Long-Term Results for Maxillary Rehabilitation with Dental Implants after Tumor Resection

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ABSTRACT

Background: Defects of the maxilla due to tumor extirpation can create accordingly high levels of psychological and physical trauma for patients and their families. However, the reconstruction of maxillary defects remains very challenging. Today, using autogenous bone grafts and dental implants is an effective method to restore maxillary defects.

Purpose: The purpose of this study was to evaluate the long-term clinical outcomes of maxillary rehabilitation with dental implants after tumor resection. Patient satisfaction after maxillary reconstruction was also assessed with regard to function and comfort.

Materials and Methods: Over a 6-year period (2000–2005), 24 patients with maxillary tumors underwent resection with either immediate ($n = 18$) or delayed reconstruction or underwent prosthetic rehabilitation ($n = 6$).The patients received 88 implants in total, including 9 zygomatic and 79 conventional implants, for maxillary rehabilitation of the defective areas.

Results: Autogenous bone grafts were successful in all patients, although partial loss of the graft was observed in one patient who received an iliac graft. Patient follow-up was started at the point of the prosthetic loading of implants. The median treatment time was 99.1 months (range:18–137 months). One patient died after 18 months of follow-up due to tumor recurrence, and two patients were lost to follow-up after 3 years of observation. Ten conventional dental implants were removed due to peri-implantitis. Six patients chose implant-supported obturators. The cumulative survival and success rates of the implants were 88.6 and 86.3%, respectively.

Conclusions: This study demonstrated that the rehabilitation of maxillary defects following tumor resection using implant-supported fixed prostheses with autogenous bone grafts or prosthetic rehabilitation is successful and is associated with high patient satisfaction. Oral function can be restored using dental implants for patients with maxillary defects.

KEY WORDS: bone graft, conventional implant, maxillary defects, prosthesis, rehabilitation, tumor, zygomatic implant

INTRODUCTION

The rehabilitation of defects of the maxilla caused by congenital malformations, trauma, and tumor extirpation remains very challenging.[1] The maxilla provides much of the foundation for oral function, facial contour, and facial profile.[2–4] Defects of the maxilla can create accordingly high levels of psychological and physical trauma for patients and their families.

Ideal reconstruction of maxillary defects requires combinations of free tissue transfer, free flaps, and prostheses. In particular, recent advances in the osseointegration of implants have markedly enhanced the surgical capacity to achieve near-anatomical form and function in the rehabilitation of maxillary defects.[5] To create the root of an implant, obtaining a sufficient volume of bone is critical for the rehabilitation of patients with autogenous bone grafts or prostheses alone. Several types of bone grafts (e.g., using the fibula, ilium, or scapula as graft donors) have been successfully

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developed to address the requirements for bone height and width on the alveolar ridge.[6–9] In addition, Brånemark zygomatic implants (ZIs) can be placed into the bone of the zygomatic arch to provide anchorage for a long fixture.[10] Additionally, considering the difficulties associated with radiation therapy, anatomic complexity, the possibility of tumor recurrence, and the refusal of many patients to undergo surgical reconstruction,[11,12] implant-supported prosthetic rehabilitation is often used to rehabilitate the maxilla after tumor resection. Use of prostheses has considerable advantages, including easy observation of the healing wound, thus enabling the clinician and the patient to monitor disease recurrence. Other advantages include the resulting aesthetic improvement, the technical simplicity involved in the procedure, and the inexpensive cost of care.[13]

The objectives of this study were to evaluate the long-term clinical outcomes of the reconstruction of maxillary defects following tumor resection and oral rehabilitation with dental implants. Additionally, patient satisfaction was assessed in terms of the restoration of function, pronunciation, and aesthetics.

MATERIALS AND METHODS

Patients

Over a 6-year period (2000–2005), 24 patients with maxillary tumors requiring prosthetic restoration using dental implants (18 males and 6 females aged between 28 and 66 years old, with a mean age of 45.2 years old) were treated in the Department of Oral and Maxillofacial Surgery and the Department of Oral and Craniomaxillofacial Implantology at the Ninth People's Hospital Affiliated with the Shanghai Jiao Tong University School of Medicine. In 24 patients, 1 suffered from a benign neoplasm, 6 patients from oral squamous cell carcinoma (25%), 9 patients suffered from ameloblastoma (37.5%), adenoid cystic carcinomas were present in 3 patients (12.5%), others were mucoepidermoid carcinoma 3 patients (12.5%), and sarcomas 2 patients (8.3%). Eighteen patients were treated using tumor resection and either immediate or delayed reconstruction with autogenous fibula ($n = 13$), ilium ($n = 3$), or scapula grafts ($n = 2$). Six patients were treated using an implant-supported prosthesis due to their objections to bone grafts. Among the 24 patients in this study, 18 patients who received bone grafts (14 males and 4 females) were selected for implant-supported fixed prostheses following tumor resection. The inclusion criteria for implant treatment were as follows: (i) a good prognosis after tumor resection; (ii) good oral hygiene; (iii) an absence of periodontal disease in the residual dentition; (iv) sufficient bone volume after the bone graft; (v) the absence of alcohol abuse or smoking; and (vi) a request by the patient to be rehabilitated with implant-supported, fixed prostheses (Table 1).

