

The Marius Implant Bridge: Surgical and Prosthetic Rehabilitation for the Completely Edentulous Upper Jaw with Moderate to Severe Resorption: A 5-Year Retrospective Clinical Study

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ABSTRACT

Background: Patients seeking replacement of their upper denture with an implant-supported restoration are most interested in a fixed restoration. Accompanying the loss of supporting alveolar structure due to resorption is the necessity for lip support, often provided by a denture flange. Attempts to provide a fixed restoration can result in compromises to oral hygiene based on designs with ridge laps. An alternative has been an overdenture prosthesis, which provides lip support but has extensions on to the palate and considerations of patient acceptance. The Marius bridge was developed as a fixed bridge alternative offering lip support that is removable by the patient for hygiene purposes, with no palatal extension beyond normal crown–alveolar contours.

Purpose: Implant-supported restorative treatment of completely edentulous upper jaws, as an alternative to a complete denture, is frequently an elective preference, and it requires significant patient acceptance beyond the functional improvement of chewing. Patients with moderate to severe bone resorption and thin ridges present additional challenges for adequate bone volume and soft-tissue contours. The purpose of this investigation was to develop a surgical and prosthetic implant treatment protocol for completely edentulous maxillae in which optimal lip support and phonetics is achieved in combination with substantial implant anchorage without bone grafting.

Materials and Methods: The Marius bridge is a complete-arch, double-structure prosthesis for maxillae that is removable by the patient for oral hygiene. The first 45 consecutive patients treated by one person (YF) in one center with this concept are reported, with 245 implants followed for up to 5 years after prostheses connection.

Results: The cumulative fixture survival rate for this 5-year retrospective clinical study was 97%. Five fixtures failed before loading, in five different patients, and two fixtures in the same patient failed at the 3-year follow-up visit. None of the bridges failed, giving a prostheses survival rate of 100%. The complications were few and mainly prosthetic: nine incidences of attachment component complications, one mesobar fracture, and three reports of gingivitis. All complications were solved or repaired immediately, with minimal or no interruption of prostheses use.

Conclusions: Satisfactory medium-term results of survival and patient satisfaction show that the Marius bridge can be recommended for implant dentistry. The technique may reduce the need for grafting, because it allows for longer implants to be placed with improved bone anchorage and prostheses support.

KEY WORDS: clinical follow-up, complete arch, double structure, esthetics, maxilla, phonetics, tilted implants

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The possibility of an esthetic fixed prosthesis supported by osseointegrated implants remains one of the most remarkable achievements in clinical dentistry.^{1–4} However, successful implant-supported restorative treatment of completely edentulous upper jaws as an alternative to a complete denture requires significant patient acceptance beyond the functional improvement of chewing, because it frequently is an elective preference rather than a functional requirement. People seek-

ing this treatment often have well-functioning upper dentures, and their pursuit of an implant-supported bridge may be based on psychological reasons involving self-image, perception of aging, and acceptance by others. Several authors have detailed the diagnostic and implant prosthodontic criteria for successful treatment outcomes for this indication.⁵⁻¹²

Resilient overdentures retained by dental implants have been used as an alternative to a fixed bridge.¹³⁻¹⁶ A variation of the overdenture is the double-structure approach, presented in various fashions, including what has become known as a spark-erosion prosthesis.¹⁷⁻²¹ The overdenture and double-structure design introduce a substantial degree of freedom in implant position and direction without compromising the esthetic outcome, compared with the more exacting placement required for a fixed prosthesis. An advantage of this flexibility of positioning is that the implants may be more optimal with respect to bone anchorage. However, disadvantages with the maxillary overdenture and spark-erosion variation observed by the authors include an undesirable bulk in contour on the palatal aspect and prosthesis instability after years of use.

