A Pilot Study in the Development of Indices for Predicting the Clinical Outcome of Oral Bone Grafts

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Purpose: *Bone grafting to repair osseous defects is widely used in dentistry, but little information on how to predict the clinical survival of grafted bone is currently available. As an initial step toward the establishment of formal criteria for predicting the clinical outcome of oral bone grafts, this pilot study sought to determine the relevance of adverse clinical and radiographic parameters as predictor variables for graft survival.* ***Materials and Methods:*** *Eighty patients presenting with a variety of clinical conditions were treated with 83 oral bone grafts. Alloplastic, allogenic, and/or autogenous materials were used with or without barrier membranes. During follow-up appointments at 1 week, 1 month, 3 months, 6 months, 1 year, and 2 years after grafting, a series of clinical and radiographic parameters were used to evaluate the degree of graft integration. The data were then analyzed to determine the prediction accuracy of each variable in relation to the results of the graft.* ***Results:*** *The findings of this clinical study suggest that the variables of (1) graft type, (2) inflammation, (3) infection, (4) fistula, (5) graft exposure, (6) pain, and (7) radiolucency were good indices for predicting graft survival, especially with cumulative data.* ***Discussion:*** *The quality of the prognostic indices appeared to be good and should be further investigated for future applications.* ***Conclusions:*** *The cumulative index, with a sensitivity of 88.9% and a specificity of 93.8%, was the best predictor of clinical outcome. The 1-month and 3-month indices were similar.* INT J ORAL MAXILLOFAC IMPLANTS 2005;20:595–604

Key words: *bone augmentation, bone grafting, indices*

Residual bone has an inherent potential to repair most osseous defects resulting from tooth extraction, but subsequent facial bone loss can be significant.[1] Some clinical situations require the use of bone grafts and/or bone substitutes as augmentative material to facilitate bone fill, especially when the osseous defect is of considerable size or when lack of intervention may lead to further jaw damage, as in the case of a trauma-related fracture.

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In implant dentistry, bone grafting, guided bone regeneration, or a combination of these procedures is often performed to augment defects and preserve or increase bone volume for implant placement.[2] It is no longer acceptable for implants to be placed in unfavorable restorative positions because of the anatomy of the residual ridges. Postextraction augmentation of tooth sockets is frequently performed to help preserve the horizontal and vertical dimensions of the ridge. However, a healing period of approximately 16 weeks is required to allow the bone to regenerate and fill the bony socket before an implant can be placed.[3] Consequently, treatment time is prolonged, and bone resorption may still occur.

In some cases, implants are placed directly into fresh tooth extraction sockets. In these cases, graft material may be placed around the crestal gap between the implant body and the tooth socket and/or a barrier membrane may be used to facilitate osseous regeneration. In the case of pneumatized

Table 1 Patient Selection Criteria

Inclusion	Exclusion

• One of the following osseous defects
  • Alveolar ridge defect
  • Cystic defect
  • Apicotomy
  • Fenestration
  • Dehiscence
  • Atrophic posterior maxilla
• Good systemic health
• Willingness to participate in the study
• Medium to high level of education
• Chronological adult
• Signed written informed consent prior to inclusion
	• Unwilling to participate in the study
	• Mental disturbance
	• Immune system diseases or immunotherapy
	• Evidence of poor oral hygiene
	• Diabetes
	• Pulmonary, renal, or cardiovascular diseases
	• Hypertension
	• Blood diseases
	• Use of anticoagulants, steriods, or anticonvulsants
	• Malignant neoplasias
	• Burns
	• Multiple injuries
	• Clinical history of the following infections:
	  • Hepatitis
	  • Septicemia
	  • AIDS or other autoimmue diseases
	  • Syphilis
	  • Tuberculosis
	  • Mycosis
	• Other diseases or conditions:
	  • Drug abuse
	  • Blood transfusion 6 months prior to grafting

maxillary sinuses, the total width and height of bone is often inadequate for initial stabilization of the implants,[4] and it is necessary to resort to maxillary sinus augmentation with simultaneous or delayed implant placement. Surgeons must advise patients of the availability of augmentation techniques that can significantly improve the ultimate success of the restoration.[5]

Grafts are also used in response to patients' demands for improved esthetics and functioning; to treat congenital and traumatic defects, severe atrophy of the mandible, and cysts; and in resective and ablative tumor surgery. Autologous, allogenic, and alloplastic materials have all been advocated as graft materials, but little evidence of long-term success has been reported. Every patient receiving an implant or graft has the right to be informed of the advantages and potential risks of the procedure and its chances for success. At present, however, it is not possible for the practitioner to fully inform the patient in regard to the benefits and risks of bone grafts.

