	2 + 1	Epidermoid carcinoma	No (secondary reconstruction)	1.8 mm	1.5	Total denture (bar)	Poor	Tobacco (10 cig/day)
56	M	7.56	1	2	Ameloblastoma	No	<0.8	2	Fixed	Good	No
56	M	5.98	1	2	Epidermoid carcinoma	No (secondary reconstruction)	<0.8	65	Total denture (bar)	Good	No
58	M	8.7	3	2	Osteoradionecrosis	No	1.2	5	Total denture (bar)	Good	No
58	M	6.37	1	2	Epidermoid carcinoma	No (secondary reconstruction)	1.3	22	Fixed	Poor	No
62	M	9.55	2	2	Balistic trauma	No	1.5	1	Total denture (bar)	Poor	Tobacco (5 cig/day)
63	M	7.84	1	3	Osteoradionecrosis	No	Loss of the implants	76	Total denture (bar)	Poor	Tobacco (10 cig/day)
64	M	7.38	1	2	Epidermoid carcinoma	No (secondary reconstruction)	<0.8	63	Fixed	Good	No
64	M	5.94	1	2	Epidermoid carcinoma	No (secondary reconstruction)	<0.8	13	Total denture (bar)	Good	Tobacco (5 cig/day)
65	M	7.71	2	5	Epidermoid carcinoma	No (secondary reconstruction)	1.3	29	Fixed	Poor	No
69	M	7.41	1	3	Osteoradionecrosis	No	1	8	Non realized*	Good	No
69	M	9.08	1	5 + 2	Epidermoid carcinoma	No (secondary reconstruction)	2.7	7	Fixed	Poor	No
70	M	10.75	3	3	Epidermoid carcinoma	No (secondary reconstruction)	<0.8	8	Fixed	Good	No
73	M	3.34	1	2 + 3	Road traffic trauma	No	2.2	7	Total denture (bar)	Poor	No

Table II. Follow up: time interval until presentation of the resorption (R+ group) and time interval for observation (R– group). Numerical data are in months.

	Resorption group	Non resorption group
Average	16.4047619	22.05882353
Quartile 1	3	1
Median	7	4
Quartile 3	18	22
Standard deviation	22.3306425	36.70868526

29 patients, with a satisfying control of plaque. Nine patients of the R+ group presented with poor oral hygiene.

Soft peri-implant tissues quality was good in 25 patients and insufficient in 14 patients (mostly due to the lack of keratinized gingiva). 72% of patients with moderate or severe PIBR presented with a poor quality of soft tissues.

Tobacco use was reported in 5 patients of the R+ group, with 1 light PIBR and 4 severe PIBR.

Discussion

Patients

Cross-referencing age with severity showed an average age of 50 years for light resorptions (9 patients) and 59.4 years for more severe cases (12 patients). Age seemed to display both occurrence and severity. This is in accordance with the literature [7].

Implants

One of the limitations of the study was that measurements were performed on panoramic radiographs, and thus could not be precise for the reconstruction length, especially when the anterior arch of the mandible was included. Furthermore, this type of radiograph may not report a buccal or lingual bone resorption aligned with an implant. However, this type of radiograph remains valuable for evaluating PIBR [8] and to assess the point of bone attachment to implants [9], especially in case of very atrophic mandibles with unfavorable imaging conditions [10]. Using ImageJ® software also allows a better measurement precision.

Biomechanical considerations

The fibula flap is known to lead to a vertical discrepancy between the fibula and the remaining mandible, resulting in an important level arm and a unfavorable crown/implant ratio [4]. Nonetheless, crown/implant ratio seems to have no influence regarding biological or technical complications [11].

The axis of the implants may also differ from the prosthetic axis, which results in torque forces that may endanger implant survival [4,12,13] and increase PIBR. Using computer-guided surgery may prevent from a major discrepancy between these two axes and increase the accuracy of the rehabilitation [14].