Implants

A total of 88 implants were used for all of the patients, including nine ZIs. ZIs are available in eight different lengths, ranging from 30 to 52.5 mm. The portion that engages the residual maxillary alveolar process has a diameter of 4.5 mm, and the apical portion inserted in the zygoma has a diameter of 4.0 mm. Three patients each received one ZI for a unilateral maxillary defect, and each patients received two ZIs to repair defects affecting the bilateral maxilla. Bone density and bone quantity were evaluated by x-ray and computed tomography scans. A total of 88 ITI (Straumann, Basel, Switzerland) and Brånemark (Nobel Biocare, Gothenburg, Sweden) implants were placed in the maxillary defects. Some patients received both ZIs and conventional implants, and they received one or two ZIs in conjunction with one, two, three, or four conventional implants. Other patients received one, two, three, or four conventional implants alone. The diameters of the implants varied from 3.75 to 4.1 mm, and their lengths varied from 10 to 50 mm. All of the dental implants were placed by the same two surgeons.

Prosthetic Procedures

Eighteen patients chose immediate reconstruction simultaneous with tumor ablation. Of these 18 patients, 10 patients received implants placed during the same period, and 8 patients had their implants placed in stages (implants placed several months after bone graft), whereas 6 patients did not select bone grafts, and in these patients, implants were placed in residual bone for rehabilitation after tumor ablation (6–24 months later). Following the maxillary classification of Brown and Shaw,[14] 15 patients were class IIb, 1 was class IIc, 3 were class IId, and 5 had all-maxillary defects. For the patients with class IIb and d defects, the maxilla were reconstructed with bone taken from the ilium, scapula, or fibula, whereas for patients with all-maxillary defects, maxillary reconstruction was completed using

TABLE 1 Anagraphic Data and Clinical Features of Patients Treated with Rehabilitation

Patient No.	Age (Year)	Sex	Type of Rehabilitation	Extent of Defect Reconstructed	Date of Implant Placement	No. of Implants	Type of Implants	Implant Site	Implant Dimensions	Date of Abutment Connection	Follow-Up after Start of Loading (Months)	Removed Implants
1	36	M	Fixed	21–28+classIIb	July 2000	3	Nobel	22–23-25	4.0 × 10	October 2000	137	0
2	52	M	Fixed	12–18+classIIb	July 2000	3	Nobel	22–24-26	3.75 × 13	October 2000	137	0
3	31	F	Fixed	11–18+classIIb	August 2000	4	Nobel	12–13-15–16	3.75 × 13	November 2000	136	0
4	48	M	Fixed	All maxilla	September 2000	6	Nobel	16-15-13–22-24–26	3.75 × 13	December 2000	135	1
5	51	F	Moveable	15–25+classIIc	April 2001	2	Nobel	13–23	3.75 × 10,13	July 2001	128	0
6	28	M	Fixed	23–28+classIIb	May 2001	3	Nobel	24–25-26	3.75 × 13	August 2001	127	0
7	42	M	Fixed	11–27+classIIb	July 2001	4	Nobel	12–14-15–16	4.0 × 42; 3.75 × 13	October 2001	125	2
8	52	M	Fixed	13–18+classIIb	October 2001	3	Straumann	13–14-16	4.1 × 10,12	January 2002	123	1
9	61	M	Moveable	21–28+classIIb	November 2001	3	Straumann	22–24-26	4.1 × 10	February 2002	death	0
10	55	F	Moveable	23–28+classIIb	November 2001	2	Nobel	23–26	3.75 × 13	February 2002	122	0
11	38	M	Fixed	21–28+classIIb	May 2002	4	Straumann	22–23-24–26	4.1 × 10,12	August 2002	118	2
12	49	M	Fixed	All maxilla	July 2002	4	Nobel	15-12-22–25	4.0 × 42; 3.75 × 10	October 2002	Dropout	0
13	58	M	Fixed	All maxilla	September 2002	4	Nobel	15-13-23–25	4.0 × 42; 3.75 × 13	December 2002	117	1
14	66	M	Moveable	21–28+classIIb	September 2002	2	Straumann	22–26	4.1 × 10	December 2002	117	0
15	29	F	Fixed	11–18+classIIb	November 2003	4	Straumann	12–13-15–16	4.1 × 10,12	February 2004	97	0
16	32	M	Fixed	21–28+classIIb	November 2003	4	Nobel	21–23-24–26	3.75 × 10,13	February 2004	97	1
17	42	M	Moveable	21–28+classIId	May 2004	4	Nobel	15–22-24–26	3.75 × 13; 4.0 × 45,50	August 2004	91	0
18	52	M	Fixed	21–28+classIIb	June 2004	4	Straumann	22–24-25–26	4.1 × 10	September 2004	90	0
19	61	F	Fixed	All maxilla	October 2004	6	Nobel	16-14-12–22-24–26	4.0 × 42; 3.75 × 10	January 2005	Dropout	0
20	46	M	Fixed	11–18+classIId	February 2005	4	Straumann	12–22-24–26	4.1 × 10,12	May 2005	82	1
21	47	M	Moveable	11–18+classIIb	April 2005	3	Straumann	12–14-16	4.1 × 10,12	July 2005	80	0
22	56	M	Fixed	21–28+classIIb	April 2005	4	Nobel	21–23-24–26	3.75 × 13	July 2005	80	0
23	38	M	Fixed	11–18+classIId	September 2005	4	Straumann	12–22-24–26	4.1 × 10	December 2005	75	0
24	46	F	Fixed	All maxilla	October 2005	4	Straumann	14-12-24–26	4.1 × 10	January 2006	74	1

