A Surgical Stent for the Brånemark Novum® Bone Reduction Procedure

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ABSTRACT

Background: The Brånemark Novum® concept (Nobel Biocare AB, Göteborg, Sweden) was introduced to load implants immediately with a definitive fixed prosthesis in the edentulous mandible. This concept is based on the use of prefabricated templates to allow precise placement of three implants and a prefabricated bar structure for the prosthetic procedure. To obtain three-dimensional stability in these prefabricated templates, surgical bone reduction may be necessary to obtain a stable adaptation between the templates and the recipient bone site.

Purpose: The aim of this work was to design a surgical stent for predictable reduction of the residual alveolar crest prior to the implant placement procedures.

Materials and Methods: A predetermined alveolar crest platform based essentially on a lateral cephalometric radiographic evaluation was simulated on a cast in order to design a transparent resin surgical guide. The predictability potential of the procedure was then evaluated in 10 patients. The prosthetic outcomes were compared with those of a similar group of 10 patients treated without the presented stent by evaluating two factors, namely, the anterior dimensions of the prostheses and the required posterior adjustments of the upper bar.

Results: Correlation analysis of our series suggested a good predictability potential for this procedure ($r = 0.9215$). The mean anterior prosthetic dimension was 32% lower and was more predictable (narrow range of 8–12 mm vs broad range of 8–21 mm) when the stent was used. Furthermore, since half as many posterior adjustments of the upper bar were required, the laboratory procedure was facilitated.

Conclusion: This individualized guide allows appropriate bone reduction for obtaining a predictable surgery and prosthetic stage.

KEY WORDS: Brånemark Novum, fixed prosthesis, immediate loading, osseointegrated implants, surgical template

Successful prosthetic rehabilitation by means of osseointegrated implants is achieved by optimal surgical insertion. Fixture-positioning guides are a key element in the surgeon's arsenal.[1] Coordination between the prosthodontist and the surgeon is therefore critical in order to optimize implant placement.

Complementary techniques have been proposed by different authors to optimize implant placement.[2–17] Engelman and colleagues[2] in 1988 proposed the use of a surgical stent indicating optimum implant placement for fully or partially edentulous patients. This surgical guide with radiopaque marks was used for a preoperative tomographic survey to assess the placement of implants. Other studies documented the same principle with various technical modifications but without radiographic preoperative evaluations.[3–5] Other types of surgical guides based on radiographs or computed tomography scans have also been developed.[6–10] In 1992 Adrian and colleagues[6] proposed a surgical guide reposing on both jaws for placing implants in edentulous mandibles. This stent was based on the ideal implant trajectory, which was determined by lateral cephalometric radiographs made with radiographic markers.

Another approach was proposed by O'Neilly and McGlumphy[11] in 1993. To enable the surgeon to maintain the same horizontal and vertical drilling axes

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during the surgery, these authors suggested using a surgical stent to keep the head of the handpiece in the same position throughout the surgical procedure. Similar techniques based on this same principle have also been proposed.[12–15]

The accuracy of implant placement using a specific surgical template was demonstrated by Naitoh and colleagues[16] in 2000. More recently van Steenberghe and colleagues[17] developed a custom template and a definitive prosthesis by using computer-aided design and computer-assisted machining before placing implants.

In 1999 Brånemark and colleagues[18] introduced the Brånemark Novum® concept (Nobel Biocare AB, Göteborg, Sweden) for the rehabilitation of edentulous mandibles. In this protocol surgical and prosthetic prefabricated components allow immediate loading of three wide implants with a definitive fixed prosthesis made the day of the surgery. This technique has a reported 3-year success rate of 98%.[18] The protocol requires panoramic, intraoral occlusal, and lateral cephalometric radiography for the preoperative radiographic evaluation. The Brånemark Novum surgical procedure uses different prefabricated surgical templates that maintain the same axes during the whole drill sequence. These templates are supported on a previously created crestal bone reduction in a plane surface.[18] In 2001 Lekholm[19] noticed that from the interjaw relation point of view, class I is the most favorable situation and that class III, if not too advanced, can be treated whereas class II should be regarded as a contraindication for this protocol. In 2001 Engstrand and colleagues[20] found that it was possible to provide patients with definitive fixed prostheses on the day of implant surgery but felt that further refinement of this procedure would be helpful to increase the flexibility of the system. Indeed, in this technique, the axis of the implants is perpendicular to the axis of the bone platform because of the prefabricated templates that are used during implant placement.[18] The axis of the prefabricated prosthetic framework supported by the implants (ie, the bar structure) is perpendicular to the axis of the implants,[18,20] so the axis of the framework is parallel to the axis of the bone platform (see ''Materials and Methods''). Therefore it appears that the spatial position of the prosthetic framework supported by the implants is directly related to the surgical procedure (bone reduction). In addition, the position of the framework in relation to the antagonist teeth is critical to facilitating the prosthetic stage because the teeth must be set in this framework in line with different prosthetic aspects such as vertical dimension, opposite arch, and occlusion. Therefore it can be anticipated that the planar bone reduction is an important stage from a prosthetic point of view[21,22] and should be adapted to it.[21] Ideally the mandibular platform and bar structure should be parallel to the occlusion plane as was underlined by Parel and colleagues[21] and Engstrand and colleagues,[20] respectively. The surgeon has to consider these prosthetic aspects before and during the surgery. An individualized surgical template may be helpful in respecting these factors. Thus the use of a bone reduction surgical guide based on an evaluation of plaster casts set in an articulator, without radiographic evaluation, was proposed in 2002 by Parel and colleagues.[21]