Quality of bone

Many authors have reported values of peri implant bone loss depending on the time interval after implant placement and the quality of bone (graft versus native bone) [15]. PIBR is more important after grafting (allografts) than in native bone [16].

The literature also reports higher failure rates in autologous bone graft than native bone; the success rate seems better in vascularized bone grafts [12]. Implant loss in composite fibula flap is equivalent as in native maxilla [17]. Time for implantation remains controversial, as implant survival in free fibula flap seems higher when placed after a 3 months' time interval than immediately placed [17].

Radiation therapy

In the series, irradiated patient did not present more bone resorption, which is in concordance with the literature [18,19]. Despite external radiotherapy seems to affect dental implant success rate, especially when placed in grafted bone, they remain a functional option in head and neck cancer patients, with a success rate ranging from 74.4 to 97% [20]. Nonetheless, in this series, only 3 patients presented with implants in irradiated MFFF.

Type of prosthesis

Of the 9 patients of the R+ group rehabilitated with fixed prosthesis, 2 presented with moderate PIBR and 1 with severe PIBR. The type of prosthesis, or even securing the implants together (with a bar or fixed prosthesis) does not seem to influence PIBR.

Follow up

The median and the first quartile of the period of observation in the non-resorption group are quite low in comparison with the resorption group. This bias may tilt significantly the results, even if the non-resorption group has a higher average and third quartile (Table II). In this series, the follow up is non homogeneous and is a source of bias in the interpretation of the results as only 6 R+ patients have a follow up superior to 36 months and 14 R+ patients have a follow up under 12 months. This could explain why there is no PIBR over 2.2 mm in this series.

Etiology

Three out of 7 patients (42%) with previous history of osteoradionecrosis presented PIBR. These implants were placed on non-irradiated flaps (secondary reconstruction) [21]. 50% of patients with primary reconstruction and implant placement in irradiated bone presented with PIBR. Three out of 4 patients

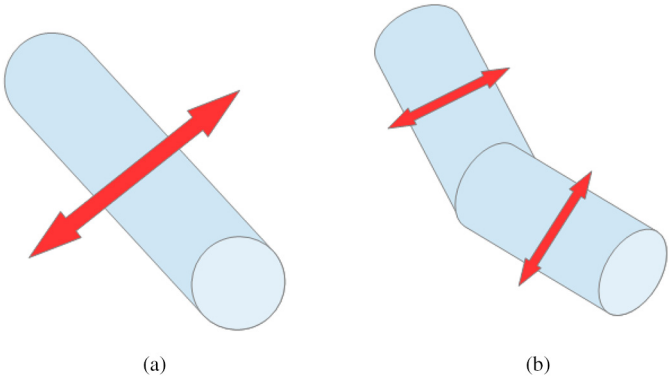

Fig. 2. (a) Illustration of the lateral forces for 1 segment reconstruction. (b) Illustration of the lateral forces for 2 segments reconstruction.

with traumatic etiology displayed bone resorption (all moderate or severe). The remaining patient was aged 25.

The etiology of the reconstruction itself did not seem to represent a risk factor for peri implant bone resorption.

Number of segments/number of implants

In this series, the higher the number of segments is, the less PIBR was observed. The higher the number of segments was, the lower the lateral forces could be expressed on the flap and the rehabilitation, resulting in a decrease of rotation axes. If there was only one segment, there was only one rotation axe (Fig. 2a). But if there were 2 or 3 segments it partially break this axe and prevented from important lateral forces (Fig. 2b). The role of the length of the flap remains unclear, as a longer flap generally requires several segments thus decreasing lateral forces.

The lack of PIBR in patients with 4 or 5 implants on their reconstruction could be explained by the division of the forces applied on each implant by the number of implants, resulting in less stress on each implant, and thus less PIBR.