autogenous bone grafts from the fibula. Other patients received reconstruction with implants sourced from the ilium or the scapula. Patients with class IIc defects also received bone grafts from the ilium. For six patients, implants were placed in the residual bone and were supported with prosthetic rehabilitation. All of the implants were allowed to integrate for at least 3 months before restoration. Panoramic radiography was obtained immediately after placing the implants and at approximately 3 and 6 months of restoration to verify the proper location and osseointegration of the implants.

Prosthodontic restoration was performed by the same two doctors who placed the implants. Eighteen patients were rehabilitated with implant-supported, fixed prostheses. Because of a lack of attached gingiva around the implants, three patients underwent free mucosal grafts taken from the palate. Six patients chose implant-supported obturators.

The following parameters were evaluated in all patients: (i) implant survival rate; (ii) implant success rate; and (iii) patient satisfaction regarding the restoration of function and aesthetics after the reconstruction and after implant-supported prosthetic rehabilitation.

Criteria for Implant Success and Survival Rates

The success of the implants was determined according to the parameters described by Albrektsson and colleagues, including the absence of persistent pain, the absence of peri-implant infection with suppuration, the absence of mobility, the absence of continuous peri-implant radiolucency, and peri-implant bone resorption of <1.5 mm in the first year of function and <0.2 mm in subsequent years.[15] Implant survival was assessed using the following criteria: the absence of persistent pain, the absence of peri-implant infection, the absence of mobility, and the absence of continuous peri-implant radiolucency.[15] X-rays were taken at the time of implant placement, at prosthetic loading, and annually thereafter. For image analysis and measurements, all of the intraoral (intraoral radiographs were taken at the time of implant placement, 6 months after implant placement, 1 year, and annually thereafter) and panoramic radiographs were acquired with a Nikon D-70S digital camera (Nikon Corp., Tokyo, Japan) and were analyzed using Image J software, version 1.38 (National Institute of Mental Health, Bethesda, MD, USA).

The measurements of bone level changes were evaluated as described previously.[15] Briefly, the mesial and distal locations of each implant were determined by measuring the distance from the top of the implant head shoulder to the most coronal level of direct bone-to-implant contact. All of the bone level measurements were related to the baseline of the panoramic radiographs taken immediately after implant placement. Software calibration was used to examine all of the measurements, and dimensional distortions were corrected according to the actual dimensions of the implants.

Patient Satisfaction

Patient satisfaction was evaluated according to four parameters: (i) the aesthetic aspects of the facial contour; (ii) the functional results of the implant-supported prosthesis; (iii) the comfort level of the prosthesis; and (iv) pronunciation. Each score was reported using a scale of 0–2 points.

RESULTS

The cumulative survival rate of the bone grafts sourced from the fibula, ilium, and scapula was 100% over the follow-up period. All of the patients regained full function within 4 to 6 months after the reconstructive procedures. Dehiscence of the flap occurred in one patient (#12), with partial exposure of the graft; however, no problems were observed with the bone grafts. Postoperative recovery after implant placement (88 implants) was uneventful in 24 patients. In one patient (#4), one implant failed to integrate before the start of prosthetic loading, and it was removed at the time of abutment connection. In seven patients (#7, 8, 11, 13, 16, 20, 24), nine implants were removed due to peri-implant infections, including one ZI. No other implants were lost during the follow-up period. The mean follow-up period after the start of prosthetic loading of the implants placed in the reconstructed areas was 99.1 months (range 18–137 months). One patient (#10) died due to tumor recurrence. Two patients (#12, 19) dropped out of the study during the follow-up period (after the start of prosthetic loading). Table 2 presents the dates related to peri-implant bone resorption during the follow-up period.