The aim of this report is to propose a technique that uses an individualized surgical guide fabricated by simulation on a plaster cast set in an articulator, in accordance with a preoperative radiographic evaluation, to obtain a predetermined bone reduction for the Brånemark Novum procedure.

MATERIALS AND METHODS

Patients

Between April 2000 and September 2003, 20 patients were treated according to the Brånemark Novum protocol[18] with 60 implants immediately loaded in the mandible. All the patients were treated by two oral surgeons (authors C. M. and P. D.). The prosthodontist (L. B.) was the same for all the patients. All the patients satisfied the interjaw-relation selection criteria mentioned by Lekholm;[19] class II and advanced class III were excluded. For the first 10 patients the crestal reduction part of the Brånemark Novum protocol was done without using the surgical stent presented in this report; these 10 patients served as the control group. The protocol described below was followed for the 10 next patients, and the alveolar reduction was done using the presented surgical guide; these patients served as the test group. Both groups consisted of 4 males and 6 females, with a mean age of 67.1 years (range, 43.1–86.7 years) and 57.3 years (range, 42.2–77.3 years), respectively (Table 1). The upper jaw type was comparable for the two groups (Table 2). The diameter of the 60 implants used was

Table 1 Number of Study Patients, by Age and Gender

	Control Group		Test Group		
Age (yr)	Male	Female	Male	Female	Total
40–49	1	—	—	2	3
50–59	—	3	1	3	7
60–69	—	1	2	1	4
70–79	1	2	1	—	4
80–90	2	—	—	—	2
Total	4	6	4	6	20

Table 2 Opposing Dentition in Study Groups

	Control Group	Test Group
Removable complete dentures	8	9
Full natural dentition	—	1
Partial natural dentition	1	—
Full fixed prosthesis supported by implants	1	—

5.0 mm. Implants 11.5 mm and 13.5 mm in length were inserted in jaws of varying anatomies[23] (Table 3). Postoperative panoramic radiography and lateral cephalometric radiography were performed.

Preoperative Assessments and Analysis Principles

Panoramic, occlusal, and lateral cephalometric radiography must be performed according to the Brånemark Novum protocol. Prior to the lateral cephalometric radiography, radiographic marks (lead foil from a periapical x-ray film) are placed on the palatal surface of the central upper incisors and in the posterior occlusal curve (Figure 1). This radiography must be performed in occlusion or (for edentulous patients) in a correct vertical dimension of occlusion. On this lateral cephalometric radiograph, the occlusal posterior curve can be determined in the sagittal direction as well as the "theoretically ideal" position of the anterior teeth of the future Brånemark Novum prosthesis, namely, just behind the palatal surface of the central upper incisors, for occlusal reasons (see Figure 1). To be in accordance with this "theoretically ideal" position of the anterior teeth of the future prosthesis, the "ideal" trajectory of the anterior implant (ie, central implant) should pass right behind the superior incisors at the level of the radiographic mark and, of course, through the mandibular symphysis. This indicates the ideal central implant axis (ICIA) in the sagittal direction. Thus the axis of the mandibular platform is perpendicular to that of the implant. It determines the ideal mandibular platform axis (IMPA). The ICIA and IMPA are in relation with the radiographic mark at the palatal face of the central upper incisors only and not with the occlusal plane.

