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Dental Implants in Patients With Type 2 Diabetes Mellitus: A Clinical Study

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Replacing missing teeth with osseointegrated dental implants is a predictable technique as evidenced by the overall 5-year implant survival rates ranging from 93% to 97%.

The first clinical application of dental implants was to retain and support a full-mouth prosthetic appliance in edentulous patients who had problems with retention or with adaptation to removable full dentures.

In the last 15 years the use of dental implants has been extended to provide mechanical attachment for support and retention of removable overdentures. Some authors described a protocol for placement of four implants in the anterior mandible to support an overdenture. The implant-supported overdenture should reduce stress on the tissues and stabilize the prosthesis, making it more wearable to patients. Therefore, an implant-retained overdenture can be considered a good alternative.

A 5-year survival rate of more than 95% in studies of implant-supporting mandibular overdentures was reported, and research has demonstrated improved masticatory function and overall satisfaction in implant patients.

Local and systemic factors can influence the success rate of dental implants. Adequate patient selection, treatment planning, implant design, suitable implant materials, good surgical technique, and restorative treatment are crucial for the success of the procedure. Yet it can also be negatively affected by factors such as impaired wound healing, metabolic bone disease, and smoking. As implant surgery and subsequent prosthetic restoration are becoming more popular, the demand for implant-retaining overdentures will increase.

The populations that can benefit most from this treatment modality are older persons. Improvements in medical care have created a higher percentage of senior patients suffering from an increased incidence of chronic illnesses, such as diabetes mellitus and metabolic bone disease, which may influence success rates of dental implants.

Umino and Nagao investigated 1012 elderly patients and found that one or more systemic diseases were present in approximately 65% of the subjects. In their study, cardiovascular diseases were the most frequent systemic diseases followed by diabetes mellitus, a disease related to an absolute or relative insulin insufficiency and the third leading cause of death in the United States. Diabetes presents in two distinct forms: the insulin-dependent and the non-insulin-dependent types. Diabetic patients are said to be more prone to develop infections and vascular complications. Tissue perfusion and microvascular diseases have an important role in wound healing. Since diabetes is associated with microvascular changes, patients with diabetes have poor wound-healing potential. The healing process of hard and soft
tissues in the diabetic patient is also delayed as a result of decreased protein metabolism. It is also affected by impaired function of the neutrophilic leucocytes. Because of such considerations, diabetes has sometimes been considered a contraindication for the use of dental implants. We describe our experience using the MIS implant system (Medical Implant System, Shlomi, Israel) for retention of overdentures in patients with type 2 diabetes mellitus, and provide data regarding the level of satisfaction of the patients and improvements in function, mucosal and perimplant health, and bone level around implants in this group.

MATERIALS AND METHODS

The group under investigation included patients with well-controlled type 2 diabetes mellitus who were referred to our clinic for insertion of dental implants in the anterior mandible, destined to serve for retention of overdentures. A prosthodontist determined the treatment planning, an oral and maxillofacial surgeon examined the patients, and these specialists then decided whether there was an indication for implant insertion and restoration as defined. Blood glucose levels were monitored and tabulated for all patients 1 week preoperatively, on the day of the operation, and 1 week following implantation. Each patient’s condition was managed and controlled by their assigned family physician. Efforts were made to meet the plasma glucose levels recommended by the American Diabetes Association (fasting plasma glucose of 140 mm/dL and 2-hour postprandial glucose of 200 mm/dL). The implants used in this study were the MIS implant system (Medical Implant System) screw type, with a 3.75-mm diameter and ranging in length from 10 to 16 mm. The second stage, uncovering, was accomplished 3 months after osseointegration of implants. Fabrication of the infrastructures, ball attachment, or bar-supporting overdenture was then started.

Perimplant health was evaluated during the observation period 3 weeks and 6 and 12 months after implantation in relation to perimplantitis, peri-implant mucositis, mucosal hyperplasia, and fistula formation.

Each patient completed a questionnaire related to his or her level of satisfaction and to the improvement of function with the new dentures. All patients underwent standardized panoramic radiography preoperatively and at 3, 6, 12, 24, and 36 months after implantation. All X-rays were digitized and stored electronically using a computer-based measurement software (X-View Inc, Jerusalem), the height of the alveolar bone was measured from the top of the implant to the most apical end, all implants were submerged.

Patients were advised to continue taking their regular medication as prescribed. Eighteen patients were instructed to receive 2 g amoxicillin daily 1 day before the operation and for 5 additional days, whereas those who were allergic to penicillin (16 patients) received 600 mg clindamycin daily.

Using local anesthesia, implants were inserted in the anterior aspect of the mandible using a standard surgical technique. Patients were scheduled for follow-up visits 1 and 3 weeks and 3, 6, 12, and 36 months after implantation.

The criteria for success of the implant were stable implants and structures with no symptoms of pain and without signs of inflammation and purulent discharge, loss of no more than 1 mm bone around the implant in the first year, and radioiucency around implants. For the purpose of analysis we divided the patients into subgroups according to age (over 65 years and 65 years and under) and to the number of implants.

Pearson correlation coefficient test was used for statistical analysis. The Pearson coefficient of correlation measures the strength of a relationship between two variables in a population; its values range between –1 for a negative correlation to +1 for a positive correlation.

RESULTS

The study group consisted of 41 patients (26 males and 15 females) with type 2 diabetes mellitus who were treated with dental implants. A total of 141 implants were placed; every patient received three or four implants at the anterior aspect of the mandible for retention of overdentures (Figs. 1 and 2). Four implants failed during the observation period; two during the second surgical stage and two during the 2-year period after implantation and restoration. The failed implants were mobile during the clinical examination. Success rates of 97.2% and 94.4% were observed during the first and fifth years, respectively.

Three months after implantation, implants were uncovered and restored; 24 patients received ball attachments for retention of overdentures while 17 patients received bars (Fig. 3).

A gradual elevation in glucose level occurred during the intraoperative and immediate postoperative period. One week after implantation, levels returned to near-preoperative values (Fig. 4). No correlation was found between failed implants and glucose levels in our study group.

The majority of patients reported improvement of function, chewing, and general satisfaction from the new treatment. Only four patients (2.8%) were completely dissatisfied with their treatment and five patients (3.4%) reported no change in function with the new implant-retained overdenture. Perimplant complications were observed in three patients; these complications were confined to the mucosa only, or a combination of the mucosa and the bone. The complications appeared to be due to poor adaptation of the denture. Perimplant mucositis or hyperplasia was observed in 1 of 26 patients (3.8%) in the ball attachment-retained overdenture group and in 2 of 15 patients (13.3%) in the bar-retained group. A high correlation was observed between mucosal health and satisfaction from the treatment ($R = 0.933$) (Fig. 4). In addition a good correlation was observed between mucosal health and improvement in function ($R = 0.737$) and chewing ($R = 0.842$). In the bar-retained overdenture group a good correlation was found between mucosal health and satisfaction from the treatment ($R = 0.865$) and between mucosal health and improvement of function ($R = 0.859$) and chewing ($R = 0.859$).
A low correlation was observed between glucose level and improvement of function. The analyses of our results show a very good correlation between males and females regarding improvement in chewing ($R = 0.996$), while the male:female correlation concerning satisfaction from the new treatment and mucosal health was much lower ($R = 0.528$).

Analysis of our results by patient age showed a better satisfaction from the new treatment in patients older than 65 years, while the improvement of chewing was equal between older and younger age groups. The analysis of the results by number of implants showed a very low correlation between number of implants and improvement of function ($R = 0.217$).

The main bone loss around implants was approximately 0.5 mm in the first year, and no correlation was found between bone loss and glucose level.

**DISCUSSION**

Proper selection of patients for dental implants treatment is one of the most important factors that can influence the prognosis and integration of implants. A primary complication in the integration of dental implants includes traumatic surgery, in which frictional heat generated during placement of implant causes necrosis to the surrounding tissues and consequently lack of healing and integration. A second complication that interferes with bone integration is an implant recipient site of low healing potential. Some authors claim that various systemic factors such as osteoporosis, diabetes, severe alcoholism, renal disease, and uncontrolled metabolic disorders increase the rate of implant failure. However, there is a lack of data regarding the influence of systemic diseases, especially diabetes mellitus, on dental implant integration and long-term success rate in humans.

Takeshiwa et al. studied differences between diabetic and nondiabetic rats treated with hydroxyapatite coated implants in the tibia. The diabetes group showed a 30% reduction in bone contact and 50% reduction in bone thickness around implants. El-deeb et al. studied the response of hydroxyapatite in diabetes-induced rats. The results of the histologic analysis revealed that the reaction of the collagen fibers in the diabetic group showed a less orga-
nized healing response compared with the nondiabetic group. Nevines et al observed the osseointegration of dental implants in diabetic and nondiabetic animals, histometric results indicated that the quality of bone formation was similar for diabetic and control animals; however, less bone–implant contact was observed among diabetic animals.