The cumulative survival and success rates of the implants at the end of the follow-up period were 88.6 and 86.3%, respectively (Table 3). None of the prosthetic rehabilitations failed during the follow-up period, with the exception of small numbers of screws loosening and two implant-support prostheses that required

TABLE 2 Means, Standard Deviations, Medians, Quartiles, and Ranges of Peri-Implant Bone Resorption

Peri-Implant Bone Resorption	At Loading (88 Implants)	1 Years (87 Implants)	2 Years (84 Implants)	3 Years (80 Implants)	4 Years (78 Implants)	5 Years (66 Implants)	6 Years (63 Implants)	7 Years (49 Implants)	8 Years (34 Implants)	9 Years (34 Implants)	10 Years (22 Implants)	11 Years (15 Implants)
Mean and SD	0.2 ± 0.3	0.6 ± 0.5	0.8 ± 0.4	0.9 ± 0.5	0.9 ± 0.4	1.1 ± 0.5	1.1 ± 0.6	1.2 ± 0.5	1.0 ± 0.4	1.1 ± 0.4	1.0 ± 0.3	0.9 ± 0.2
Median	0	0.5	1	1	1	1	1	1	1	1	1	1
I quartile	0	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	0.75	0.75
III quartile	0.5	1	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	1
Minimum	0	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	1
Maximum	3	3	3	3	3	3	3	3	3	3	3	3

TABLE 3 Cumulative Survival and Success Rates of Implants

Interval	Implants at Start of Interval	Dropout Implants	Failing Implants	Removed Implants	Survival Rate per Year (%)	Cumulative Survival Rate (%)	Success Rate per Year (%)	Cumulative Success Rate (%)
Placement to loading	88	0	0	10	88.6	88.6	88.6	88.6
Loading to 1 year	87	0	1	0	100	88.6	98.8	86.3
1–2 years	87	0	1	0	100	88.6	98.8	86.3
2–3 years	84	6	3	0	100	88.6	96.4	86.3
3–4 years	80	0	4	0	100	88.6	95	86.3
4–5 years	78	0	2	0	100	88.6	97.4	86.3
5–6 years	66	6	1	0	100	88.6	98.4	86.3
6–7 years	63	0	0	0	100	88.6	100	86.3
7–8 years	49	0	0	0	100	88.6	100	86.3
8–9 years	34	0	0	0	100	88.6	100	86.3
9–10 years	34	0	0	0	100	88.6	100	86.3
10–11 years	22	0	0	0	100	88.6	100	86.3
11–12 years	15	0	0	0	100	88.6	100	86.3

Failing implants: implants with bone resorption >1.5 mm after the first year of loading and >0.2 mm in the following years but fulfilling the other criteria of Albrektsson and colleagues (1986).

TABLE 4 Patients' Satisfaction

Patient No.	Age	Sex	Facial Contour	Prosthesis Comfort	Pronunciation	Prosthesis Function
1	36	M	2	2	2	2
2	52	M	2	2	2	2
3	31	F	2	2	2	2
4	48	M	2	2	2	2
5	51	F	1	1	2	1
6	28	M	2	2	2	2
7	42	M	2	2	2	2
8	52	M	2	2	2	2
9	61	M	2	2	2	2
10	55	F	1	1	1	1
11	38	M	2	2	2	2
12	49	M	2	2	2	2
13	58	M	2	2	2	1
14	66	M	2	2	2	2
15	29	F	2	2	2	2
16	32	M	1	2	2	1
17	42	M	1	1	1	1
18	52	M	2	2	2	2
19	61	F	2	2	2	2
20	46	M	2	2	2	2
21	47	M	2	2	1	1
22	56	M	2	2	2	2
23	38	M	2	2	2	2
24	46	F	2	2	2	2

0 = unsatisfied; 1 = partially satisfied; 2 = fully satisfied.

modifications. Twenty patients were fully satisfied, and four were partially satisfied with their facial contours. Of the 24 patients, 21 were fully satisfied with the comfort of their prostheses, and 18 patients were fully satisfied with the functional aspects of their prosthetic restorations. Among the six patients who were partially satisfied with the function of their prostheses, four patients (#5, 10, 17, 21) had received dental implant-support prostheses, and two patients (#13, 16) suffered from peri-implant infections. Three patients (#5, 10, 17) were only partially satisfied with the comfort of their prostheses due to insufficient stability. The patient satisfaction scores are reported in Table 4. The restoration outcomes of three cases (#2, 10, 22) are illustrated in Figures 1–3. Besides, six implant-supported obturators were used to patients. Because of strictly selecting indications, including without radiotherapy and sufficient residual bone mass, a high success rate of these cases is obtained. However, compare to the fixed prostheses, the satisfaction of obturator patients is lower, such as patients #5 and #10.