Additional information

Poor oral hygiene is a risk factor for PIBR [12]. Thus, 9 patients (90%) with moderate or severe PIBR presented with poor oral hygiene. Tobacco use is also known as a risk factor for implant loss. When combined with poor oral hygiene, it leads to severe PIBR in 4 patients (out of 5 smokers).

Excessive thickness and mobility of the overlying soft tissues limit oral rehabilitation [22,24]. These mobile soft tissues might cause peri implant mucositis. It occurs 2 to 4 months after abutment connection, and provokes hypertrophy around the abutments (4). Thus, pocket formation is increased [23,24]. Many authors [5,12,18,23] propose the use of palatal mucosal grafts at the second stage of the surgery to avoid this hypertrophy. In the series, patients treated for ameloblastoma generally presented a light PIBR, as soft tissues are preserved and there is a sufficient amount of keratinized gingiva. Curettage around the implants and improvement of oral hygiene was proposed to patients with moderate and severe PIBR.

Thinning of the graft can also be proposed to reduce the height of soft tissues. Vestibuloplasty may also be mandatory to create adequate space for the prosthesis [25].

Other bias

As several data lacked, chronological evaluation could not be performed for each patient.

The type of dental rehabilitation was not recorded either in this retrospective study. The prothesis defines the different forces applied on implants which contribute to determine their durability. Furthermore, short follow up does not allow significant conclusions.

Patients treated with MFFF followed by dental implants only represent a small sample of the population, which explains the small number of clinical reports included, and the difficulty to establish relevant statistics.

Conclusion

The results of this study show that some parameters appear to be in relationship with PIBR. As in non-reconstructed patients, age and poor oral hygiene seem to increase the risk of developing PIBR. The number of implants and the number of segments of the reconstruction may also be relevant risk factors. Indeed, the results present a decreasing risk correlated to an important number of implant (4 or 5) and for a reconstruction with more than 1 segment. Nonetheless, due to the small number of patients and short follow up, further studies are required to establish solid conclusions.

Conflict of interest statement

None to declare.

References

1. Disa J, Cordeiro P. Mandible reconstruction with microvascular surgery. Semin Surg Oncol 2000;19:226–234.
2. Hidalgo DA, Disa JJ, Cordeiro PG, Hu QY. A review of 716 consecutive free flaps for oncologic surgical defects: refinement in donor-site selection and technique. Plast Reconstr Surg 1998;102:722–732; discussion 733-734.
3. Sozzi D, Novelli G, Silva R, Connelly ST, Tartaglia GM. Implant rehabilitation in fibula-free flap reconstruction: a retrospective study of cases at 1-18 years following surgery. J Cranio-Maxillo-Facial Surg 2017;45:1655–1661.