There are limited series and sporadic reports on the use of dental implants in diabetic patients. Some authors claim that systemic diseases decrease vascular supply to the implant bed, thus decreasing wound-healing potential—a possible risk factor for placement of dental implants. In a retrospective analysis of 104 consecutive patients treated with 313 NobelBiocare implants in a different location in both jaws, Smith et al studied the potential medical risk associated with dental implant failure and found no increase in implant failure in patients with a compromised medical status, including those with diabetes mellitus. Shernoff et al studied 187 implants in 89 patients with type 2 diabetes mellitus and showed a short-term failure rate of 2.2%; however, the failure rate rose to 7.3% after 1 year. This study raised the question of whether failure is related to diabetes or improper implant loading. Balshi et al reported a 94.3% survival rate for implants placed in diabetic patients. The finding of our study is in agreement with others, and suggest that dental implants can be used safely in diabetic patients if a proper patient’s selection is done and if diabetes is well controlled. The majority of patients in our study reported satisfaction and improvement with treatment, though treatment satisfaction was higher in patients older than 65 years. As our results show, mucosal health is the strongest predictive value related to treatment satisfaction in this patient group. Another parameter concerning this factor is the diabetes did not affect mucosal health. Although it can cause discomfort and impair wound healing, diabetes should not alter mucosal health if the disease well controlled.

CONCLUSION

The clinical outcome of dental implant placement in a selected group of patients with well-controlled type 2 diabetes mellitus is encouraging. Further investigations and clinical trails over a longer period are needed to determine the long-term survival of implants in diverse groups of patients with diabetes mellitus.

Disclosure

The authors claim to have no financial interest in any company or product mentioned in this article.

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Dental Implants in Diabetes: Type II Patients

**Abstract Translations [German, Spanish, Portuguese, Japanese]**


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Dr. Klinikische Studie zum Thema: Zahnimplantateinsatz bei Patienten mit Typ II Diabetes


**Schlüsselwörter:** Erfolgsrate, Diabetes, Zahnimplantate, Periimplantitis, Blutzuckerspiegel

Implantes dentales en pacientes con diabetes tipo II: un estudio clínico

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ABSTRACTO: PROPÓSITO: Factores sistémicos, tales como la diabetes mellitus (DM) pueden influirane el éxito de los implantes dentales. El propósito de este estudio es describire nuestra experiencia usando el sistema de implante MIS (Medical Implant System Shlomi, Israel) para la retención de sobredentaduras en pacientes con diabetes tipo II. Debería proporcionar datos sobre el nivel de satisfacción de los pacientes, la mejora de la función, salud mucosal y perimplante y el nivel del hueso alrededor de los implantes en este grupo. MÉTODOS: El grupo de estudio consistió de 41 pacientes con diabetes mellitus tipo II quienes recibieron 141 implantes para la retención de sobredentaduras. RESULTADOS: El éxito fue del 97,3% y 94,4% luego de uno y cinco años respectivamente a la colocación del implante. La mayoría de los pacientes indicaron una mejora en la función luego del nuevo tratamiento. Se observó una alta correlación entre la salud mucosal y la mejora de la función. No se encontró correlación entre los implantes fallados y el nivel de glucosa. CONCLUSIÓN: El resultado clínico de los implantes dentales en un grupo seleccionado de pacientes con diabetes mellitus II bien controlada es satisfactorio y positivo. Se necesitan investigaciones adicionales y pruebas clínicas durante un período largo de tiempo para poder determinar la supervivencia a largo plazo de los implantes en diversos grupos de pacientes que sufren de diabetes mellitus.

PALABRAS CLAVES: tasa de éxito, diabetes, implantes dentales, perimplantitis, nivel de glucosa

Implantes odontológicos en pacientes con diabetes del tipo II: estudio clínico

SINOPSE: Objetivo: fatores sistêmicos, como diabetes mellitus (DM) podem influenciar o índice de sucesso de implantes odontológicos. Este estudo tem como propósito descrever nosso experimento ao usarmos o sistema de implante médico (MIS, ou Medical Implant System, Shlomi, Israel) para a retenção de sobredentaduras em pacientes com diabetes do tipo II. Os dados provenientes deste estudo devem fornecer informações a respeito do grau de satisfação dos pacientes, de aprimoramento das funções, da saúde mucosal e perimplantária e do nível ósseo em redor dos implantes neste grupo. Metodologia: o grupo de estudo avaliou 41 pacientes com DM do tipo II, os quais receberam 141 implantes para retenção de sobredentaduras. Resultados: o índice de sucesso foi 97,3% e 94,4% para, respectivamente, um e cinco anos após a implantação. A maioria dos pacientes registrou melhoria de funções consecutivas ao novo tratamento. Observou-se uma alta correlação entre a saúde dos tecidos e a melhoria das funções. Não registrou-se correlação entre implantes fracassados e nível de glicose. Conclusão: o resultado clínico de implantes odontológicos em um seleto grupo de pacientes com diabetes mellitus do tipo II bem controlada é satisfatório e estimulador. Faz-se necessário um número maior de investigações e experimentos clínicos ao longo de um maior período de tempo, a fim de determinar a sobrevivência de implantes a longo prazo em diversos grupos de pacientes portadores de diabetes mellitus.

PALAVRAS-CHAVES: índice de sucesso, diabetes, implantes odontológicos, perimplantite, nível de glicose
Use of dental implants in patients with Down syndrome: a case report

Joseph P. Lustig, DMD, Robert Yanko, DMD,* Uri Zilberman, DMD, PhD
Use of dental implants in patients with Down syndrome: a case report

INTRODUCTION

Down syndrome is caused by a trisomy of the 21st chromosome. It is a relatively common genetic anomaly (one in every 600 to 700 births) and is the best known example of growth and developmental abnormalities associated with an extra chromosome. The disorder affects general body size as well as mental and systemic development. Dental features associated with Down syndrome include: shortened and high palate, microdontia of permanent dentition, altered crown morphology and shape, enamel hypoplasia and hypocalcification, thinner enamel and dentin in the permanent dentition, taurodontism, and hypodontia.

Congenital absence of permanent teeth among the general population ranges from less than 1% to nearly 9%, not including third molars. Dental agenesis is a common characteristic of people with Down syndrome. Barkla reported that 12% of 122 patients with Down syndrome were missing permanent teeth. Other studies have reported higher rates of dental agenesis among this population. McMillan and Kashgarian documented congenitally missing permanent teeth among 48% of 80 people with Down syndrome, and Orner reported the condition among 53% of 212 patients in this population. The permanent tooth most often recorded as missing was the maxillary lateral incisor (31%) followed by the mandibular second premolar (26%), maxillary second premolar (18%), mandibular lateral incisor (12%), and mandibular central incisor (7%). As with any dental patient, missing permanent teeth can cause functional and esthetic problems for patients with Down syndrome.

In the general population, dental implants have been used to replace missing permanent teeth with very high success rates. In patients with Down syndrome, however, implant placement is not considered as a restorative option in part because bone morphology and development may be altered as a result of the genetic anomaly. For example, Garcia-Ramirez and associates reported that rib growth cartilage in fetuses with Down syndrome showed an increase in the hypertrophic portion with a concomitant decrease in proliferating and resting zones. This abnormality may represent an early manifestation of an abnormal growth cartilage maturation pattern, which manifests postnatally in long bones, leading to diminished growth rates. Furthermore, studies have documented reduced bone mineral density among people with Down syndrome when compared with the general population, which is probably due to the muscular hypotony associated with Down syndrome.

This case report describes the clinical history of dental implants placed in a 16-year-old boy diagnosed with Down syndrome.

CASE REPORT

A 16-year-old boy who had Down syndrome was referred to the Dental Clinic for High Risk Patients at Barzilai Medical Center, Ashkelon, (Israel) in December 1999 with a complaint of pain in the area of the left posterior mandible. The patient had moderate mental retardation but was able to
was impacted. The primary teeth nos. A, J, and L showed total root resorption, and tooth no. T had very short roots.

The initial treatment plan included periodontal therapy, restoration of teeth nos. C, 9, and 11 with composite material; sealant application on the permanent molars and premolars; extraction of primary teeth nos. A, J, L (due to root resorption), and T (due to shortened roots); and restoration of the permanent premolars using dental implants. Alternative treatment plans which were discussed considered options other than implants; that is, partial fixed prostheses to restore missing premolars or a removable partial prosthesis. The use of a fixed prosthesis would have required the removal of healthy tooth tissue and reliance on teeth with short mobile roots. The use of a removable partial prosthesis was also discussed but has been reported to be problematic in patients with Down syndrome. The three treatment plans were presented to the family, who accepted the plan that involved placement of dental implants.

Due to management problems that we encountered with the patient and the length of time required for the implant placement, treatment was carried out three weeks after the office visit under general anesthesia. Periodontal and conservative treatment were uneventful. Dental implants were placed by an experienced oral surgeon (LJP) in the sites of missing teeth (nos. 4, 13, 21, and 29) Two implants measuring 13-millimeters (mm) long by 4.2 mm diameter were inserted in the upper jaw (teeth nos. 4 and 13), one implant 13-mm long by 3.75-mm diameter was inserted in the left mandible (tooth no. 21), and one implant 11.5-mm long by 4.2-mm diameter was inserted in the right mandible (tooth no. 29), as immediate implants. All implants used were screw-type implants (MIS Implant Technologies Ltd., Shlomi, Israel) The sites for teeth nos. 24 and 25 were unsuitable for implant placement because of insufficient bone width.

The gingival tissue was thick and difficult to handle. The alveolar bone was very soft with large lacunae in the trabecular area. Only a 2-mm diameter guiding drill was needed, and the implants were screwed in place using two fingers. The surgeon used 4-0 resorbable vycril sutures for primary closure of the gingiva over the implants. Postoperative healing was uneventful.