DISCUSSION

In this study, we evaluated the clinical outcomes of maxillary rehabilitation for 24 patients who received implant restoration with tumor resection from 2000 to 2005.The results showed that bone defects with the resection of maxillary tumors could be satisfactorily reconstructed with autogenous bone grafts and dental implants.

The complete and effective functional reconstruction of the maxilla following the ablation of tumors is a systematic procedure including free tissue transfer, free flaps, implant placement, and prostheses. Many previous reports have demonstrated that the use of

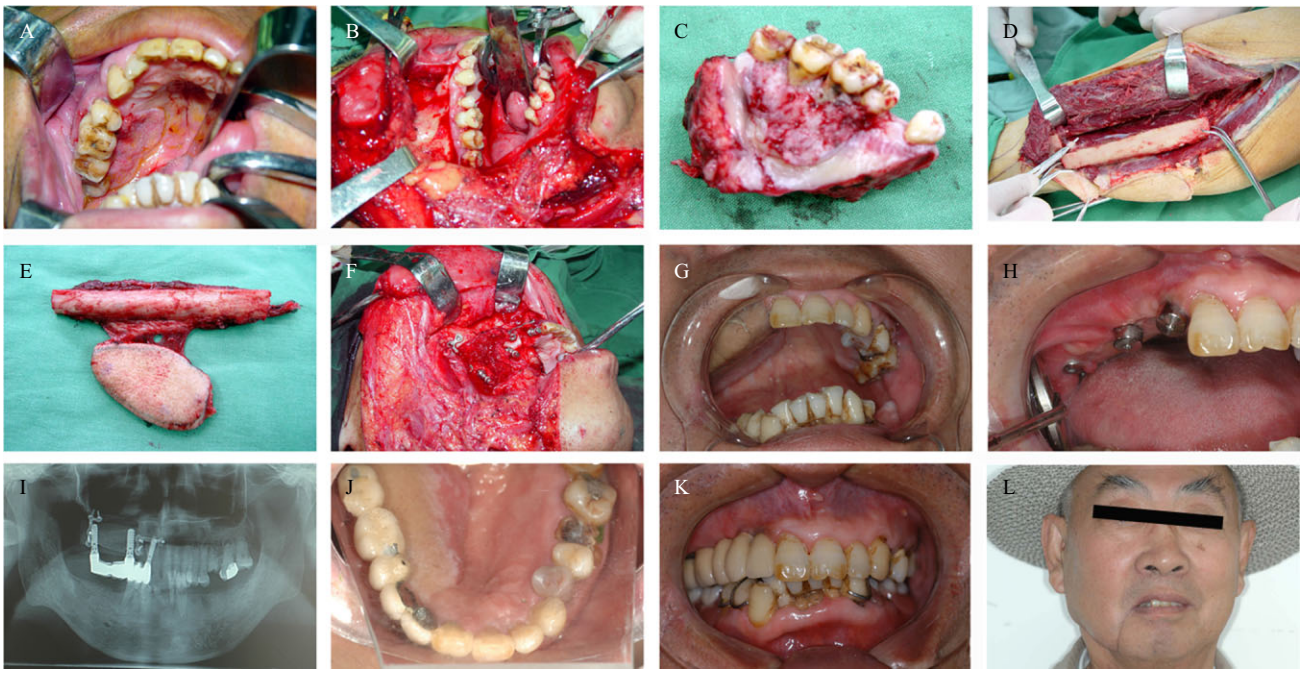

Figure 1 Clinical view of a maxillary defect reconstruction after tumor resection using conventional, implant-supported, fixed prosthetic replacement (class IIb). (A–C) tumor resection; (D–F) bone graft taken from the fibula; (H–K) implant-supported, fixed prosthetic rehabilitation; (L) picture of the patient after reconstruction.

autogenous bone grafts that are taken from the fibula, ilium, or scapula is a reliable method for the reconstruction of maxillary defects due to tumors.[16–18] However, different bone graft might determine implants' survival rate. Compared with other bone grafts, the fibula and the iliac crest showed best options in maxillofacial reconstruction, and provided adequate bone volume for implant placement.[19] For scapula, although it relies on