4. Bodard AG, Salino S, Bemer J, Lucas R, Breton P. Dental implant placement after mandibular reconstruction by microvascular free fibula flap: Current knowledge and remaining questions. Oral Oncol 2011;47:1099–1104.
5. Chiapasco M, Romeo E, Coggiola A, Brusati R. Long-term outcome of dental implants placed in revascularized fibula free flaps used for the reconstruction of maxillo-mandibular defects due to extreme atrophy. Clin Oral Impl Res 2011;22:83–91.
6. Granström G. Osseointegration in irradiated cancer patients: an analysis with respect to implant failures. J Oral Maxillofac Surg 2005;63:579–585.
7. Compton SM, Clark D, Chan S, Kuc I, Wubie BA, Levin L. Dental implants in the elderly population: a long-term follow-up. Int J Oral Maxillofac Implants 2017;32:164–170.
8. Gbara A, Darwich K, Li L, Schmelzle L, Blake F. Long-term results of jaw reconstruction with microvascular fibula graft and dental implants. J Oral Maxillofac Surg 2007;65:1005–1009.
9. Kullman L, Al Asfour A, Zetterqvist L, Andersson L. Comparison of radiographic bone height assessments in panoramic and intraoral radiographs of implant patients. Int J Oral Maxillofac Implants 2007;22:96–100.
10. Zechner W, Watzac G, Gahleitner A, Busenlechner D, Tepper G, Watzek G. Rotational panoramic versus intraoral rectangular radiographs for evaluation of peri-implant bone loss in the anterior atrophic mandible. Int J Oral Maxillofac Implants 2003;18:873–878.
11. Meijer HJA, Boven C, Delli K, Raghoebar GM. Is there an effect of crown-to-implant ratio on implant treatment outcomes? A systematic review. Clin Oral Impl Res 2018;29 (suppl 18):243–252.
12. Laverty DP, Kelly R, Addison O. Survival of dental implants placed in autogenous bone grafst and bone flaps in head and neck oncology patients: a systematic review. Int J Implant Dent 2018;4:19.
13. Watzinger F, Ewers R, Henninger A, Sudasch G, Babka A, Woelfl G. Endosteal implants in the irradiated lower jaw. J Craniomaxillofac Surg 1996;24:237–244.
14. De Maesschalck T, Courvoisier DS, Scolozzi P. Computer-assisted versus traditional freehand taechnique in fibular free flap mandibular reconstruction: a morphological comparative study. Eur Arch Otorhinolaryngol 2017;274:517–526.
15. Bui Quoc J, Vang A, Evrard L. Peri implant bone loss at implants placed in preserved alveolar bone versus implants placed in native bone: a retrospective radiographic study. The Open Dentistry J 2018;12:529–545.
16. Barone A, Orlando B, Cingano L, Marconcini S, Derchi G, Covani U. A randomized controlled trial to evaluate and compare implants placed in augmented versus non-augmented extraction sockets: 3-year results. J Periodontol 2012;83:836–846.
17. Shaw RJ, Sutton AF, Cawood JI, Howell RA, Lowe D, Brown JS, Rogers SN, Vaughar ED. Oral rehabilitation after treatment for head and neck malignancy. Head Neck 2005;27:459–470.
18. Chiapasco M, Romeo E, Coggiola A, Brusati R. Clinical outcome of dental implants placed in fibula-free flaps used for the reconstruction of maxillo-mandibular defects following ablation for tumors or osteoradionecrosis. Clinical Oral Implants Research 2006;17:220–228.
19. Jackson RS *et al*. Evaluation of Clinical Outcomes of Osseointegrated Dental Implantation of Fibula Free Flaps for Mandibular Reconstruction. JAMA Facial Plast Surg 2016;18:201–216.
20. Shugaa-Addin B, Al Shamini HM, Al Maweri S, Tarakji B. The effect of radiotherapy on survival of dental implants in head and neck cancer patients. J Clin Exp Dent 2016;8:e194-e200.
21. Salinas TJ *et al*. Clinical evaluation of implants in radiated fibula flaps. J Oral Maxillofac Surg 2010;68:524–529.
22. Kumar VV, Ebenezer S, Kämmerer PW, Jacob PC, Kuriakose MA, Hedne N, Wagner W, Al-Nawas B. Implants in free fibula flap supporting dental rehabilitation – implant and peri-implant related outcomes of a randomized clinical trial. J Craniomaxillofac Surg 2016;44:1849–1858.
23. Ciocca L, Corinaldesi C, Marchetti C, Scotti R. Gingival hyperplasia around implants in the maxilla and jaw reconstructed by fibula flap. Int J Oral Maxillofac Surg 2008;37:478–480.
24. Chang Y, Chan C, Shen Y, Wei F. Soft tissue management using palatal mucosa around endosteal implants in vascularised composite grafts in the mandible. Int J Oral Maxillofac Surg 1999;28:341–343.
25. Iizuka T, Häfliger J, Seto I, Rahal A, Mericske-Stern R, Smolka K. Oral rehabilitation after mandibular reconstruction using an osteocutaneous fibula free flap with endosseous implants. Factors affecting the functional outcome in patients with oral cancer. Clin Oral Implants Res 2005;16:69–79.