Treatments success was monitored through monthly clinic visits for the first six months. A panoramic radiograph taken six months after the procedure (Figure 3) and a subsequent evaluation showed that the implant in site no. 21 had exfoliated spontaneously. Neither the patient nor his family were aware that the implant had been lost. The other three implant sites were found to be normal clinically. The implants were uncovered eight months after they had been inserted. Screw-type posts (MIS Implant Technologies Ltd.) were fitted immediately and temporary acrylic crowns were placed. This procedure also was carried out with the patient...
under intravenous sedation. Because of the poor bone quality implant loading was gradual.

The patient and his parents were instructed in ways to improve his oral hygiene, and success of the treatment was monitored at the clinic every three months for one year. During this period, the post and temporary crown on the implant replacing tooth no. 29 were lost. As a result, this implant had to be uncovered and a new post and temporary crown were placed. The oral surgeon used a CO2 laser to uncover the implant. This procedure also was carried out with the patient under intravenous sedation.

After a year of gradual loading, direct impressions for ceramic crowns were made under general anesthesia. Permanent ceramic crowns were cemented, again while the patient was under deep I.V. sedation, in October 2001 (Figure 4). The patient has been closely monitored since then through regular clinic visits, and the implants and crowns appear to function well (Figure 5).

**DISCUSSION**

Down syndrome is one of the most investigated chromosomal abnormalities. The review of Barden on growth and development of hard tissues in subjects with Down syndrome concluded that retardation in skeletal maturation and skeletal growth is most severe in early childhood. The larger primary dentition and smaller permanent dentition in people with Down syndrome suggests that there is a transitional acceleration in mitotic activity (apparent in primary teeth) followed by a retardation in growth that is apparent in permanent teeth and some other aspects of physical development. The anomalies in tooth morphology and increased dental asymmetry probably result from the amplified developmental instability caused by the chromosomal imbalance.

The most significant dental anomaly in people with Down syndrome is congenitally missing teeth. This case report presented here suggests that dental implants may be an effective restorative method for patients with Down syndrome. Admittedly, the osteoporotic feature of bone observed in patients with Down syndrome affects the success of the clinical procedure and is not a risk factor that influences the success rate of implants in a healthy general population. In addition, a problem that may arise is the tendency of increased interproximal bone loss that has been reported in adults with Down syndrome. This suggests that a meticulous oral hygiene regimen must be followed. As shown in this case report, it is important for the patient to work together with his/her parents or caregiver(s) toward achieving and maintaining good gingival health. This
may be problematic in patients who have severe mental retardation or those who live in institutions. In healthy patients with implants, poor oral hygiene has not been reported as the main cause for failure of the final restoration. The host response of the gingiva to plaque accumulation tended to be more pronounced around natural teeth than the peri-implant mucosa. In the maxilla the peri-implant mucosa has been reported to have a greater likelihood of elevated gingival index scores relative to plaque index scores when compared with the gingiva around natural teeth. Marginal bone loss around osseointegrated implants has often been associated with peri-implantitis, but clinical studies have not proven this relationship. In one patient whose progress was followed for five years, the amount of bone loss around natural teeth was significantly higher than around implants. Excessive loading of implants has been shown in animal studies to be positively associated with implant failure measured by implant mobility and marginal bone loss.

The implant that spontaneously exfoliated from the left mandible (no. 21) was a more narrow implant compared to the others that were inserted (3.75 mm versus 4.2 mm). The width of the implant may have caused its failure, since reports have shown that implant design influences vertical bone loss. The bone type in this site was not different from the other three successful sites. Our experience suggests that implants with a larger diameter should be used in patients with osteoporotic bone.

CONCLUSION

This case report followed a person with Down syndrome for two-and-a-half years after insertion of the implants and eight months after cementation of the crowns. No bone loss has been observed, and the patient's periodontal condition was healthy at the last follow-up visit. Use of implants in more patients with Down syndrome is required and for a longer period of time to determine whether this is a suitable treatment option for this population.

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SINUS ELEVATION

with Xenograph (Bio-Oss) in

ADVANCED MAXILLARY ATROPHY
Sinus Elevation with Xenograph (Bio-Oss) in Advanced Maxillary Atrophy

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Introduction

In the last decade, the use of dental implants to rehabilitate edentulous individuals with adequate residual ridges has become a common procedure with a high rate of success. However, in the posterior segments of patients who exhibit significant alveolar resorption or excessive enlargement of the maxillary sinus, implantation must be preceded by ridge augmentation. In the middle of the 1970’s a surgical procedure for the elevation of the sinus floor was developed (1-3) by Tatum (4,5) and first published by Boyne and James in 1980 (6). It has been variously called subantral augmentation, sinus lift, sinus elevation and sinus grafting. They performed a 10 mm. antrostomy in the lateral wall of the sinus and removed the bone covering the sinus. They then elevated the Schneiderian membrane lining the sinus and filled the resulting void with autogenous bone taken from the iliac crest. After approximately three months blade implants were placed (7). In recent years there have been many developments in the field of sinus augmentation and today it is possible to accurately assess rates of success (3,8,9). Most research has shown that long term osseointegration is successful in 85% of the dental implants placed in augmented sinuses (10-13).

The maxillary sinus (antrum of Highmore) is the largest of the nasal cavities. It is formed as a pocket of the nasal mucosa in the area of the semilunar hiatus, which gradually grows within the developing maxilla (see diagram #1) (14). Since the sinus membrane lies directly on the periosteum it is termed mucoperiosteum. The membrane is thinner than but continuous with that lining the inside of the nasal passage through the sinus opening (ostium) in the middle nasal meatus (15).

After the eruption of the permanent maxillary molars and with the end of puberty, the sinus ceases its migration into the alveolar process and reaches its mature pyramidal shape. At this stage the sinus floor is located 5-12 mm below the floor of the nasal passage (14). As a rule the size and shape of the sinus does not continue to change. However, in certain patients the sinus continues to expand and shape of the sinus does not continue to change. At this stage the sinus floor is located 5-12 mm below the floor of the nasal passage (14). With the end of puberty, the sinus floor in time will fill the entire residual alveolar process (14). In this situation the maxillary ridge cannot meet the minimal vertical requirements for dental implants (1, 17).

Zitzmann established a new classification for grading pneumatization of the maxillary sinus as an aid during preoperative evaluation (2, 6, 18, 19):

A  An almost unchanged alveolar ridge with the sinus floor above the level of the root apices of the maxillary posterior teeth (at least 14 mm)
B  The sinus floor at the level of the apical third of the maxillary posterior teeth (11-13 mm)
C  The sinus floor at the level of the middle third of the maxillary posterior teeth (7-10 mm)
D  The sinus floor at the level of the cervical third of the maxillary posterior teeth (3-6 mm)
E  The sinus floor at the level of the cortical bone leaving only a thickness of less than 2 mm

The three approaches accepted today of sinus augmentation include (6,12):

1  A two stage lateral approach - similar to the original method proposed by Boyne and James (2, 7, 20, 21).
2  A single stage lateral approach - in which the implant is placed at the same time as the sinus floor is elevated; developed by Tatum (1986) (5) and published by Kent and Block (1989) and others (22,23).
3  A single stage crestal approach using an osteotome - raising the sinus membrane through the dental implant site was first described by Tatum (1986) (5) and developed by Summers (1994) (6).

As in other oral surgery procedures requiring bone augmentation, sinus floor lifts make use of a wide range of implant materials in various combinations (1, 9, 10, 13, 18, 24-28).

1  Autogenic Bone (autograph; bone transplanted from one individual to another genetically distinct individual) - usually composed of small particles of cortical and spongy bone taken from a number of other sites such as the iliac crest (3, 32), the skull (29, 30), the tibia (31), the chin (20, 21), the lateral side (30) or the ramus of the mandible (26, 32) or the maxillary tuberosity (1, 24).
2  Allogenic Bone (allograph; bone transplanted from one site to another within the same individual) - usually composed of small particles of cortical and spongy bone transplanted from the iliac crest, mandible (26, 32) or the maxillary tuberosity (1, 24).
3  Xenogenic Bone (xenograph; bone taken from a different species than that of the recipient) - the most common is bovine in origin, i.e. Bio-Oss (25, 34).
4  Bone Substitutes (alloplast; synthetic bone) - an example would be hydroxyapatite in various forms i.e. PHA (Porous Hydroxyapatite) (4, 35) or Beta Tricalcium Phosphate i.e. Cerasorb (36, 37).

Methods and Materials

All the patients described underwent maxillary sinus floor augmentation using Bio-Oss xenografts introduced through lateral access in a two-stage procedure. This method was chosen because in all of the cases described, the vertical dimension of the bone in the intended implantation area was less than five mm and thus insufficient for the necessary, primary stability of the implants, yet the ridges exhibited adequate width.
The area was anesthetized using an infraorbital regional block as well as buccal infiltration and palatal injections. Using the same crestal incision that would later be utilized when placing the implants during the second stage (18, 39), a full thickness, subperiosteal buccal flap was raised. With a round bur a rectangular window was cut in the lateral wall of the sinus approximately 3 mm above the sinus floor. The upper edge of the window was cracked but not detached so as to permit it to act as a hinge in order to rotate the released piece of bone superiorly into sinus, pushing the membrane in front of it. In order to be able to place the implants with a buccal inclination, the granules of Bio-Oss were tightly compressed toward the medial wall of the sinus (18). After the window was filled with the xenograph, the flap was sutured into place (see diagram no. 3) (14). Prophylactic antibiotics and oral rinses were prescribed for all the patients for one week.