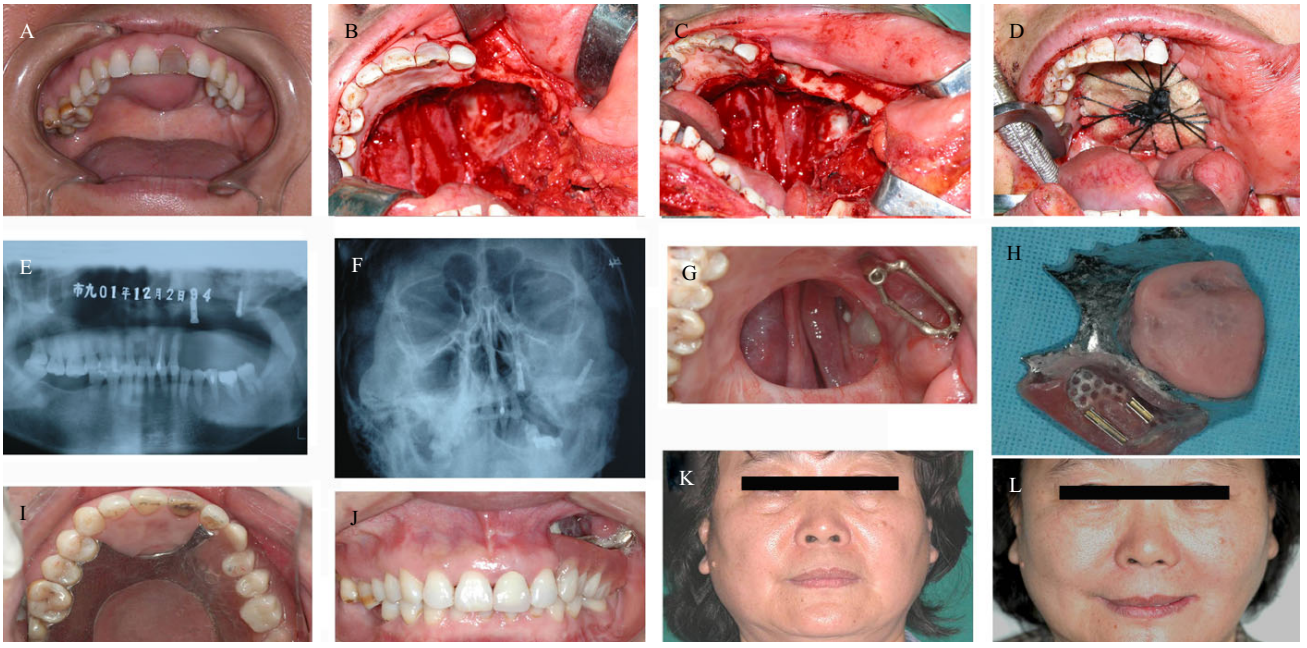

Figure 2 Clinical view of maxillary defect reconstruction after tumor resection using conventional, implant-supported, moveable prosthetic rehabilitation (class IIb). (A,B) tumor resection; (C–J) implant-supported, moveable prosthetic rehabilitation; (K,L) pictures of the patient before and after reconstruction.

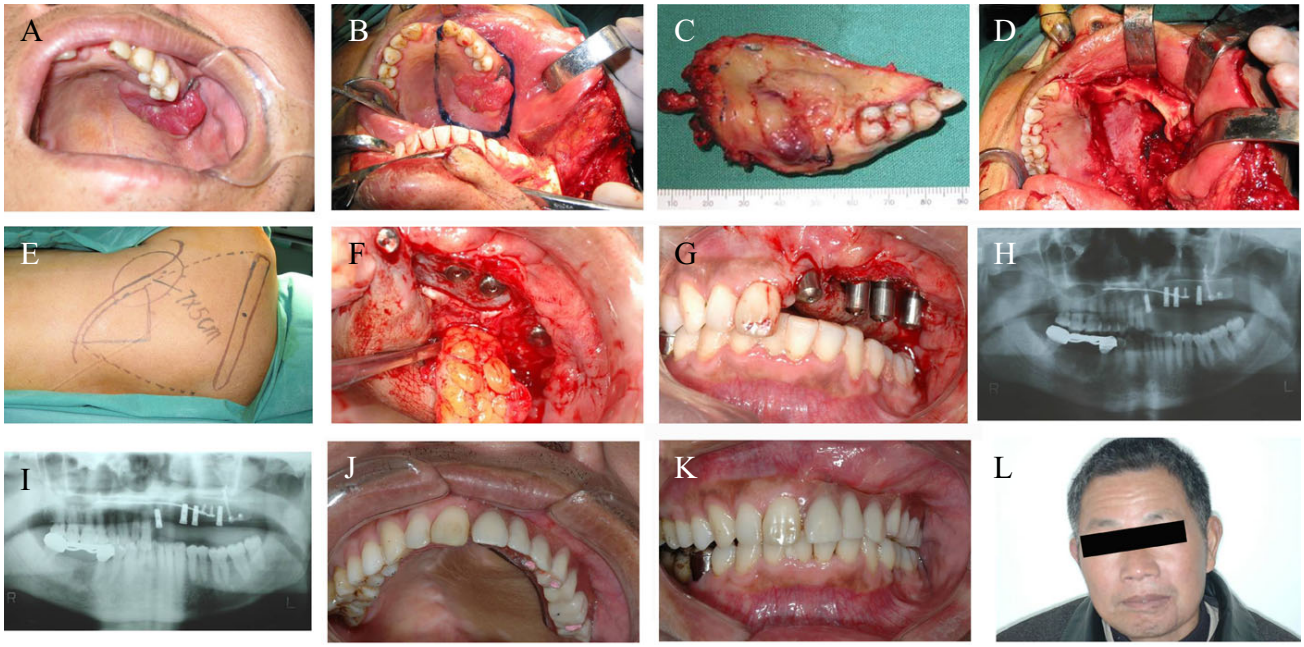

Figure 3 Clinical view of a maxillary defect reconstruction after tumor resection using conventional, implant-supported, fixed prosthetic rehabilitation (class IIb). (A–D) tumor resection; (E–I) bone graft taken from the scapula and implants placed; (J–K) implant-supported, fixed prosthetic rehabilitation; (L) picture of the patient after reconstruction.