Another important restriction for complete-arch implant prostheses in the maxilla is the often limited amount and quality of bone available at the site of implant placement.²² Radiographically, the maxilla may show available height of bone, but owing to the resorptive pattern, the residual ridge is often too narrow in a labial-palatal dimension for implant placement. Onlay bone grafting has been used to overcome this deficiency in bone volume.²³⁻²⁶ The technique of implant tilting in the maxillary arch has been clinically documented and demonstrates a viable technique for improving bone anchorage and prosthesis support, while often avoiding bone grafting procedures.²⁷⁻³⁰

The Marius reconstruction (named after the first patient treated with this modality) is a specific double-bridge structure. It was developed during a search for a method to provide routine fixed solutions for the completely edentulous upper jaw, to provide esthetic anatomic contours when restoring hard- and soft-tissue deficits, without the necessity of bone grafting procedures. The concept is based on four factors:

1. The ability to place fixtures in the posterior region along the anterior ascending wall of the maxillary sinus,

2. The ability to place fixtures in the anterior region adjacent to the incisal foramen,
3. Use of an anterior undercut in the bridge mesobar to provide primary retention for the superstructure, and
4. Presentation to the patient as a fixed bridge, yet removable for oral hygiene purposes

The aim of this article is to present a method that evaluates the functional outcome and patients' satisfaction with the use of Marius reconstruction relative to the hypothesis that this treatment modality combines the advantages of an overdenture and a fixed bridge for edentulous maxillae.

MATERIALS AND METHODS

Patients

Results from the first 45 consecutive patients treated with the Marius bridge are presented. The patients included in the study were treated by one person (YF) in one clinic. All patients were completely edentulous in the upper jaw and candidates for implant treatment who fulfilled the following inclusion criteria:

- Necessity of lip support or position of the lip when smiling, requiring a flange extension to the prosthesis, and
- Sufficient bone available for placing implants with a minimum diameter of 3.75 mm, in tilted position if desired, in positions suitable to support a fixed bridge.

The patients were shown the alternative of the Marius bridge, using a well-produced model, and the concept was presented as a fixed bridge that is removable by the patient for oral hygienic purposes. Exclusion criteria were those generally used when candidates for implant treatment are selected.³¹

The patients were treated with a total of 245 implants (Brånemark System®, Nobel Biocare AB, Gothenburg, Sweden). The vast majority ($n = 43$) of the patients had been edentulous in the maxilla for over 5 years. The first implant was placed in May 1991 and the last one in June 1994. The first bridge was placed in April 1993 and the last one in May 1995. Data from the patients' treatment were retrospectively followed from records before July 1, 1995; after that time, follow-up was conducted according to a standardized format.

There were 15 male and 30 female patients in the study. The age distribution is given in Table 1, and bone quality, according to Lekholm and Zarb,³² estimated from presurgical radiographs and surgical assessment, is given in Table 2. The implant positions in the jaws are described in Table 3 and implant lengths in Table 4. The reasons that patients gave for their choice of treatment are given in Table 5, and the number of implants per bridge is described in Table 6.

Surgical Aspects

The surgical approach for the Marius bridge recognizes that in the moderately to severely resorbed maxilla, the residual bone ridge is often too thin to allow straight placement of 10-mm or longer dental implants, especially for posterior support. In these situations, tilted implants are used in the posterior, following the anterior wall of the maxillary sinus. These posterior tilted implants are considered to be significant in the structural foundation for the nonresilient fixed restoration and are referred to as posterior bodyguard implants to differentiate them from other posterior implants that may be placed. After posterior bodyguard implant placement, appropriate sites for anterior implants on each side lateral to the incisal foramen are identified; these two implants are also considered critical to the structural support and are referred to as anterior bodyguard implants. Only after these four implants are placed are other sites considered, based on available bone.

All implants (Brånemark System) were placed following the general principles of Brånemark.²² The surgical preparation began with the posterior implants at each side, placed in the pyramid of bone anterior to the maxillary sinus. These pyramids are composed of the anterior wall of the sinus, the buccal plate, and the palate (Figure 1). The sites were begun on the palatal side of the crest. There was only one pass made with the 2-mm and 3-mm twist drills to minimize the risk of overprepara-

TABLE 2. Bone Quality According to Lekholm and Zarb³²

	Bone Quality			
	1	2	3	4
Implants (n = 245))	0	111	111	23
Implants lost (n = 7)	—	4	1	2

TABLE 3. Positions of Maxillary Implants

	Incisor*	Canine	Premolar or Molar†
Implants (n = 245)	89	66	90
Implants lost (n = 7)	1	0	6

*Anterior bodyguard; †posterior bodyguard.