As an initial step toward the establishment of formal criteria for predicting the clinical outcome of oral bone grafts, this pilot study sought to determine the relevance of adverse clinical and radiographic parameters as predictor variables for graft survival.

MATERIALS AND METHODS

Patients

Candidates for this study were patients with maxillary osseous defects who presented for treatment at 5 different study centers in Granada, Spain: Granada University School of Dentistry, Virgen de las Nieves Hospital, Nuestra Señora de la Salud Clinic, Inmaculada Concepción Clinic, and a private surgery practice. A comprehensive diagnostic workup that included oral and radiographic examinations, a review of medical and dental histories, mounted diagnostic casts, and diagnostic waxups was conducted for all patients. After alternative treatment options and requirements for study participation were thoroughly explained, patients who met strict selection criteria (Table 1) were admitted to the study.[6,7]

Grafts and Membranes

Study patients were treated with a variety of graft materials with or without barrier membranes (Table 2). Autogenous grafts were usually harvested from the symphysis region. In cases where the bone deficit was small, the graft was sometimes harvested from a site adjacent to the deficit itself to avoid another surgery. If a graft of greater volume was necessary (eg, for bilateral maxillary sinus floor augmentation),

Table 2 Description of Graft Materials Used in the Study

Type/Source	Description	Benefits	Supplemental material
Graft			
Autograft Patient	Bone harvested from many sites, including the mandibular symphysis, maxillary alveolar crest and zygomatic process, mandibular retromolar trigone, maxillary tuberosity, mandibular torus, anterior nasal spine, and iliac crest	Osteogenic, osteoinductive, and osteoconductive properties may enhance bone regeneration	Barrier membrane used in some cases
Allograft Cadaver	Demineralized cortical powder* Cancellous bone chips†	Avoidance of donor site morbidity; alternative for patients who refuse autografts	Barrier membrane used in all cases‡
Synthetic	Calcium-layered copolymer§ Nonresorbable hydroxyapatite (HA)‖,¶	Avoidance of donor site morbidity; alternative for patients who refuse autografts	Barrier membrane used in some cases
Xenograft Bovine	Bovine bone#	Avoidance of donor site morbidity; alternative for patients who refuse autografts	Barrier membrane used in some cases
Barrier membrane			
Resorbable Bovine	Collagen type 1**	Exclusion of epithelial cells from the graft site	Bone graft material and fixation screws††,‡‡,§§ used in all cases
Porcine	Collagen types 1 and 3‖‖	Exclusion of epithelial cells from the graft site	Bone graft material and fixation screws††,‡‡,§§ used in all cases
Synthetic	Polyglactin 910¶¶ or Polylactic acid##	Exclusion of epithelial cells from the graft site	Bone graft material and fixation screws††,‡‡,§§ used in all cases
Nonresorbable Synthetic	Expanded polytetrafluoroethylene	Exclusion of epithelial cells from the graft site	Bone graft material and fixation screws††,‡‡,§§ used in all cases

*Central Florida Tissue Bank, Orlando, FL.
†Tissue Bank of Samara, Samara, Russia.
‡Gore-Tex, W.L. Gore, Flagstaff, AZ.
§Bio-Plant HTR, South Norwalk, CT.
‖Calcitite, Zimmer Dental, Carlsbad, CA.
¶Osteograf, Dentsply Friadent Ceramed, Lakewood, CO.
#Alveolar and Surgical Laddec, Laboratories Transphyto, Clermont-Ferrand, France.
**BioMend, Zimmer Dental.
††Titanium screws: Memfix System, Straumann USA, Waltham, MA; Osteosynthesis Screws, Walter Lorenz Surgical, Jacksonville, FL.
‡‡Mini screws: Frios Augmentation System, Dentsply Friadent, Ceramed.
§§In some cases, the implant's surgical cover screw was used to secure the membrane.
‖‖Periogen, Collagen, Palo Alto, CA.
¶¶Vicryl, Ethnor S.A., Neuilly, France.
##Guidor, Huddinge, Sweden.