the lateral edge of the scapula, it is variable, but frequently, it is too thin for implants placement.[20]

In this study, none of the patients experienced a total failure of the grafting procedure. Successful bone grafts provided not only adequate facial contours but also the creation of adequate support for the subsequent phases of implant placement and for restoration of oral biological functions. Based on reconstruction of the underlying bone, true restoration of oral biological functions, such as mastication and pronunciation, can be achieved using implant technology for patients with maxillary defects.

Because of the excellent bone grafts performed, the implant survival rate reached 88.6% over a relatively long observation period. During this period, a total of 10 implants in eight patients were removed due to serious bone resorption. It is worth noting that the loss of nine implants occurred in patients who had thick flaps of mucous membrane tissue in the areas of the implants around the graft. Despite surgery to graft the attached gingiva to the area where the implant was placed, it was not possible to prevent the occurrence of peri-implant infection completely. The presence of attached gingival plays a key role in the success of implant-supported restorations.[21] However, prior studies of long-term implant success and implant survival have suggested there is little or no difference in the success rates of implants placed in the oral mucosa zone compared with the attached gingival zone.[22–27] Common clinical observations reveal that mobile mucosal tissue, especially skin flap tissue, around implant restorations often promotes soft tissue inflammation. In contrast, the presence of attached gingival facilitates plaque control, limits the movement of soft tissue around implant restorations, and reduces the incidence of plaque-related peri-implant infections. However, none of the patients in our study had any attached gingiva in the restored areas. There are several differences between the use of thick and thin tissue flaps when restoring mucous membranes. In the cases of implant failure, all of the implants were placed in areas of relatively thick soft tissue flaps on the reconstructed parts of the maxilla. After implant placement, peri-implant infection occurred, followed by bone resorption. However, two implants were preserved using periodontally based treatment technology. The data in this study demonstrate that the prosthetic load appears to inhibit bone resorption effectively, allowing for functional and biomechanical stimulation of the graft. However, when comparing with the survival rates of the implants and the success rates of implants for rehabilitation of edentulous maxilla (96.8 and 92.6%,

respectively[28]), our success rates for patients with tumors were lower (88.6 and 86.3%).These differences are likely due to the following reasons: (i) the reconstruction of maxillary defects from ablation of tumors requires relatively more bone and soft tissue; (ii) the edentulous maxilla more easily acquires attached gingiva in the implanted area; (iii) the incidence of peri-implant infections is higher in patients with tumors; (iv) the oral hygiene of cancer patients is lower than healthy ones; (v) regular radiotherapy also reduces the overall success rates. Nevertheless, our data confirmed that patients with maxillary defects resulting from tumor ablation can achieve satisfactory restoration of otherwise lost functions, such as facial contour, speech, swallowing, and mastication, based on implant-mediated oral functional reconstruction.

In this report, six patients chose to use obturator prosthesis to restore oral function. Although high success rate has been achieved, the disadvantage is also very relevant. As previously described,[9] leakage, cleaning, and repeated prosthesis refinement are difficult to deal with, and also stability of the prosthesis will continuously got decreased during the process of wound healing and tissue remodeling. This results with minor leakage and food secretions into nasal cavity, which will bring more additional problems. Therefore, the satisfaction of obturator patients gets dropped more often.

Because of the retrospective nature of this study, it has some drawbacks, such as its unmatched, the style of prosthesis, nonselected patient population and its lack of a control group. Resolving these problems should be a requirement for prospective, randomized studies on this topic.

CONCLUSION

This study demonstrated that bone defects following the resection of maxillary tumors could be satisfactorily reconstructed with autogenous bone grafts taken from the fibula, ilium, or scapula. We also found that the long-term survival and success rates of implants placed in the reconstructed areas (88.6 and 86.3%, respectively) should yield a satisfactory prognosis for implant-supported prosthetic rehabilitation. However, peri-implant infection remains a disturbingly common problem, making it necessary to review patient oral hygiene instructions regularly.