It should be noted that it is very important to avoid tearing the membrane when drilling the window and while elevating them both to create the space that will receive the graft. Tearing the membrane or separating too much of it because of overfilling with Bio-Oss can cause increased post-operative morbidity (17, 39, 40). Bio-Oss (Geistlich Biomaterials, Wolhusen, Switzerland) is an osseous mineral (xenographic material) from bovine sources that undergoes deproteination by being heated to 300°C for more than 15 hours in order to remove all potential organic and antigenic components. After alkaline treatment the material contains hydroxyapatite and carbonate and is sterilized at 160°C, preserving the integrity of a crystalline structure with 75-80% porosity and crystal dimensions of 10-60 nm (6, 8).

In the years 1999-2001, the outpatient department of the Rabin Medical Center performed unilateral, two stage, sinus floor elevations using xenographs on a total of 28 patients. This series did not include single stage cases or those using autogenous bone. There was a healing period of six months before implants were introduced. All the cases utilized screw type implants in diameters of 3.75-5.0 mm and lengths of 13-16 mm from two manufacturers: Calcitek (11 patients) and MIS (17 patients).

Example no. 1 A male patient, aged 53, was referred for sinus elevation and placement of implants in the upper left quadrant. Upon examination, it was found that tooth no. 27, the only molar in this quadrant, was fractured, with its roots extending into the maxillary sinus, and scheduled for extraction (photograph 1A). Because of the uncertain prognosis of tooth no. 24, it was decided, at this stage, to keep it under observation. Accordingly, tooth no. 27 was extracted and the sinus floor was raised with the aid of 1.5 g of granular Bio-Oss (photograph 1B) shows the site two months after the procedure. Six months after the surgery, two MIS implants 4.2 mm in diameter with lengths of 16 mm were placed (photograph 1C).

Example no. 2 A female patient, was referred for sinus elevation and placement of implants in an edentulous upper right quadrant. The panoramic radiograph shows almost complete resorption of the residual ridge and widespread pneumatization of the maxillary sinus (photograph 2A). The right sinus floor was raised with the aid of 2.0 g of granular Bio-Oss (photograph 2B), and after six months three MIS implants 4.7 mm in diameter and 13 mm in length were placed (photograph 2C).

Discussion

In terms of rates of success, the ideal material in which to place implants is still autogenous bone, mainly because of the presence of living, mature osteo-competent bone cells, bone marrow cells and endosteal osteoblasts (1, 9, 10, 17, 24). These cells are able to bring to the host site three mechanisms for the production of new bone: osteogenesis, osteoconduction and osteoinduction (20,32). The preferred donor site for autogenous bone is from the iliac crest because of the large quantity that can be harvested, its long term survival at the implant site (24) and the ability to include three types of bone: cortical, cancellous and mixed (18). However, the disadvantages of the method are obvious: the need for hospitalization and general anesthetic, a protracted post-operative period of recuperation at the harvest site, high cost, etc. (26, 32). Thus, in those cases where there is no need for a large volume of donor bone, it is possible to use an intraoral site (1). The surgical access is easier and faster, the procedure can be performed with a local anesthetic and the results are good even when the bone is mixed with allogenic or alloplastic substitutes (18, 26). In the area of the mandibular symphysis it us usually possible to obtain large amounts of donor material. However, the risk of complications, such as damage to the mandibular incisive nerve is greater. In any event, it should be kept in mind that it requires an additional surgical site, lengthening the procedure and increasing the morbidity.

The use of allogenic bone eliminates the need for an additional surgical site and accompanying blood loss and operating time but its effectiveness is limited (24, 41). In addition, in spite of all the processes to reduce antigens, in recent years there is growing concern on the part of patients over the use of bone from human cadavers (36, 39). Good results have also been achieved with synthetic bone substitutes such as hydroxyapatite (19, 20, 37), and especially xenogenic bone (25). The advantages of these materials are (19, 36):

1. Readily available - no limit to the amount
2. Speed of the procedure - no need for additional surgery
3. Peace of mind - no patient concern about infectious diseases
4. No donor site morbidity
5. Low relative cost
6. Suitable for patients with general anesthetic contraindications - the average age of patients undergoing sinus floor elevations in various research is 48-58 (2, 6, 40-42).

In research comparing the three most common methods of sinus floor elevation in conjunction with Bio-Oss, a two stage lateral approach achieved a larger increase in bone height (an average of 12.7 mm) than with a single stage (an average of 10 mm). With a single stage osteotome procedure, the increase was minimal (an average of 3-4 mm) and thus is appropriate only when the existing bone is greater than 6 mm in height (Class A/C). The rate of
success of implants in areas where the sinus floor was raised with all three methods averaged 95-100% during a 16 month follow-up (6). However, the single stage methods are usually recommended only in those instances where the amount of remaining bone is sufficient to achieve primary stability of the implant at the time the sinus floor is raised (12). This is because performing single stage sinus lifts when there is less than 6 mm of bone has, in some studies, a lower rate of success - 61-80% (25, 36, 38, 40, 42). Bio-Oss has been found to be a very biocompatible material with osteoconductive qualities (1, 2, 8, 16, 39, 42). In biopsies taken from 6 months to 4 years after lateral access sinus floor elevations with Bio-Oss, the granules are well integrated and enclosed with new well cellularized bone (8, 34). The phenomenon of bone formation woven around the particles of material can be described as “bridging”, a manifestation of the osteoconductive nature of the material. In other words, the material behaves like non-vital autogenic bone that is undergoing a very slow process of replacement (25, 26). These histologic studies show that Bio-Oss can be used as a suitable implant material to raise sinus floors and for bone augmentation in situations with significant atrophy of the residual ridge (6, 16).

**Conclusion**

At a time when the long-term success of dental implants has been proven, there is increasing demand on the part of the dental patient for a permanent, stable alternative to the full denture. The sinus elevation procedure provides a solution for those patients who, until now, were forced to settle for full dentures because of atrophied, maxillary, posterior alveolar ridges or advanced pneumatization of the maxillary sinus. Today there is an additional factor: the use of xenogenic material to raise the maxillary sinus floor transforms the procedure into one that is simpler, faster and cheaper, and can be performed with a local anesthetic in the dental clinic with high rates of success. According to reports in the literature, the rates of bone formation, its density and the rates of success for dental implants placed in areas with raised sinus floors in conjunction with xenographic bone, are comparable with those of in autogenic bone.

In addition, the low post-operative morbidity allows these procedures to be offered to patients for whom general anesthetics are contraindicated as well as those who would otherwise be unwilling or unable to change their daily routine.
A STATISTICAL STUDY

Success and failure rates of osteointegrated MIS implants for 6 to 48 months
Success and failure rates of osteointegrated MIS implants for 6 to 48 months

A statistical study

Abstract

Two hundred sixty-two titanium MIS implants were placed in the mandible and maxilla with follow up of 6 to 48 months. The procedure was carried out by the authors. One hundred forty seven implants were placed in both jaws without a need for another procedure. Another 115 implants were placed in defective bony areas: 12 with buccal fenestration or dehiscence, 27 in post extraction sockets, 12 after bucco lingual ridge augmentation, 22 after vertical ridge augmentation either by onlay bone graft or vertical distraction osteogenesis, and 42 implants with maxillary sinus floor augmentation. They were evaluated according to Albrektsson’s criteria. The overall cumulative success was 94.7%. In normal bone, from 147 implants, five were lost (96.6% success). Of 115 implants that were inserted in the regenerated defective bone nine implants were lost (92.2% success).

This finding shows that the titanium MIS implants placed either in healthy or augmented bone will achieve satisfactory osteointegration maintained under function over time.

Materials and Methods

Following a thorough review of the medical history, patients were deemed unsuitable to receive implant therapy based on the following criteria:

1. Presence of uncontrolled diabetes or immune diseases.
2. Radiation therapy of the head and neck region or chemotherapy in 24 month period prior to proposed therapy.
3. Uncontrolled periodontal disease.
4. Severe psychological problems.
5. An unwillingness to commit to a long term, post therapy maintenance program.

A complete examination of oral hard and soft tissues was carried out for each patient. Panoramic radiographs were taken of all patients, as were CT scans when they were deemed clinically necessary.

104 patients were treated. Of these patients, 58 were female and 46 were male. Patient age ranged from 17 to 77 years. All surgical therapy and preoperative and post operative measurements were performed and recorded by the authors.

A total of 262 screw vent MIS implants were placed in both jaws. 147 implants were placed in normal non-defective bone and another 115 implants were placed with...
the following adjunctive procedures (Table 1):
1. 27 implants were placed in sockets immediately after tooth extraction.
2. 12 implants were placed with a resultant buccal fenestration or dehiscence. The defects were covered with DFDBA. An e-PTFE membrane was then placed over the defects.
3. 12 implants were placed after buccal lingual ridge augmentation of an area deemed to be of insufficient buccolingual/palatal dimension to stabilize the implant in an acceptable position for subsequent restoration. DFDBA and e-PTFE membrane were placed over the defects.
4. 22 implants were placed after vertical ridge augmentation: 8 implants after only a bone graft and 14 implants after vertical alveolar ridge distraction. The alveolar ridge distraction was started by segmental alveolar osteotomy and placement of a distraction device. Following 4 days of latency period, a gradual distraction of 0.8mm per day was performed for 14 to 20 days. A mean alveolar augmentation of 10.8mm was achieved. After three months of retention, the MIS implants were introduced to the augmented bone.
5. 42 implants were placed after maxillary sinus floor augmentation by a mixture of BIO-OSS and autogenous bone graft. When the initial alveolar ridge height was more than 5mm preoperatively, a one stage implant was performed. When the initial alveolar ridge height was less than 5mm, two-stage procedures were performed. Table 1 shows the distribution of implant placement by treatment indication.