autogenous bone was harvested from the iliac crest. If the deficit was adjacent to an important anatomic structure, such as a nerve, the nasal fossae, or the maxillary sinus, autogenous grafts were used. Other types of grafts were used in small- or medium-sized defects to avoid donor site morbidity or when the patient refused the placement of autografts. In 17 cases where the osseous defect was very large and it was not possible to obtain an autograft from the iliac crest, composite grafts were placed: autograft and allograft (5 cases); autograft and HA (5 cases); allograft and HA (4 cases); or autograft, allograft, and HA (3 cases). All composite grafts consisted of 50% autogenous bone.

In some cases, grafts were placed with barrier membranes for guided bone regeneration and held

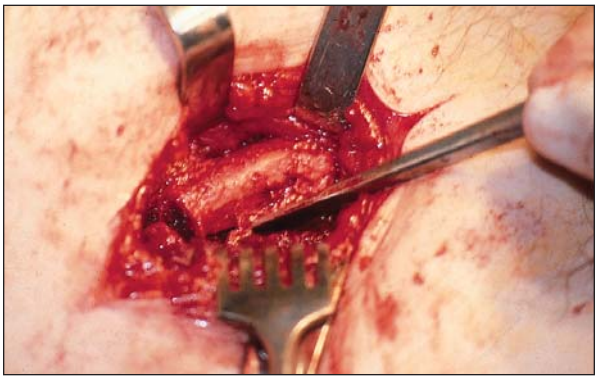

Fig 1a Iliac crest graft.

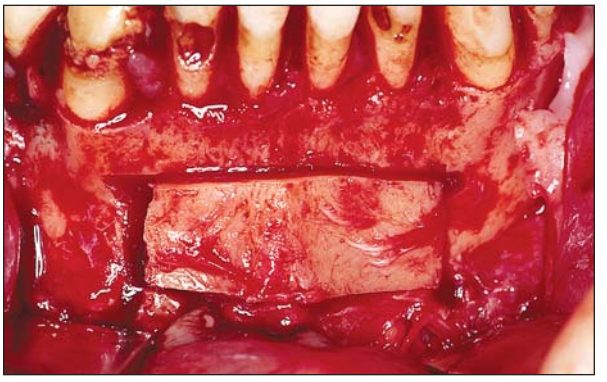

Fig 1b Mandibular symphysis graft.

in place with fixation screws (Table 2). Resorbable membranes were used in maxillary sinus floor augmentation as well as in some cases of osseous dehiscences and fenestrations around implants. Nonresorbable membranes were used in some cases of alveolar ridge augmentation.

Surgical Procedures

An aseptic surgical technique was utilized. Patients who received grafts from oral donor sites (65%) were treated under local anesthesia, while patients who received grafts harvested from the iliac crest (35%) were treated under general anesthesia.

Autogenous grafts were harvested from the iliac crest with a slow-speed rotary saw and consisted of a single layer of the outer cortex and a thicker cancellous component (Fig 1a). Rectangular grafts were obtained from the mandibular symphysis using a microsaw; care was taken to keep the lingual cortex and the mental nerve intact (Fig 1b). Other donor sites included the anterior nasal spine, which was trimmed with a gouge; the maxillary alveolar crest and zygomatic process, from which small cortical grafts were obtained with extreme care to prevent damage to the maxillary sinus; and the retromolar trigone, from which graft material was obtained using a technique similar to that used for extracting third molars. An exostosis in the mandible (ie, a mandibular torus) was used in only 1 case; the bone was harvested using the conventional technique. When bone chips were used, the edges were smoothed to help prevent foreign-body rejection. Autografts were kept in physiologic serum until their use.