tion, with the preparation directed following the anterior wall, attempting to allow the cortices to guide the drill direction upwardly and anteriorly.²⁷⁻³⁰ Use of the pyramid of bone anterior to the maxillary sinus also allows

TABLE 4. Implant Lengths

Implant Length (mm)	Implants (n = 245)	Implants Lost (n = 7)
7	6	2
8.5	1	0
10	72	0
12	8	0
13	68	5
15	71	0
18	15	0
Unknown	4	0

TABLE 5. Patients' Reasons for Treatment Choice

Reason	Number of Patients (n = 99)*
Phonetic	11
Esthetic	17
Psychological	30
Functional	41

*Some patients had a combination of two or more reasons.

TABLE 1. Patient Age Distribution

Age (y)	Number (n = 45)
18-30	1
31-40	10
41-50	21
51-60	7
61-70	5
71-80	1

TABLE 6. Number of Implants per Bridge

Number of Implants	3	4	5	6	7
Number of bridges	1	10	8	25	1

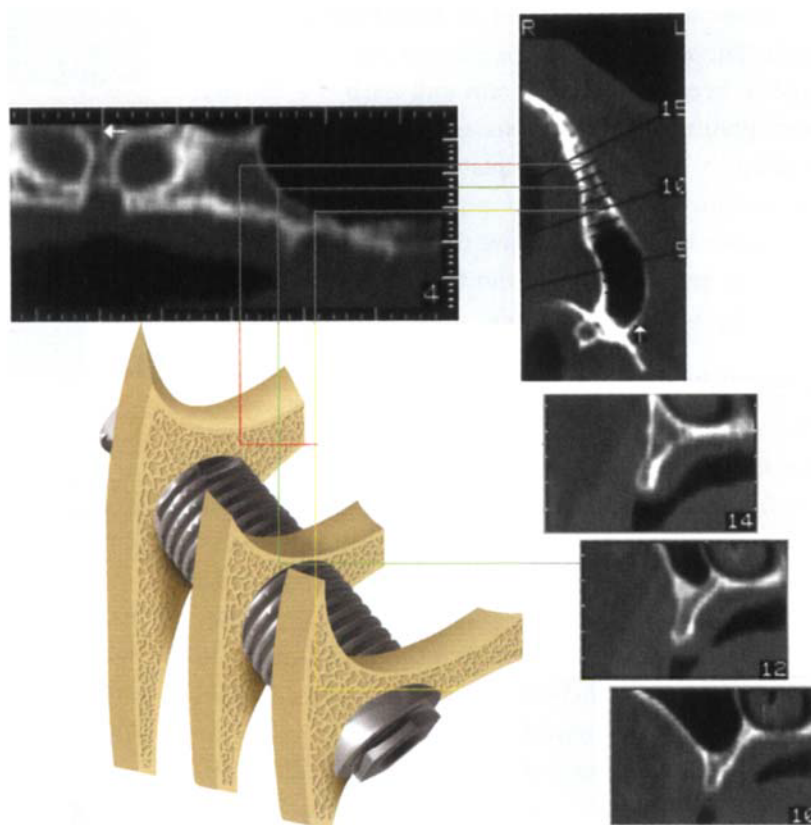


Figure 1. The three-dimensional pyramid of bone that is often located anterior to the maxillary sinus wall. This pyramid is suitable for the placement of one tilted implant following the inclination of the cortex of the anterior sinus wall and medial to the buccal plate. (CT scan courtesy of D. Levitt, DDS.)

treatment of patients with otherwise knife-edge ridges that would be too thin for implant placement. The implants were tightened with a minimum of 30 Ncm torque resistance, and no more than two exposed threads on the palatal aspects of implants were present. This procedure led to stable posterior implants with the heads routinely emerging in the second premolar locations (i.e., posterior bodyguards) (Figure 2).