All patients were seen at least every 2 months postoperatively. The individual implants were examined for mobility, and clinical parameters (gingival index) were recorded. Radiographs were taken at yearly intervals and were compared to those taken at the time of implant restoration.

Implants were deemed successful if they met the following criteria:
1. The implant was absolutely stable.
2. There was no pain or suppuration.
3. There was no evidence of a periimplant radiolucency.
4. Vertical bone loss was less than 1.5mm in the first year in function and less than 0.2mm annually in subsequent years in function.

Results
A total of 262 MIS implants were placed in 104 patients. The implant success/failure in function is presented in Table 2 and implant success/failure by treatment indication is presented in Table 3. The overall cumulative success of MIS implants was 94.7%. In normal bone, from 147 implants, 5 were lost (96.6% success). In regenerated defective bone, from 115 implants placed, 9 implants were lost (92.2% success). Of all implants, 11 were lost in the maxilla and 3 were lost in the mandible. The overall success in the maxilla was 92.2%. In the maxilla, most failures happened after maxillary sinus floor augmentation (9.5%). In the mandible, the overall success was 98.5%. Two implants failed in a buccally augmented ridge that supported a fixed prosthesis.

According to defect type, the highest success rate was after implant placement into intact sockets (96.3%) followed by vertical ridge augmentation (95.5%). The lowest success rate was after buccolingual ridge augmentation (83.3%).

Table 1. Jaw defects and implant distribution

<table>
<thead>
<tr>
<th>Defect Type</th>
<th>Total implants placed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dehiscence or Fenestration</td>
<td>12</td>
</tr>
<tr>
<td>2. Placement into intact socket</td>
<td>27</td>
</tr>
<tr>
<td>3. Bucco lingual ridge augmentation</td>
<td>12</td>
</tr>
<tr>
<td>by bone graft (onlay)</td>
<td>8</td>
</tr>
<tr>
<td>by distraction osteogenesis</td>
<td>14</td>
</tr>
<tr>
<td>5. Sinus floor augmentation</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
</tr>
</tbody>
</table>

Table 2. Jaw defects and implant distribution by treatment indication

<table>
<thead>
<tr>
<th>Months in function</th>
<th>Maxilla</th>
<th>Mandible</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12</td>
<td>39</td>
<td>38</td>
</tr>
<tr>
<td>13-24</td>
<td>38</td>
<td>32</td>
</tr>
<tr>
<td>25-36</td>
<td>34</td>
<td>25</td>
</tr>
<tr>
<td>37-48</td>
<td>30</td>
<td>26</td>
</tr>
</tbody>
</table>
Failed 3%

Implants in normal jaws

Success 97%
Failed 3%

Total implants success

Success 95%
Failed 5%

Implants in regenerated defect bone

Success 93%
Failed 7%

**Table 2. Implant success/failure in function**

<table>
<thead>
<tr>
<th>Months in function</th>
<th>0-12</th>
<th>13-24</th>
<th>25-36</th>
<th>37-48</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td>39 (3)</td>
<td>38 (2)</td>
<td>34 (3)</td>
<td>30 (3)</td>
<td>141 (11)</td>
</tr>
<tr>
<td>Mandible</td>
<td>38 (0)</td>
<td>32 (1)</td>
<td>25 (1)</td>
<td>26 (1)</td>
<td>121 (3)</td>
</tr>
<tr>
<td>Total</td>
<td>77 (3)</td>
<td>70 (3)</td>
<td>59 (4)</td>
<td>56 (4)</td>
<td>262 (14)</td>
</tr>
</tbody>
</table>

*Number in parenthesis is number of implant failures during interval in question*

**Table 3. Implant success/failure by treatment indication**

<table>
<thead>
<tr>
<th>Defect type</th>
<th>No. of Implants placed</th>
<th>Implants lost/failed in function</th>
<th>Absolute success rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dehiscence or fenestration</td>
<td>12</td>
<td>1</td>
<td>91.7%</td>
</tr>
<tr>
<td>2. Placement into intact socket</td>
<td>27</td>
<td>1</td>
<td>96.3%</td>
</tr>
<tr>
<td>3. Buccolinguai ridge augmentation</td>
<td>12</td>
<td>2</td>
<td>83.3%</td>
</tr>
<tr>
<td>4. Vertical ridge augmentation</td>
<td>22</td>
<td>1</td>
<td>95.5%</td>
</tr>
<tr>
<td>5. Maxillary sinus augmentation</td>
<td>42</td>
<td>4</td>
<td>90.5%</td>
</tr>
<tr>
<td><strong>Total implants in regenerated defective bone</strong></td>
<td><strong>115</strong></td>
<td><strong>9</strong></td>
<td><strong>92.2%</strong></td>
</tr>
<tr>
<td><strong>Total implants in normal bone</strong></td>
<td><strong>147</strong></td>
<td><strong>5</strong></td>
<td><strong>96.6%</strong></td>
</tr>
<tr>
<td><strong>Total implants</strong></td>
<td><strong>262</strong></td>
<td><strong>14</strong></td>
<td><strong>94.7%</strong></td>
</tr>
</tbody>
</table>

**Summary**

This report presents the success and failure rates of MIS implants done by the authors, including a follow-up between 6 to 48 months. The stability of the MIS implants was examined for up to 48 months and was very satisfactory.

The overall cumulative success rate was 94.7%. When the implants were placed in normal non-defective bone the success rate was 96.6% but when the implants were inserted in regenerated defective bone, the overall success rate was 92.2%.

This finding supports that the titanium MIS implants placed either in healthy or augmented bone will achieve satisfactory osteointegration maintained under function over time.
RISK FACTORS
for
implant failure and complications
Risk Factors for Implant Failure and Complications

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Introduction

Osseointegrated dental implants represent a widely accepted and documented treatment modality for the rehabilitation of the partially or totally edentulous ridge. The goal of dental implants is to restore the damaged dentition to a state of physiological balance. In many situations, the implant-supported restoration has emerged as the treatment of choice for replacement of a single missing tooth. Few studies, however, systematically address the frequency or nature of the risk factors responsible for failure and complications in the use of dental implants. Reported complication rates range so widely, i.e. 1%-40%, as to be rendered clinically meaningless. The differences in reported rates may be attributable to the differing definitions of complications.

Even less has been written about risk factors for surgical complications related to the use of dental implants. The complications are classified as:

- Operative: bleeding, nerve injury, fracture, displacement of the implant and injury to adjacent teeth.
- Inflammatory: perimplantitis, mucositis, mucosal hyperplasia, and fistula.

Knowledge regarding the type and frequency of complications and the risk factors for failure are an important aspect of treatment planning, surgeon-patient communication, informed consent and post-treatment care.

The purpose of the present study is to identify the risk factors for implant complications and failure.

Materials & Methods

A total of 2640 MIS implants were placed in 625 patients between 1996 and 1998. The patients were either referred to the clinic by their dentists or had contacted the clinic directly. A two-stage surgical technique was performed as recommended by the manufacturer. The implants were placed and allowed to heal unloaded for 3 months in the mandible and 6 months in the maxilla.

Long term study
- A total of 2640 implants were followed in 625 patients
- 5 year follow up

Materials & Methods
- 2640 screw type implants were placed in 625 patients between 1996 to 1998.
- The patients were either referred to the clinic by their dentists or had contacted the clinic directly.
Criteria for Implant Success

- The individual implant is immobile when tested clinically
- No radiographic evidence of peri-implant radiolucency
- Bone loss no greater than 0.2 mm annually
- Gingival inflammation amenable to treatment
- Absence of symptoms of infection and pain
- Absence of damage to adjacent teeth
- Absence of parasthesia, anesthesia or violation of the mandibular canal or maxillary sinus
- Should provide functional survival for 5 years in 90% of the cases and for 10 years in 85%


Results

250 patients (40%) were female and 375 (60%) were male. 1295 implants (49%) were inserted in the mandible and 1345 (51%) in the maxilla. 45% of our patients were smokers.

In 587 patients the reasons for extraction and implant placement were known. In 293 (50%), the extraction was due to periodontal reasons. In 163 (28%) endodontal. In 105 (18%) trauma, and in 26 (4%) root fracture. 27% of the patients suffered from systemic diseases, this group received 722 implants. The overall success rate was 97%. The overall complications rate was 9%: 5% prosthetic complications and 4% surgical complications.

Success and failure among patients with systemic diseases

A significant correlation exists between region and success.

Associated procedure

No significant difference between failure and smoking

Significant difference between complications and smoking p<0.001
A significant statistical difference between complications and success rate (p<0.001) was found. In cases that we observed early unplanned, exposure of the implants, the success rate was 85%. While smoking did not significantly affect the rate of success, it did statistically increase the rates of complications. A significant difference exists in the distribution of reasons for implantation and the success rate (root fracture mostly resulted in failure) (p<0.001). In addition a significant difference exists in the rate of failure and region of implantation (p<0.001).