Wide incisions extending beyond the osseous defect were made mesial and distal to the defect. A full-thickness flap was elevated to expose the defect, and the surface of the bone was cleaned of remaining muscle and periosteal fibers. The bone was perforated to induce bleeding, and the selected graft material was allowed to become completely saturated with the patient's blood as it was placed into the osseous defect. Graft coverage was achieved without tension by mobilizing the mucoperiosteal flap through a transperiosteal incision at its base, followed by suturing. If an autogenous graft was obtained from the symphysis, a chin cap was placed to prevent bruising.

Postsurgery

Postoperative antibiotics, anti-inflammatories, and analgesics were prescribed for 1 week, and chlorhexidine 0.2% mouth rinse was used for 2 weeks. Patients were advised to apply ice to the surgical area from time to time immediately after the operation. One week after surgery, the sutures were removed. In cases of alveolar ridge augmentation, a provisional removable denture was adjusted to avoid contact with the grafted area.

Patients were recalled for postoperative monitoring at 1 week, 1 month, 3 months, 6 months, 1 year, and 2 years after grafting. Adverse clinical and radiographic parameters were evaluated, recorded, and treated during each monitoring appointment (Table 3 and Figs 2a to 2d). Radiolucency around more than 60% of the graft or an adverse clinical parameter (Table 3) and the presence of a nonincorporated graft were deemed evidence of graft failure. In contrast, a graft was considered successful if it was clinically incorporated and exhibited no evidence of graft failure and if radiolucency did not exceed 60% of the graft's perimeter.

Table 3 Postoperative Clinical Monitoring: Adverse Parameters Evaluated, Recorded, and Treated

Clinical Pathologies	Radiographic Abnormalities
• Soft tissue: Fistula, inflammation, infection, graft exposure • Neurological: Pain, parasthesia, dysesthesia • Systemic: Fever, asthenia • Maxillary sinus: sinusitis, epistaxis, cacosmia • Donor site • Iliac crest: Pain, hyperesthesia, paresthesia, delay in walking, hernia, bruising, seroma • Intraoral: Pain, inflammation • Mandibular symphysis: Paresthesia, dysesthesia, tension	• Radiolucent area in the panoramic radiograph: < 30%; 30% to 60%; > 60% • Encapsulation/fibrous halo in the panoramic radiograph: Radiolucency in the area surrounding the graft • Osseous voids in the panoramic radiograph or CT scan: Radiolucency within the graft • Irregular radiolucency within the panoramic radiograph: Irregular radiolucency around the graft

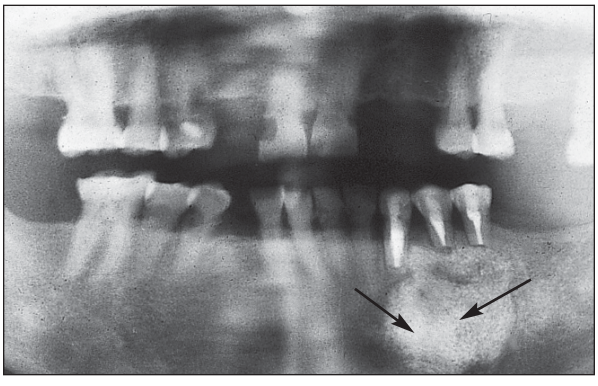

Fig 2a Encapsulation, appearing as a fibrous halo *(arrows)* in the panoramic radiograph.

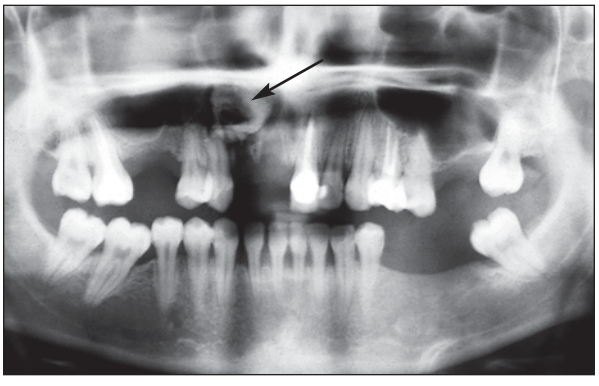

Fig 2b Panoramic radiograph demonstrating osseous voids *(arrow)*.