Following placement of the posterior bodyguards, two implants were placed anteriorly on either side of the

incisal foramen, as could be accommodated by available bone. A pyramid of bone generally lies on either side of the incisive foramen, extending superiorly and following the direction of the canal. These anterior bodyguard implants follow the natural profile of each pyramid on either side of the canal. Four implants were aimed for, with additional implants added only if bone volume allowed further placement between the four implants first placed. Often additional implants could not be placed in the canine site, because the anterior extension

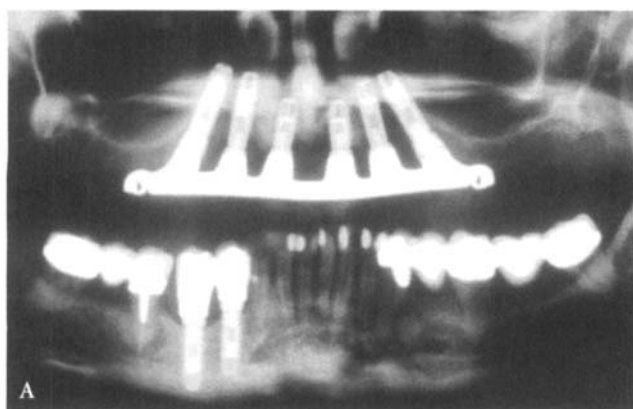


Figure 2. A, Radiograph demonstrating tilting of posterior bodyguard implants. B, Occlusal view of mesostructure showing flexibility in position of implant placement. Note distal inclination of both posterior gold screws following the axial orientation of implant placement.

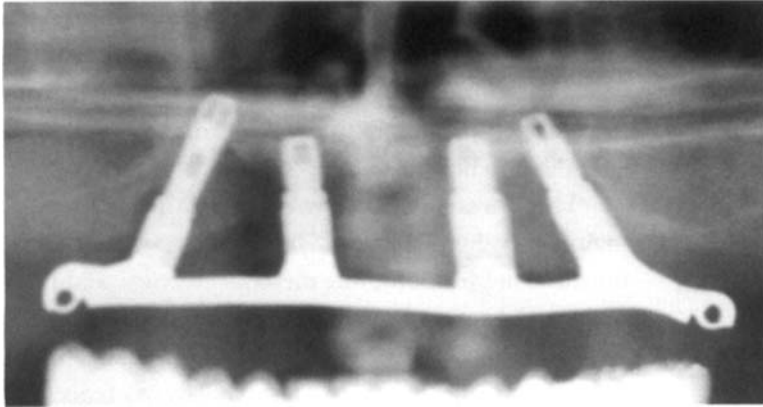


Figure 3. Four implants is the minimum goal for a fixed restoration in the fully edentulous maxilla. Often the maxillary ridge is too thin to allow placement of intermediary implants without onlay bone grafting.

of the bodyguard implant occupied its superior aspect (Figure 3), or the residual ridge was too thin to allow implant placement without onlay bone grafting.

Restorative Aspects

The Marius bridge is fully implant supported, with no resiliency incorporated into the design, even though the patient can remove the bridge superstructure. This allows for an anterior flange for lip support in a fixed, stable design that is still removable for patient hygiene access (Figure 4). The bridge uses a cast mesostructure and superstructure incorporating an approximately 20-degree anterior angle and a posterior locking mechanism (Figure 5). This anterior undercut serves several functions. First, as the superstructure rolls around this mesostructure undercut upon insertion, this anterior undercut provides primary retention for the entire prosthesis, even before the posterior locks (Mk I Universal Attachments, Sande, Germany) are engaged (Figure 6). The design of this anterior bar segment fits within the confines of upper incisor cervical morphol-

ogy and flows with the palate contours, allowing proper tongue spacing with minimal encroachment (Figure 7).

Survival Criteria and Follow-up

A surviving implant was defined as an implant that was clinically stable and fulfilled its purported function without any discomfort to the patient.³³ Once the treatment was finalized, the patients were asked about their satisfaction with regard to phonetics, esthetics, and psychological and functional aspects.

The patients were assessed every 6 months after bridge connection. The mesobar stability was checked at the position of each implant and any complication registered. Implant mesobars were not routinely removed; however, if a gold prosthetic screw was found to be loose, the mesobar was removed and each abutment screw was individually assessed for tightness. Panoramic survey films were taken on an annual basis; no systematic bone level measurements were carried out, and intraoral radiographs were only taken in situations when needed to ascertain implant integration.



Figure 4. A, Anterior view of Marius bridge superstructure with full flange extension. The Marius bridge uses a prosthetic means to provide lip support and to correct soft-tissue deficits when sufficient bone is present for implant anchorage. B, Marius superstructure from above. Although an anterior flange is present, there is minimal bulk on the palatal aspect. The posterior locks protrude when they are not engaged.