### Discussion

Given the predictability of successful dental implants, the attention of the scientific community is moving from descriptions of implant success toward a more detailed analysis of factors contributing to implant failure and complications. Few studies however, catalog the various risks factors affecting the rates of failure and complications related to the use of dental implants.

This presentation identifies the risk factors for implant failure. Of those, inflammatory complications are the most common. Complications can be avoided or reduced with proper patient selection and evaluation. Based on our results, reasons for extraction, unplanned, early exposure of the implants, associated procedures and location of the implant within the jaw, can all be considered as risk factors in implant dentistry.
CLINICAL multicenter multicriteria STUDY on 239 MIS implants
ABSTRACT

KEY WORDS: M.I.S. Implant, surgical study

This study, conducted over the course of two years (1999 - 2000), is based on 239 M.I.S. implants which were inserted by two attending dental surgeons from the Department of Stomatology at Saint Antoine Hospital, Paris, and in their private practices. The same working methods, which were strictly observed both in the hospital and in their private practices, included selection criteria, drug regimens, and treatment modalities that conform to accepted international standards. The hospital setting was used for the more difficult cases with systemic problems or severe osseous resorption. It also allowed for the use of pre-implant surgical techniques, such as osseous grafting, sinus lift, etc.

Generally, implants were placed using a conventional two stage surgical technique. However, in some instances it was elected to use single stage surgery with a healing cap, immediate insertion in a fresh socket or in conjunction with an osseous graft.

Success criteria for this surgical implant study consisted of:

- No pain or infection during the period of osseointegration
- No radiographic gaps at the bone-implant interface at second stage surgery
- No mobility or pain upon reentry
- Clear, solid tone when tapping the healing cap

The study draws statistical conclusions as to the success rates of commonly used implant sizes in various anatomic areas. The results indicate that M.I.S. implants conform to internationally accepted rates of success.

INTRODUCTION

239 M.I.S. (Medical Implant System) implants were placed in 97 patients (n=2.46), consisting of 47 males and 50 females, ranging in age from 19 to 84. Over a period of 24 months, two dentists performed the surgeries in Saint Antoine Hospital, Paris, and in their private practices. All three clinical locations adhered to the same criteria for case selection, sterile conditions and operative protocols.

MATERIALS AND METHODS

From a total of 239 implants, 232 were grade 4 TiCP Internal hexagon (ref. MF2) and 7 were grade 2 TiCP External hexagon (ref. EF2).

Patients were selected on the basis of the following:
- Interview
- Clinical examination
- Biological data
- Radiographic examination

Patients were rejected from the study if any of the following contra-indications were exhibited:
- American Society of Anesthesiology level 3, 4 and 5 conditions
- Insufficient height between edentulous ridges
- Microstomia, macroglossia, poor oral hygiene
12 Implants were inserted in three HIV seropositive patients.
2 Implants were inserted in a patient with Paget’s disease.

Before implant surgery all patients underwent scaling and prophylaxis, in addition to periodontal treatments, residual root extractions and operative dentistry when indicated. In a number of cases pre-implant surgeries (crestal expansion, sinus augmentation, osseous grafting) were performed, followed by a six-month healing period.

Sterile surgical conditions (sterile gowns and gloves, surgical hand scrub, single use drapes) conformed to accepted international standards of treatment. All surgical kits and implant armamentaria were autoclaved at 135 °C.
All patients were premedicated (2g Amoxicillin/day, 600mg Tiaprosen acid/day) starting 48 hours before and ending 5 days after surgery. Patients were given two capsules of paracetamol-dextropropoxyphene for post-operative pain management every four hours for two days.

The operative protocol for submerged implant placement was as follows:

- Local anesthesia
- Crestal incision
- Full thickness flap reflection
- Controlled-speed drilling with sterile irrigation
- Manual insertion of the implant
- Closure with interrupted sutures (black silk 3/0)
- Suture removal after 15 days

Implants were left covered for four months in the mandible and for six months in the maxilla.

Healing caps were placed at second stage surgery, except for four implants placed using a single stage procedure.

The criteria for surgical success were:

- No pain or infection during the period of osseointegration
- No radiographic gaps at the bone-implant interface at second stage surgery
- No mobility or pain upon reentry
- Clear, solid tone when tapping the healing cap

For this study the mandible was divided in two anatomic zones:

- Symphysis: canine to canine, inclusive
- Posterior mandible: premolars and molars

The maxilla was similarly zoned:

- Pre-maxilla: canine to canine, inclusive
- Posterior maxilla: premolars and molars

### IMPLANTS DISTRIBUTION

**Table 1:**

<table>
<thead>
<tr>
<th>Zone</th>
<th>Implant distribution by zone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRE-MAXILLA</strong></td>
<td>canine to canine, inclusive</td>
</tr>
<tr>
<td><strong>POSTERIOR MAXILLA</strong></td>
<td>premolars and molars</td>
</tr>
<tr>
<td><strong>SYMPHYSIS</strong></td>
<td>canine to canine, inclusive</td>
</tr>
<tr>
<td><strong>POSTERIOR MANDIBLE</strong></td>
<td>premolars and molars</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>239 implants (100%)</td>
</tr>
</tbody>
</table>

**Table 2:**

<table>
<thead>
<tr>
<th>Diameter</th>
<th>No. of Fixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.75 mm</td>
<td>Fixtures</td>
</tr>
<tr>
<td>length 8 mm</td>
<td>3</td>
</tr>
<tr>
<td>length 10 mm</td>
<td>29+1*</td>
</tr>
<tr>
<td>length 11.5 mm</td>
<td>40</td>
</tr>
<tr>
<td>length 13 mm</td>
<td>67+6**</td>
</tr>
<tr>
<td>length 16 mm</td>
<td>6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>239 implants (100%)</td>
</tr>
</tbody>
</table>

**Table 3:**

<table>
<thead>
<tr>
<th>Length</th>
<th>No. of Fixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 mm</td>
<td>11</td>
</tr>
<tr>
<td>10 mm</td>
<td>52</td>
</tr>
<tr>
<td>11.5 mm</td>
<td>67</td>
</tr>
<tr>
<td>13 mm</td>
<td>102</td>
</tr>
<tr>
<td>16 mm</td>
<td>7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>239 implants (100%)</td>
</tr>
</tbody>
</table>
RESULTS

Maxilla: SUCCESS RATE: 97.7%
2 lost implants (2.32%)
Pre-maxilla: 1 implant MF2/11.5x3.75 inserted in an expanded, thin ridge
Posterior Maxilla: 1 implant MF2/11.5x3.75 inserted in an HIV positive patient with poor bone density

Mandible: SUCCESS RATE: 93.5%
10 lost implants (6.53 %)
Symphysis: 1 implant EF2/11.5x3.75 inserted in symphysis suture; edentulous for 20 years
Posterior Mandible: 2 implants MF2/10x3.75
4 implants MF2/11.5x3.75
2 implants MF2/10x4.20
1 implant MF2/13x4.20

GLOBAL SUCCESS RATE: 95%

CONCLUSIONS

On the basis of this study, it appears that M.I.S. implants have a surgical success rate similar to that of other major TiCP axial insertion implants.
- The most frequently used diameter is 3.75 (63.59%)
- The most frequently used length is 13 mm (42.67%)
A more precise analysis is given in the body of the study.

The parameters of this study complied with the requirements of the international scientific community for osseointegration. From the 12 implants lost in different quadrants no cause-effect link has been found, except in edentulous zones of more than five years duration, resulting in diminished function with poor osseous trabeculation and modified physiology. Hypercorticalization due to long term use of removable dentures may cause more difficulty when drilling. These results suggest the possibility of restoring physiological activity in hypercorticalized, long-standing edentulous zones, prior to implant procedures, by endosteal stimulation to increase success rates.
SINGLE TOOTH IMPLANT
in the
ANTERIOR MAXILLA
Single tooth implant in the anterior maxilla: pilot result of the MIS implant system

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ABSTRACT:

Purpose - To document and compare clinically important outcomes of Medical Implant System (MIS), to Calcitek.

Materials/Methods - The study was designed as a prospective cohort study. The sample was comprised of patients needing one or more implants placed into the anterior maxilla and restored with a fixed prosthesis. The predictor variable was the implant system used, i.e. MIS or Calcitek. The major outcome variables were periimplant bone loss, bleeding on probing, and plaque accumulation. Appropriate uni-, bi-, and multivariable statistics were used to assess the relationships among the study variables.

Results - Between 1995 and 1998, 132 patients had 154 implants inserted. Calcitek and MIS implants were placed into 71 and 61 patients, respectively. At four years, the implant survival rates for the Calcitek and MIS systems were 93.9% and 98.6%, respectively. Over the four-year study interval, the mean marginal bone levels decreased 0.46±0.31 mm and 0.58±0.34 mm (small p<0.1) for the Calcitek and MIS systems (p<0.01). There were no statistically significant differences between the two implant systems in terms of periimplant marginal bone loss or other periodontal parameters. MIS implants offer a predictable solution for the replacement of missing maxillary anterior teeth.