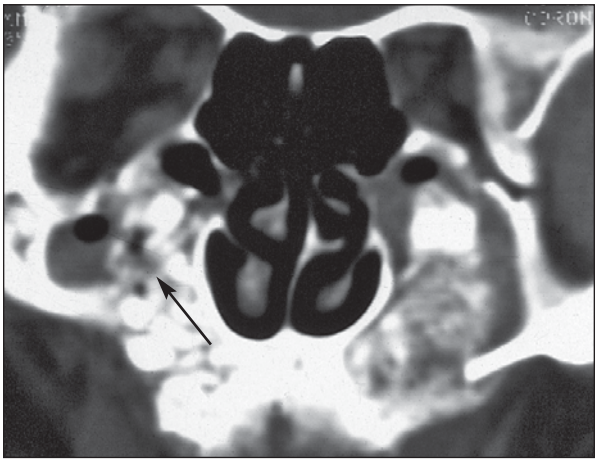

Fig 2c CT scan demonstrating osseous voids *(arrow)*.

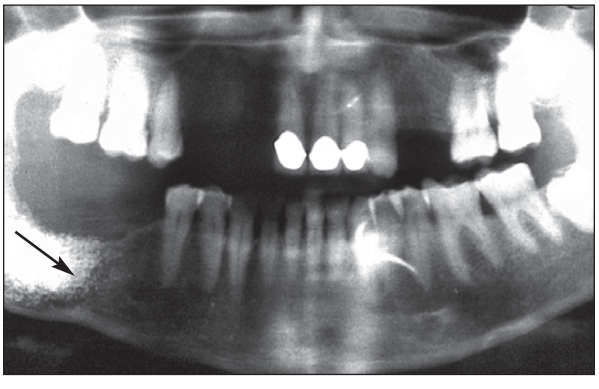

Fig 2d Panoramic radiograph demonstrating irregular radiolucency *(arrows)*.

Table 4 Models of Results Derived from Data Obtained During Follow-up Period

Variable	Week 1			Month 1			Month 3		
	Odds ratio	95% CI	*P*	Odds ratio	95% CI	*P*	Odds ratio	95% CI	*P*
Graft	5.3	1.1–26.9	.05	4.4	0.6–35.5	.1831	10.1	0.4–755	.2141
Inflammation	5.5	1.5–21.8	.01						
Fistula							35.4	2.7–2258	.01
Exposure of graft				6.9	1.1–53	.05			
Radiolucent area >30%				35	5.3–439	.01	27.8	3.1–1358	.001

Table 5 Models of Results Derived from Data Obtained During Follow-up Period

Variable	Model I			Model II		
	Odds ratio	95% CI	*P*	Odds ratio	95% CI	*P*
Graft	5.20	0.3–312.8	.3339	2.9	0.1–65.8	.7532
Inflammation after 1 week	1.20	0.0–14.8	>.99			
Exposure of graft after 1 month	3.80	0.3–49.5	.3514			
Fistula after 3 months	20.0	1.7–1083.3	<.05	36.4	3.6–621.7	<.001
Radiolucent area >30% after 1 month	22.2	1.3–1678.4	<.05	58.0	6.3–984.1	<.001
Radiolucent area >30% after 3 months	3.70	0.2–278.4	.6293			

Statistical Analysis

A descriptive analysis of all variables in the study was carried out using frequency distribution. In the following phase, the bi-variant association of the different factors together with the graft failures was studied, using the appropriate table of contingency and the Fisher exact test (or its generalization in the case of tables that were not 2 × 2). Since the sample size was small, exact logistic regression was used in multivariate analysis to study association among different factors and failure of grafts. The statistical analyses were conducted with predictive analytics software (SPSS 10.0; SPSS, Chicago, IL) and logistic regression software (LogXact 3.0; Cytel Software, Cambridge, MA). A *P* value of < .05 was considered statistically significant .

RESULTS

Eighty patients ranging in age from 17 to 64 years (mean = 40.6 years) were selected for the study and treated with a total of 83 grafts (bilateral sinus augmentation was performed in 3 cases). Cysts were the type of osseous defect most frequently treated with grafts (33%). Maxillary sinus augmentation was the most common procedure (26.8%), followed by grafting of the alveolar ridge (16.5%). As stated, the choice of graft type was not random; the results obtained have been evaluated accordingly.