Figure 5. Side view of mesostructure. Note approximately 20-degree anterior undercut and circular receptacle for lock engagement. Once the superstructure is rotated around the anterior undercut, the locks are placed through the mesostructure, with no resiliency present.

Dropouts

Six patients were withdrawn from the study: one patient did not show up after prosthesis delivery, and five were lost to follow-up after 2 years because they moved far away or their addresses became unknown. Thirty-nine (87%) of the patients were followed through the complete study time, 5 years.

RESULTS

Five implants failed before loading (all in different patients), and two implants failed at the 3-year follow-up visit (in the same patient), giving the cumulative implant survival rate of 97% (Table 7). None of the bridges failed, giving a prosthetic survival rate of 100%. In situations where intraoral radiographs were taken, no radiolucent areas were observed.

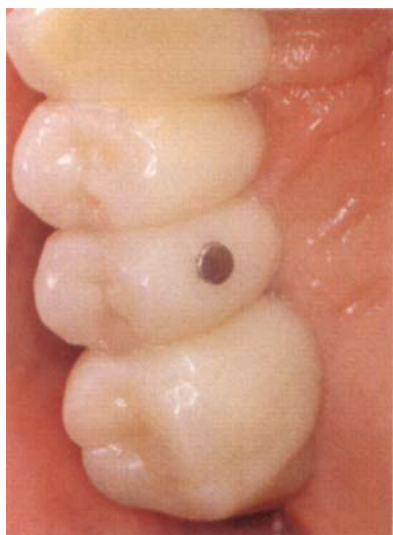


Figure 6. When the posterior lock is seated, the patient can easily verify complete seating with his or her tongue. The locks are easily disengaged with a pin mechanism.

All patients were satisfied with phonetics, esthetics, and psychological and functional aspects once treatment was completed. Thirty-nine of the patients considered their prostheses to be fixed, whereas six considered them to be removable.

There were only a few complications reported, mainly prosthetic: nine incidences of attachment component complications, one mesobar fracture, and three observations of gingival inflammation. All prosthetic complications were solved or repaired immediately, and the use of the prosthesis was only shortly interrupted, if at all.

DISCUSSION

The 5-year cumulative survival rate of 97% compares favorably with historic materials.^{34,35} It is believed that the reasons for the good result are the biomechanical advantages of the concept and the well-anchored implants placed in strategic positions from a load-sharing point of view.

As bone loss was not systematically measured, the probability for the implants to remain stable could not be predicted.³⁶ However, the majority of implant losses

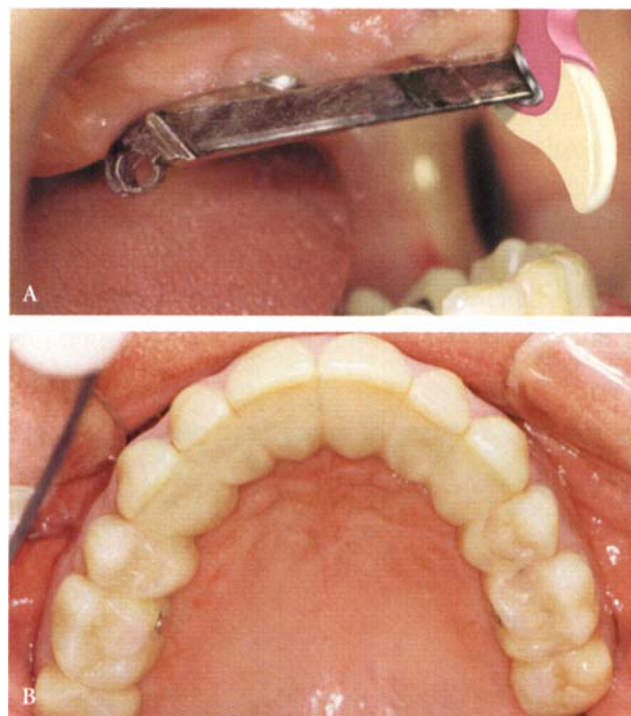


Figure 7. A, Side view of mesostructure with illustration overlay demonstrating retention and lack of bulk, with bar tucked inside cervical morphology of anterior teeth. B, Occlusal view of seated Marius bridge. Even though a full flange is present in the anterior, the palatal aspect is similar in contour to a fixed restoration on natural teeth.