INTRODUCTION:

The replacement of a single anterior maxillary tooth is a complex, challenging procedure that must provide the patient with a predictable, aesthetic and functional result. Osseointegrated dental implants are a predictable technology in facilitating the replacement of missing teeth. In many situations, the implant has emerged as the treatment of choice for replacement of a single tooth and different surgical and restorative techniques have been developed towards this aim. The replacement of single maxillary anterior tooth with a dental implant can avoid further ridge resorption, especially in the buccal-palatal aspect, and can improve the prognosis and the periodontal status of the surrounding dentition.

MIS (Medical Implant System, Shlomi, Israel) implant system was introduced into clinical practice in 1995. The purpose of this study was to document implant survival and stability of bone level for an innovative implant system (MIS) and to compare the results of the MIS system and the Calcitek implant system (Sulzer Spline, Carlsberg, CA, USA).
MATERIALS & METHODS

The study sample was derived from the population of patients who presented for implant evaluation and treatment at the authors’ private clinics between 1995-1998. To be included, the patient would need to have one or more implants placed in the anterior maxilla for restoration with a single crown prosthesis.

Study Variables - The major predictor variable was the implant system used, HA coated 3.25 mm (Calcitek) and sandblasted and acid etched surface 3.75 mm diameter (MIS). Treatment was not randomly allocated: Calcitek implants were selected for patients with a narrow alveolus, (<4 mm) while the MIS implant was selected for patients with residual alveolus (= 4 mm).

The primary outcome variable was implant survival versus implant failure. Secondary outcome variables were periimplant bone level, periodontal parameters, plaque accumulation, and bleeding upon probing. To assess changes in the bone level, peri-apical radiographs were obtained in a standardized manner (timing and technique described below). Radiographs were examined with 5x magnification and the bone level measured from a defined point implant abutment interface at the top of the implant on the mesial and distal aspects. The gingival status around the implants was recorded using dichotomized indices (presence or absence) of the plaque and bleeding upon gentle probing.

Clinical and Radiological Examination

Every patient was examined clinically and radiologically (including computerized tomography and peri-apical x-ray) for the determination of the suitability for implant placement. Special attention was given to the height and the width of the edentulous ridge, the occlusion relations, and aesthetic demands. Intraoral peri-apical radiographs were obtained using the long-cone paralleling technique. Radiographs were taken immediately post-op and then at 6, 12, 24, and 48 months postoperatively.

Surgical Procedure

Implants were placed using local anesthesia. Mid-crestal incisions were performed. In those cases where the attached gingiva at the buccal aspect of the implant site was narrow, the incision was made palatally.

Full thickness mucoperiosteal flaps were reflected and the recipient site was prepared for implant insertion, using a well-established protocol with serial drill sizes to the level of 2-3 mm apical to the cemento-enamel junction of the adjacent tooth.

Implants were then inserted with the shoulder of the implant placed about 1 mm coronally to the crest. The length of the implants ranged from 13-16 mm. The exact site determination and the angulation of the implant were performed considering the desired position of the final restoration. The flaps were then replaced and the surgical site was sutured using nylon sutures. Sutures were removed a week later. The patients were placed on Amoxicillin, (500 mg tid), and 0.2% CHX oral rinse (twice daily) during the first week postoperatively.

The patients were enrolled in a maintenance program, providing oral hygiene instruction and professional supportive treatment 2-3 times a year. Six months later, the second stage surgery procedure was performed.

Restoration of the implants was performed using titanium abutments and porcelain fused to metal crowns in 53 implants, Cerastetic plus abutments in 40 implants and plastic abutments with gold base in 74 implants.

Data Analysis

was performed using SPSS version 10 statistical package. Descriptive statistics were computed from each variable. Appropriate bi-variant analysis was performed to measure the association between each of the study variables and type of implant used. Multivariate analysis of variance (MANOVA), i.e. repeated measure, was used to measure the association between the study variables and changes in bone level over time. The level statistical significance was set at 0.05.

Baseline Parameters MIS and Calcitek implants

<table>
<thead>
<tr>
<th>Implant type</th>
<th>CA (n=82)</th>
<th>MIS (n=71)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of implant</td>
<td>3.25 mm</td>
<td>3.75 mm</td>
</tr>
<tr>
<td>Length of the implant</td>
<td>13-16 mm</td>
<td>13-16 mm</td>
</tr>
<tr>
<td>Restored with Ti abutments</td>
<td>44</td>
<td>5</td>
</tr>
<tr>
<td>Restored with Ceraestetic plus</td>
<td>38</td>
<td>2</td>
</tr>
<tr>
<td>Restored with plastic abutments</td>
<td>0</td>
<td>64</td>
</tr>
<tr>
<td>Reason for tooth loss (n=167)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CA</th>
<th>MIS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma or fracture of the root</td>
<td>59</td>
<td>34</td>
</tr>
<tr>
<td>Deep dental caries</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Congenital missing of single tooth</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Unknown</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>75</td>
</tr>
</tbody>
</table>

Lifetable analysis of implants in the study

<table>
<thead>
<tr>
<th>Loading</th>
<th>#implants</th>
<th>failed</th>
<th>withdrawn</th>
<th>interval success</th>
<th>cumulative success</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CA</td>
<td>MIS</td>
<td>CA</td>
<td>MIS</td>
<td>CA</td>
</tr>
<tr>
<td>1y-2y</td>
<td>79</td>
<td>71</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>2y-4y</td>
<td>77</td>
<td>70</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

Crestal bone loss (mean ± SD) of the implants

<table>
<thead>
<tr>
<th>Time period</th>
<th>Abutment connection</th>
<th>HA (Calcitek)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>D</td>
<td>Mean</td>
</tr>
<tr>
<td>Abutment connection</td>
<td>0.17 ± 0.23</td>
<td>0.18 ± 0.23</td>
<td>0.17 ± 0.23</td>
</tr>
<tr>
<td>1 year</td>
<td>0.25 ± 0.28</td>
<td>0.26 ± 0.28</td>
<td>0.25 ± 0.28</td>
</tr>
<tr>
<td>2 year</td>
<td>0.3 ± 0.31</td>
<td>0.3 ± 0.31</td>
<td>0.3 ± 0.31</td>
</tr>
<tr>
<td>4 year</td>
<td>0.45 ± 0.29</td>
<td>0.47 ± 0.30</td>
<td>0.46 ± 0.30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time period</th>
<th>Abutment connection</th>
<th>SB (MIS)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>D</td>
<td>Mean</td>
</tr>
<tr>
<td>Abutment connection</td>
<td>0.15 ± 0.2</td>
<td>0.18 ± 0.23</td>
<td>0.16 ± 0.22</td>
</tr>
<tr>
<td>1 year</td>
<td>0.25 ± 0.3</td>
<td>0.28 ± 0.3</td>
<td>0.26 ± 0.3</td>
</tr>
<tr>
<td>2 year</td>
<td>0.33 ± 0.33</td>
<td>0.37 ± 0.36</td>
<td>0.35 ± 0.35</td>
</tr>
<tr>
<td>4 year</td>
<td>0.51 ± 0.31</td>
<td>0.65 ± 0.36</td>
<td>0.58 ± 0.34</td>
</tr>
</tbody>
</table>
RESULTS:

The study group consisted of 85 males and 52 females ranging in age between 17-52 years (mean 42.4±7.9 years). Ninety-three of the missing teeth were due to trauma or from fracture of the root; 10 teeth were lost due to deep dental caries, 20 cases were from congenitally missing teeth. In the rest of the cases the reason for tooth loss was unknown. The study group included 153 implants placed in 131 patients that were present at all of the follow-up visits. 82 implants were Calcitek HA coated, while the remaining 71 implants were MIS sandblasted and acid etched.

Both plaque and bleeding on gentle probing were relatively infrequent at 1 & 4 years post-op follow-up visits and were not significantly different between groups. In the Calcitek group, severe bone resorption occurred around 3 implants within the first 2 months; these were explanted. In 2 cases, the abutment's screw fractured and could not be retrieved, requiring the removal of the implant. In the MIS group, one abutment was self-drilled out at 6 months. The abutment’s screw was torqued back and the crown re-cemented. Mobility was detected in the one implant 2 years after placement and explantation was preformed. Notable recession (2-3 mm) was observed at the distal and the palatal aspects of 2 cases, which resulted in exposure of the crown. Overall, 5 Calcitek implants (6.1%) and 1 MIS implant (1.4%) failed during the follow up period. That represents a cumulative success rate of 93.9% and 98.6% respectively. Mean cumulative bone loss from baseline (at 1, 2, 4 years respectively) in the Calcitek group was: 0.18 mm (0.23), 0.25 mm (0.28), 0.30 mm (0.32) and 0.45 mm (0.29) on the mesial surface; 0.18 mm (0.23), 0.26 mm (0.28), 0.30 mm (0.31), 0.47 mm (0.30) on the distal surface.

With the exception of the distal surface after 4 years, [where the MIS implant exhibited slightly greater crestal resorption comparatively to the Calcitek group (p<0.05)], there were no statistically significant differences between the two groups at any time point.

DISCUSSION:

This four-year retrospective study compares the crestal bone resorption at the interproximal sites of two types of implant systems. No significant differences were observed between the two system types.

Marginal crestal bone resorption around the implant ranged from 0.08 to 0.18 mm annually, during the whole study. This minimal bone resorption could be explained by the supracrestal position of the shoulder of the implant. Microscopically, the abutment/implant interface creates a microgap. As this gap is exposed to the oral environment, it is consistently flushed with saliva and the flora of the mouth, creating a reservoir of potential irritants to the surrounding bone. Placing the implant shoulder 1-2 mm supracrestally keeps that reservoir away from the bone without compromising the aesthetic aspects of the treatment.