Follow-up

1 Week Postgrafting. During the first week, the variables "graft" and "inflammation" affected the variable "results of graft." This effect was independent for each of these 2 variables. Treatment with a heterologous graft increased the risk of graft failure by 5.3 times in relation to treatment with other graft types (odds ratio [OR] = 5.3). The existence of serious inflammation during the first week postsurgery increased the possibility of failure by 5.5 times (OR = 5.5). During the first week, no other clinical or radiographic variables were associated with the results of the graft (Table 4).

1 Month Postgrafting. During the first month after grafting, the parameters most relevant to the results of the graft were exposure of the graft material (OR = 6.9) and radiolucency > 30% (OR = 35.0) (Table 4).

3 Months Postgrafting. The presence of a fistula 3 months after grafting was associated with an increased risk of failure (OR = 35.4), as was radiolucency > 30% (OR = 27.8) (Table 4).

Models

After the 3-month follow-up, model I was constructed from the accumulated data derived from all the relevant variables studied at every patient follow-up during the first 3 months: type of graft and inflammation at the 1-week follow-up, exposure of the material at the 1-month follow-up, the presence of a fistula at the 3-month follow-up,

Table 6 Prognostic Indices by Time Interval

Index/Score	Success n	Success %	Failure n	Failure %	Total
Week 1 Prognostic Index					
0	47	72.3	5	27.8	52
1	17	26.2	8	44.4	25
2	1	1.5	5	27.8	6
Total	65		18		83
Month 1 Prognostic Index					
0	52	80.0	1	5.6	53
1	3	4.6	2	11.1	5
2	6	9.2	2	11.1	8
3	2	3.1	1	5.6	3
5	1	1.5	2	11.1	3
6	1	1.5	3	16.7	4
7	0	0.0	6	33.3	6
8	0	0.0	1	5.6	1
Total	65		18		83
Month 3 Prognostic Index					
0	48	73.8	0	0.0	48
1	5	7.7	3	16.7	8
3	11	16.9	7	38.9	18
4	1	1.5	0	0.0	1
6	0	0.0	4	22.2	4
7	0	0.0	4	22.2	4
Total	65		18		83
Cumulative Prognostic Index					
1	61	93.8	2	11.1	63
2	2	3.1	4	22.2	6
3	2	3.1	6	33.3	8
5	0	0.0	6	33.3	6
Total	65		18		83

and radiolucency > 30% after the 1- and 3-month follow-ups (Table 5). The variables most closely associated with the results of the graft were radiolucency > 30% after 1 month (OR = 22.2) and the presence of a fistula after 3 months (OR = 20.0).

Subsequently, model II (Table 5) was constructed to fit these data. Model II revealed that, statistically, the effect of graft type on the results of the graft was not independent of the influence of radiolucency > 30% or of the presence of a fistula at the 3-month follow-up. Also, the presence of radiolucency > 30% at the 1-month follow-up proved to be a significant risk factor for graft failure (OR = 58.0), as did the presence of a fistula at the 3-month follow-up (OR = 36.4).

Prognostic Indices Obtained During Follow-up

Using the results of the models derived from the follow-up study, prognostic indices were obtained from the OR for the different models.

Week 1 Prognostic Index. Using the data available from the 1-week follow-up, a prognostic index was created that included the type of graft and the presence or lack of inflammation (Table 6): 0 = no risk factors present, 1 = 1 risk factor present, 2 = both risk factors present. Adopting a cutoff value of 1, this index had a sensitivity of 72.2% and a specificity of 72.3%.

Month 1 Prognostic Index. For this index, a value of 1 was assigned for the presence of the graft, a value of 2 for exposure of the graft material, and a value of 5 for the presence of radiolucency > 30% (Table 6). The other values were obtained by adding various parameters. When a cutoff value of 2 was adopted, this index had a sensitivity of 83.3% and a specificity of 84.6%. As might be expected, these values were higher than those that only included data from the 1-week follow-up.