TABLE 7. Cumulative Implant Survival Rate

Time Period	Implants	Failed	Withdrawn	CSR (%)
Placement–loading	245	5	0	98.0
Loading–6 mo	240	0	6	98.0
6–12 mo	234	0	0	98.0
12–18 mo	234	0	0	98.0
18–24 mo	234	0	11	98.0
24–30 mo	223	0	17	98.0
30–36 mo	206	2	0	97.0
60 mo	204	0	0	97.0

with the Brånemark System occur during healing or the first year of function³⁶; therefore, because the patients of the present study were followed for 5 years, the result indicates that the concept is viable long term.

Historically, implant treatment of the completely edentulous maxilla has been evolving toward the placement of more implants than the standard four to six implants originally introduced by the Brånemark team. However, from a biomechanical point of view, placement of the two well-anchored posterior bodyguard implants, with the addition of at least two more anterior bodyguard implants in the anterior segment, provides a predictable foundation for an implant-supported prosthesis.³⁷ The interfixture spread is favorable, cantilevers are minimized, and the posterior implants are well anchored. In addition, it is easier to achieve a well-fitted prosthesis with fewer implants. This means that limiting the number of implants to four to six for the maxillary complete-arch prosthesis helps to ensure optimal mechanical stability. This principle, to use a few well-anchored and positioned implants rather than the maximum possible number of implants, is supported by clinical documentation in which the same success rates for fixed bridges in both jaws for the full-arch prosthesis anchorage has been shown, whether four or six implants were used.³³

It has been shown by intraoral implant load measurements that tilting of an implant that is part of a multiple implant-supported bridge structure does not increase bone stress per se.²³ Therefore, placing tilted implants in posterior maxillary locations has potential advantages over the more conventional straight implant alignment. The head of the implant may be placed in an optimized position with respect to load distribution, reducing cantilevers and eliminating implant off-set, and anchored in denser bone structures. The tilting

of the sites allows for placement of relatively longer implants than could be accomplished with more traditional straightly aligned implants.

With a traditional attempt to place implants in a relatively straight manner in maxillae, the longest implant is in the area of the canine eminence, and only short implants can be placed posteriorly, limited in length by the maxillary sinus (Figure 8).²² Since 1992, this treatment method has used tilted maxillary implants, which