Both systems exhibited a very high four-year cumulative success rate (93.9% for the Calcitek implants and 98.4% for the MIS system).

One possible reason for the early (pre-loading) failures in the Calcitek group could have been the result of compromised local bone quality, narrow implant diameter or the disruption of the HA coat. Watson and coworkers reported a cumulative success rate of 97% and 58% for Calcitek implants after 1 and 4 years of follow-up, respectively.

The main reason for the high failure rate was crestal bone loss of greater then 4 mm. The difference between the cumulative success rate in Watson’s study and our study may be attributed to the type and the quality of the HA coat. Anderson and coworkers reported a 3-year cumulative success rate of 100% for the standard-diameter (3.75 mm) implants and 93.8% for narrow-diameter (3.25 mm) implants, both self-tapping titanium (non HA).

In conclusion, a single tooth implant supported restoration should be considered a safe and predictable treatment for replacement of teeth in the partially edentulous anterior mouth. Both narrow cylindrical HA coated, and sandblasted titanium alloy implants were proven equally effective.
Immediate Loading of Transitional and Permanent Implants
Immediate Loading of Transitiond and Permanent Implants

Introduction

Ever since the use of implants became widespread more than a decade ago, dentists have been asked by their patients to provide them as a substitute for dentures. Many partially or fully edentulous patients refuse to "hear of dentures," and are willing to expend significant sums of money for implants, in order to avoid them.

However, when presented with a treatment plan to restore a full or partial dentition with implants, the phrase, temporary denture, is usually objectionable. This is followed by a series of questions such as: how long, how will I manage, why a denture if we're discussing implants, etc.

An intermediate solution to this problem was found several years ago in the form of "transitional implants." These particularly thin implants that are placed between the permanent implants at the time of implantation do not undergo osseointegration, but only support the temporary restoration while the permanent implants heal, and are then removed.

There are two types of transitional implants:

1. Thick, with a ball-attachment; two are usually adequate for a temporary denture.

2. Thin, intended to be joined by a metal strip that supports a slotted rider within a temporary bridge.

While the transitional implants provide the patient with a more comfortable solution, they can cause bony damage without contributing to the final restoration.

Attempts to shorten and simplify the course of treatment while avoiding, as much as possible, the use of temporary dentures continued to evolve. This led to "immediate placement" (extraction with immediate implant insertion) followed by "immediate loading" (the provision of a temporary restoration supported by the freshly placed fixtures). The implants and abutments must be placed and the temporary crowns adapted at the same sitting.

In an article by Aires and Berger, loading is considered to be immediate if done within three weeks of implantation.

This study presents clinical cases that demonstrate the advantages of immediate loading as well as potential difficulties that can arise during treatment.
Case Presentations

The first case (photographs 1a-1d) shows immediate loading on transitional implants.

A 55-year-old man presented with a temporary lower denture and a complaint of decayed roots in the mandible. Three months after extracting the remaining roots nine implants were inserted. Tooth #48 [32] was retained to prevent loss of vertical dimension until completion of the final restoration. In order to protect the implant sites, the denture was supported by two transitional mini-implants. After a four month period to allow for integration, the transitional implants were removed and the permanent implants were restored with cemented bridges. The temporary implants provided the patient with a relatively comfortable solution but still involved a removable appliance, even though the treatment plan called for a porcelain fused to metal, fixed bridge.

The second case (photographs 2a-2f) illustrates immediate loading on permanent implants.

A 53-year-old man presented with a terminal dentition (with the exception of the lower canines) for implant-supported reconstruction of the maxilla. Two months after extractions, 8 implants were inserted; 6 of them were loaded immediately by an acrylic bridge.

The easiest and simplest method of constructing the temporary bridge is to utilize a clear, vacuum formed matrix based on the temporary denture. This is filled with self-polymerizing acrylic and placed over abutments (in this case four plastic and two metal) that have been connected to the implants. Care should be taken to avoid transmitting excessively elevated temperatures to the implants during curing by cooling and periodically removing the polymerizing acrylic from the abutments. The final bridge #16-26 [3-14] was delivered 6 months later on 7 implants (one failed due to micromovement /bruxism/heavy smoking).

The last two cases are examples of immediate loading in conjunction with immediate placement.

In one case (photographs 3a-3c) a 56-year-old man had multiple extractions in the front lower jaw while placing and loading 5 implants.

In another case (photographs 4a-4e) a 46-year-old woman presented suffering from a loss of bony support in the upper incisors accompanied by anterior flaring and mobility, creating an esthetically compromised appearance. The incisors were extracted with the immediate placement of four fixtures and four splinted temporary crowns.

Contact between the temporary restoration and the opposing arch should be avoided as well as with the adjacent natural teeth, in this case the maxillary canines.

Normal physiologic movement of the canines during mastication through the width of the periodontal membrane (0.2 mm) can be deleterious to the implants during the first stages of healing. The permanent restoration was placed four months after implantation.

Discussion

During the last 2 years there has been a growing body of research supporting extraction, followed immediately by implantation and temporary restoration. There are those who contend that four implants per arch are sufficient to support immediate loading of a denture. Needless to say, the dimensions of the implants are no less important then their number. The surface area of a 5.0 X 13 mm implant is almost twice that of one measuring 3.3 X 10 mm. The wider implant has the advantage of offering greater primary retention in the coronal third of the socket where 80% of the lateral (damaging) forces of occlusion exist. Quality (type) of bone has a great influence — researchers say a torque of minimum 30N is needed to be on the safe side for immediate loading.
It should be kept in mind that immediate loading takes for granted a single stage procedure where the head of the implant is left exposed, as opposed to two stages requiring exposure.

Today, the more protracted, staged procedure is still common, necessitating: (1) extraction, (2) delayed implantation, (3) exposure with healing cap and (4) temporary restoration.

With the shorter method the entire procedure is completed in one stage. The treatment period is contracted, less chair time is needed and the immediate, temporary restoration accompanies the patient throughout the period of osseointegration. While the currently acceptable integration periods are three months in the mandible and six months in the maxilla, in the future, these time frames may be considered too long. For using this procedure with single units, initial reports on ten maxillary premolars using hydroxyapatite covered anatomical implants are encouraging.

In terms of the transition to a final restoration, the immediate method presents a clear advantage over a staged procedure. It allows for the creation of papillae and eliminates the esthetic problem of interproximal "black holes." The gingival margin stabilizes after three months and permits an accurate impression with total control over the location of the finishing line by using intermediate abutments of suitable heights. Ideally, the abutment head or top of the intermediate abutment should be 1mm sub-gingival, but if esthetics are paramount, 2-3 mm is preferable. According to Cooper et al, final impressions of mandibular implants that underwent immediate loading were taken at three months, and at an eighteen-month evaluation, no pathology was evident. The conclusion is that no undue risk is inherent in immediate loading.

Similarly, in cases involving over-dentures, in a one-year follow-up, both soft and hard peri-implant tissues are identical to those with conventional implants.

Histologically, there is no difference in osseointegration of immediately loaded and unloaded implants.

**Conclusions**

Immediate loading with restorations of the implants in the cases presented, as well as those in many other articles, did not diminish the chances for successful implantation. The length of treatment as well as chair time was reduced. The method provides comfort for the patient and improves esthetics and function for the treatment period.

In addition, the patient sees results immediately after surgery, and is saved the anesthesia and pain of two additional procedures: pre-op extractions and post-op fixture exposure. For the dentist, there is the additional immediate benefit of being able to anticipate the final restoration and to have complete control over the healing of the gingiva with the temporary crowns.

**Summary**

Transitional implants are not as necessary today as in the past. Immediate loading on implants, including those placed at the time of extraction, is gradually becoming an accepted procedure, with a high rate of success, and esthetic and functional advantages. It is a treatment modality that requires a combination of surgery and prosthetics. In order to minimize load, the temporary restoration must be taken out of contact insofar as possible. And for the same reason, repeatedly removing and replacing it should be discouraged. The patient should be held to high standards of hygiene and kept on a soft diet. In spite of the method's advantages, higher risk cases involving bone defects, bruxism, poor compliance or a single tooth implant, should be carefully evaluated.
Photograph Captions

1-a Pre-operative film showing root fragments in the mandible. Tooth #48 [#32] maintains the VDO until completion of the final bridge.

1-b Between the permanent implants are two temporary implants to support and retain the temporary denture. At exposure of the permanent implants, these were removed and the denture relined to fit the healing caps.

1-c Final restoration — three porcelain fused to metal bridges.

1-d Post-operative panoramic film

2-a Pre-operative panoramic film. With the exception of the lower canines, a full clearance was performed and immediate dentures inserted.

1-b After a two month healing period, delayed implants were inserted in the maxilla.

2-c, d Immediate loading on four plastic and two metal abutments. An acrylic, full arch, maxillary, temporary bridge. The shape of the temporary crowns and pontics will be recreated in the healing gingival.

2-e, f Post-operative clinical and panoramic film
3-a Pre-operative photograph

3-b Immediate loading (one tooth still in place)

3-c Post-operative panoramic film, bridge # 36-43[19-27]

4-a Loss of bony support in maxillary incisors

4-b Excessive unaesthetic flaring of incisors

4-c, d Bite correction at time of extraction, fixture placement and immediate loading #12-22[7-10].

4-e Final bridge