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REFERENCES

1. Brown JS. Reconstruction of the maxilla with loss of the orbital floor and orbital preservation: a case for the iliac crest with internal oblique. Semin Plast Surg 2008; 22:161–174.
2. Brennan PA, Pratt C, Brown JS. Reconstruction of the total maxillectomy defect using a pedicled coronoid flap and deep circumflex iliac artery free flap. Br J Oral Maxillofac Surg 2008; 46:423–424.
3. Schulten EA, Winters HA, Koch AE. Reconstruction after surgical treatment of head and neck cancer: surgical and prosthetic possibilities. Ned Tijdschr Tandheelkd 2008; 115:215–223.
4. Cordeiro PG, Disa JJ. Challenges in midface reconstruction. Semin Surg Oncol 2000; 19:218–225.
5. Dalgorf D, Higgins K. Reconstruction of the midface and maxilla. Curr Opin Otolaryngol Head Neck Surg 2008; 16:303–311.
6. Hanasono MM, Skoracki RJ. The omega-shaped fibula osteocutaneous free flap for reconstruction of extensive midfacial defects. Plast Reconstr Surg 2010; 125:160e–162e.
7. Schliephake H. Revascularized tissue transfer for the repair of complex midfacial defects in oncologic patients. J Oral Maxillofac Surg 2000; 58:1212–1218.
8. Genden EM, Wallace D, Buchbinder D, Okay D, Urken ML. Iliac crest internal oblique osteomusculocutaneous free flap reconstruction of the postablative palatomaxillary defect. Arch Otolaryngol Head Neck Surg 2001; 127:854–861.
9. Mücke T, Hölzle F, Loeffelbein DJ, et al. Maxillary reconstruction using microvascular free flaps. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011; 111:51–57.
10. Higuchi KW. The zygomaticus fixture: an alternative approach for implant anchorage in the posterior maxilla. Ann R Australas Coll Dent Surg 2000; 15:28–33.
11. Hashemi PMS. Malignant melanoma of the oral cavity: a review of literature. Indian J Dent Res 2008; 19:47–51.
12. Harrison DF. Total rhinectomy – a worthwhile operation. J Laryngol Otol 1982; 96:1113–1123.
13. Rodrigues SJ, Saldanha S. Prosthetic rehabilitation of a patient after partial maxillectomy: a clinical report. Contemp Clin Dent 2011; 2:355–358.
14. Brown JS, Shaw RJ. Reconstruction of the maxilla and midface: introducing a new classification. Lancet Oncol 2010; 11:1001–1008.

15. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants 1986; 1:11–25.
16. Wu YQ, Huang W, Zhang ZY, Zhang ZY, Zhang CP, Sun J. Clinical outcome of dental implants placed in fibula-free flaps for orofacial reconstruction. Chin Med J (Engl) 2008; 121:1861–1865.
17. Swartz WM, Banis JC, Newton ED, Ramasastry SS, Jones NF, Acland R. The osteocutaneous scapular flap for mandibular and maxillary reconstruction. Plast Reconstr Surg 1986; 77:530–545.
18. Frodel JL Jr, Funk GF, Capper DT, et al. Osseointegrated implants: a comparative study of bone thickness in four vascularized bone flaps. Plast Reconstr Surg 1993; 92:449–455.
19. Mitchell DA, MacLeod SPR. Strategies for avoiding complications with vascularized bone flaps in head and neck microvascular reconstruction. Semin Plast Surg 2008; 22:175–185.
20. Genden EM. Reconstruction of the mandible and the maxilla: the evolution of surgical technique. Arch Facial Plast Surg 2010; 12:87–90.
21. Krygier G, Glick PL, Versman KJ, Dahlin CJ, Cochran DL. To minimize complications, is it essential that implant abutments be surrounded by keratinized tissue. Int J Oral Maxillofac Implants 1997; 12:127.
22. Branemark PI, Svensson B, van Steenberghe D. Ten-year survival rates of fixed prostheses on four or six implants ad modum Branemark in full edentulism. Clin Oral Implants Res 1995; 6:227–231.
23. Buser D, Mericske-Stern R, Bernard JP, et al. Long-term evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. Clin Oral Implants Res 1997; 8:161–172.
24. Jemt T, Chai J, Harnett J, et al. A 5-year prospective multicenter follow-up report on overdentures supported by osseointegrated implants. Int J Oral Maxillofac Implants 1996; 11:291–298.
25. Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. Clinical results and marginal bone loss. Clin Oral Implants Res 1996; 7:329–336.
26. Mericske-Stern R. Treatment outcomes with implant-supported overdentures: clinical considerations. J Prosthet Dent 1998; 79:66–73.
27. Wannfors K, Smedberg JI. A prospective clinical evaluation of different single-tooth restoration designs on osseointegrated implants. A 3-year follow-up of Branemark implants. Clin Oral Implants Res 1999; 10:453–458.
28. Mertens C, Steveling HG, Stucke K, Pretzl B, Meyer-Baumer A. Fixed implant-retained rehabilitation of the edentulous maxilla: 11-year results of a prospective study. Clin Implant Dent Relat Res 2012. DOI: 10.1111/j.1708-8208.2011.00434.x.