Month 3 Prognostic Index. A value of 1 was assigned for the presence of a heterologous graft, and a value of 3 for the presence of a fistula or radiolucency > 30% (Table 6). Other values resulted from adding these parameters. This index had a sensitivity of 83.3% and a specificity of 81.5%; the cutoff value was 3.

Cumulative Prognostic Index. This index was constructed from the data obtained from the first 3 follow-ups, using the most discriminating variables; hence, it provides the best results (Table 6). When a

cutoff value of 2 is adopted, this index presents a sensitivity of 88.9% and a specificity of 93.8%. A value of 2 corresponded to the presence of a fistula after 3 months and a value of 3 to radiolucency > 30%.

DISCUSSION

Augmentation of atrophic jaws with inlay[8–10] and/or onlay[8,11–17] bone grafts has been widely reported in the dental literature. In the present study, 33% of clinical cases involved the grafting of deficits caused by cysts. This percentage is related to the high frequency of this type of lesion. Augmentation of the maxillary sinus floor represented 27% of the grafts. While research continues on new bone graft materials, the current consensus is that autogenous bone exhibits the most suitable properties (ie, osteogenesis, osteoinductivity, osteoconductivity), despite the many problems associated with donor site morbidity.[3,4,18,19]

In the present study, 80% of the autografts were obtained primarily from the mandibular symphysis. Harvesting bone from the symphysis requires less extensive surgery than harvesting bone from an extraoral site.[20] Intraoral bone presents a lower level of resorption than extraoral grafts[21] and has a high osteoinductive potential. Authors such as Misch and colleagues[22] and Buser and associates[23] also prefer this type of bone because of its high quality. Nevertheless, in some situations, such as defects caused by congenital malformations, severe trauma, large cysts, or neoplastic processes, the iliac crest is the most suitable donor site because of its structure and the large volume of bone available.[24,25] For these reasons, bone from the iliac crest was used for sinus floor elevation in this investigation. In this study, the worst results were obtained with heterologous graft materials.

The clinical and radiographic parameters evaluated during follow-up enabled the observation of the integration of the grafts placed in each clinical situation and the prediction of the degree of success or failure of each graft by means of indices which have hitherto been unavailable in the literature on the subject.

Each parameter evolved over time. Some were interrelated and even associated; multivariate analysis revealed the influence of individual factors. In many cases, however, it was not possible to obtain external validation, as no other studies of this kind were found in the literature.

Follow-up

1 Week Postgrafting. The most common clinical parameter among patients, regardless of graft type, was inflammation of the affected area (96.4%), followed by pain (37.3%) and infection (19.5%). However, in the case of small fenestrations, the percentage of patients not presenting inflammation was significantly higher than in other clinical situations. Inflammation is a consequence of the trauma arising from surgery and of the arrival of inflammatory cells concentrating around the newly incorporated graft, which is perceived as a foreign body. When the graft is gradually degraded by osseous tissue, the incorporation occurs by creeping substitution.[26] Osseous voids in 2 patients were the only radiographic parameters presented; these were related to incorrect packing of the graft or early loss of material because of infection. To prevent insufficient material packing and to obtain the greatest possible number of cells per surface unit, the graft was always compacted as much as possible when autogenous grafts were used. To prevent the exposure of material from stress, either wide flaps were used or an incision was made in the periosteum at the base of the flap to enable repositioning.

1 Month Postgrafting. Inflammation was considerably reduced, but dysesthesia was found to in 33.7% of the patients. This sensitivity disorder was manifested by the patient as an "itching" sensation or as an awareness of "something" in the graft zone. When the patients were examined by panoramic radiography, 16.9% presented a level of radiolucency of between 30% and 60%. This was particularly evident in cases where HA graft material had been used. Radiolucency was lower for autogenous grafts.