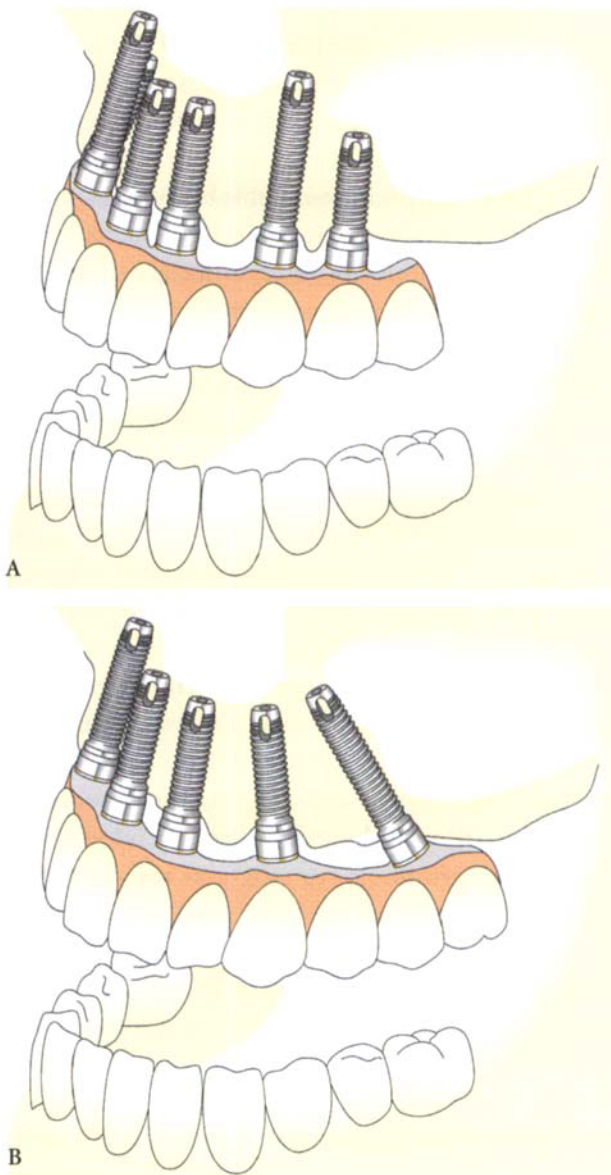


Figure 8. A, Traditional approach to implant placement in the fully edentulous maxilla. The longest implant is located in the area of the canine eminence and a shorter implant located underneath the ascending anterior wall of the maxillary sinus. B, The surgical aspect of the Marius bridge uses the increased length available from a tilted implant following the anterior cortex of the maxillary sinus. For a full-arch restoration, the emergence of the head of the implant underneath the functioning occlusal plane is of more significance than its inclination in the bone.

allows the head of the implant to emerge underneath the occlusal plane in a more posterior position, typically in the premolar or molar region. Other authors have confirmed tilting of implants as a viable alternative.²⁷⁻³⁰ The direction the implant follows is through dense bone structures, leading to improved primary anchorage. In summary, the following two steps are pursued: (1) the desired position of the implant head is determined from a prosthetic point of view, and (2) the implant is tilted to optimize its bone anchorage.

The Marius bridge constitutes a combination of the fixed bridge and the overdenture for edentulous maxillae. An implant-supported fixed restoration, either hybrid type or porcelain-fused-to-metal, has obvious prosthetic advantages compared with a denture; the fixed nature, being only removable by a dentist, and the wide open palatal area are desirable benefits for this treatment. The porcelain-fused-to-metal restoration is ideal in instances of minimal resorption, where only the crown structures of the teeth are being replaced and there may be only slight soft-tissue deficiency. The hybrid-type restoration, with denture teeth and acrylic, has the ability to prosthetically replace some larger soft-tissue deficits along with the missing teeth. A limitation of both types of fixed bridges, however, is the hygienic compromise that may be introduced with ridge lapping, in an attempt to provide lip support without a true flange extension. This compromise may stem from the patient expectation of a fixed restoration but also fullness in the nasal filtrum area. The overdenture prosthesis does provide lip support with an anterior flange extension and hygiene access but has more substantial encroachment into the palatal area. In addition, the overdenture prosthesis typically uses resilient attachment mechanisms that allow for some movement. The Marius bridge is perceived as fixed and yet is removable for hygiene access on a daily basis. The lip-support benefits of a flange are available in a nonresilient fixed restoration without compromising the phonetic functioning of the patient. The palatal contours of the restoration are analogous to teeth contours with no further extensions into the palatal area. The use of pre-machined components and the introduction of an anterior undercut to the mesobar has significantly reduced bulk in the palatal areas compared with previous patient-removable appliances, such as the spark-erosion prosthesis. The angled bar that fits inside the cervical tooth contours can be an advantage over the

vertically oriented bar with a 2-degree taper, as previously seen with spark-erosion prostheses when interarch space is limited,^{17,18} as there is only a 4-mm height requirement for the Marius bar. The use of pre-machined components and laboratory handling procedures have allowed predictable assembly of the screw-retained bridge structures, with passive and full seating of the bridge superstructure routinely achieved to engage the anterior undercut and posterior locking mechanisms. The high success, the low number of complications, and patient satisfaction demonstrate that the Marius bridge concept is well designed for routine clinical practice and that it combines the advantages of an overdenture and a fixed bridge for treatment of edentulous maxillae.

CONCLUSION

The Marius bridge is an effective and predictable fixed implant-supported prosthesis for the patient with a fully edentulous maxilla. Even though the double-structure bridge design is removable by the patient for hygiene access, it is accepted by the patient as a fixed restoration, yet it comprises the lip support and esthetic and phonetic advantages of a removable prosthesis.

ACKNOWLEDGMENT

The authors thank Dr. Åsa Taylor (Nobel Biocare, Gothenburg, Sweden) for her work in data compilation and formatting.

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