3 Months Postgrafting. During this interval, 1 patient lost a graft. The patient was purged from the study and re-treated. The "exposure of material" parameter rose compared to the levels at the 1-month follow-up. After 3 months, all 4 radiographic parameters had been encountered. Almost all the patients presented a level of radiolucency of less than 30% because of initial, natural resorption of the graft, although the number of patients presenting radiolucency of 30% to 60% had increased. The percentage of patients with osseous voids also increased, particularly in cases where it was difficult to pack the graft, such as sinus lifts, cyst defects, remodeling of alveolar ridges, and large defects. In time, osseous voids appeared in zones where graft vascularization did not occur, which supports the finding that osteocytes die if they are located more than 300 μm from vascular support.[25] Irregularities also increased and a new parameter appeared, encapsulation or fibrous halo (7.3%), a more or less well-defined radiolucent halo surrounding the graft, which indicated that new bone had failed to aggregate over the graft. This halo occurred most frequently with HA grafts.

6 Months Postgrafting. Clinical parameters were, in general, less marked than radiographic parameters. By the 6-month follow-up, 74 patients remained in the study; 5 patients had been excluded because of graft failure. The latter were subsequently retreated but purged from the study data. The study was thus limited to patients for whom the graft functioned well, which accounted for the presentation of fewer problems. Radiographic parameters were seen more frequently than during the 3 previous months because of graft consolidation and a reduction in the varied symptomology characteristic during the earlier stages of clinical follow-up. Radiolucency of > 30% was present in 39.2% of the cases. There was a slight increase (from 6% to 6.8%) in the percentage of patients presenting radiolucency > 60%, which represented the radiographic failure of the graft. Osseous voids were found in 28.4% of cases, irregularities in 24.3%, and a fibrous halo in 21.6%.

1 Year Postgrafting. The most notable clinical parameter was dysesthesia (25%); all other parameters were relatively infrequent (1% to 4%). During follow-up, dysesthesia served as an indicator that the graft was successful, as long as no other symptoms were perceived. Radiographic parameters, in general, were also more evident. Because of a lack of vascularization in the graft, osseous voids were seen, mainly in zones bordered by thick, wide cortical tissues or in large cavities.

2 Years Postgrafting. At this point, 60 patients remained in the study, and 19 patients had been excluded as a result of graft failure or voluntary withdrawal prior to completing the second year of follow-up. Most of the clinical parameters continued to be presented infrequently, but 16.7% of patients still presented with dysesthesia. Of the radiographic parameters, radiolucency > 30%, osseous voids, and encapsulation increased. Nevertheless, there were fewer irregularities, as the grafts were now integrated and, in almost every case, surrounded by appositional bone penetrating the graft like the fingers of a glove. The process of repair was complete.

There appeared to be a clear relationship between the clinical and radiographic parameters in the present study. Radiographic parameters provided important information about the state and integration of the grafts placed and about the formation of appositional bone around the grafts. Clinical parameters were valuable in providing an early warning of the success or failure of the graft. The ORs may be large because of the size of the sample and the number of failures, and must therefore be interpreted with caution; they are presented here only as tendencies.

After 1 month of clinical follow-up, patients with infection had a greater probability of presenting radiolucency of 30% to 60% than those without infection. This was also true for those with fistulas, pain, or exposure of material. In patients with dysesthesia, however, there was a lower probability of radiolucency of 30% to 60%, which served as a positive indicator of graft success. After 3 months of clinical follow-up, there were significant signs that patients with inflammation and infection had a greater probability of presenting radiolucency of > 60%. It was also observed that, as infection increased, so did the level of radiolucency, but no definitive conclusions could be drawn because of the small sample size. Patients with dysesthesia were more likely to present with encapsulation, and those with osseous voids tended to suffer more pain. Nevertheless, no relationship was found between irregularities and the other clinical parameters. Patients presenting fistulas, exposure of material, and pain had a greater probability of radiolucency > 60%, which may be attributed to a pattern of infection that affected the consolidation of the graft and resulted in a larger percentage of it being reabsorbed.

The existence of a relationship between the clinical and radiographic parameters led to the consideration that the relatively simple task of evaluating a series of parameters may be used as a means of predicting the results of graft treatment. The application of such predictive indices could be useful, and although other similar studies have not been found for comparison, this may be a suitable starting point for future research.

CONCLUSIONS

The quality of the prognostic indices appeared to be excellent. The most accurate index was the cumulative index, with a sensitivity value of 88.9% and a specificity value of 93.8%. The 1-month and 3-month indices were similar. Oral surgeons may effectively apply these indices to predict the results of grafts. Further research to this end would be of interest.

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