Determination of the Platform Axis in the Sagittal Direction. The axis of the central implant is perpendicular to the axis of the prosthetic framework,[20] which is also parallel to the platform's axis. It is possible to determine whether the axis of the framework resulting from the ICIA allows a favorable situation, from a prosthetic point of view, in posterior areas; the axis of the framework and therefore the mandibular platform's sagittal axis should ideally be parallel to the occlusal curve (as pointed out by Engstrand and colleagues)[20] to avoid prosthetic complications (see Figure 1). Thus the

Table 3 Number of Implants, by Implant Length in Relation to Bone Quantity*†

	Control Group			Test Group		
Quantity	11.5 mm	13.5 mm	Total	11.5 mm	13.5 mm	Total
A	—	2	2	—	2	2
B	1	3	4	—	5	5
C	2	2	4	—	2	2
D	—	—	—	1	—	1
Total	3	7	10	1	9	10

*According to Lekholm and Zarb classification.
†The diameter of all implants was 5.0 mm.

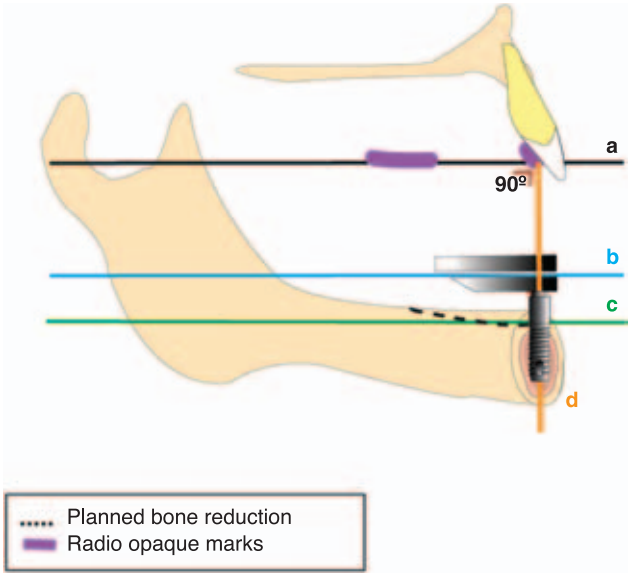

Figure 1 Diagram showing parallelism between the bone platform and the prosthetic framework. These planes are perpendicular to the axis of the implants. The occlusal plane ideally should be parallel to the prosthetic framework and therefore to the mandibular platform. Letter markers indicate the occlusal plane (a), the axis of the framework (b), the ideal mandibular platform axis (c), and the ideal central implant axis (d).

ideal situation is achieved when parallelism between the occlusal plane and the IMPA is observed. In this case the IMPA can be chosen as the platform axis.

In the case of divergence between the occlusal plane and the IMPA, if the opposite arch is a total removable prosthesis, the fabrication of a new prosthesis with an adapted occlusal plane before the Brånemark Novum surgery can be proposed to the patient to create the "ideal" situation described above. Parallelism between the occlusal plane and the predetermined IMPA will be verified when the removable prosthesis is made, as follows: At the time of the bite registration, lead foil is incorporated into the upper occlusal rim to mark the occlusal plane in the sagittal direction and the site of the incisors (Figure 2), and a lateral cephalometric radiograph is taken with the two occlusal rims in the mouth. If the superior teeth are natural teeth, use of the Brånemark Novum protocol should be considered with caution. Indeed, in this situation the consequences of an axis of the mandibular platform that diverges too much from the IMPA or occlusal plane may create problems for making the prosthesis, such as an important overjet between the prosthetic framework and the upper teeth in the anterior region or such as premature contacts of the

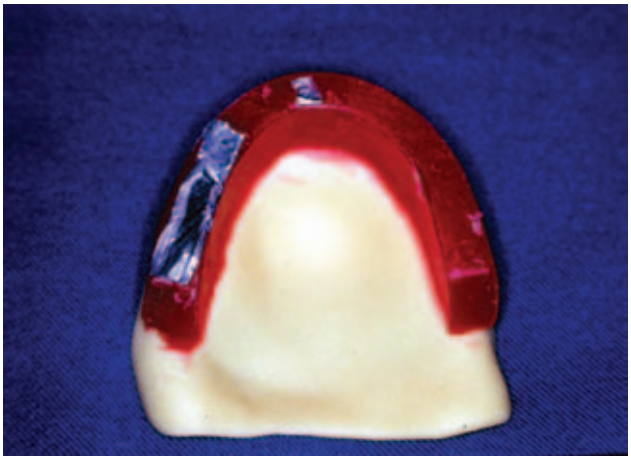

Figure 2 Lead foils used as radiographic marks incorporated in the upper occlusal rim to visualize the occlusal plane and the sites of the anterior teeth.

upper bar with the antagonist (see "Discussion"). For these reasons the position of the prosthetic framework must be anticipated.[21]

A transparent sheet representing the lower and upper bar structure in lateral view has been designed (Figure 3) to allow for deformation of the film by the lateral cephalometric x-ray machine. Applying this bar structure's representation to the radiograph enables one to gauge the magnitude of a possible prosthetic anteroposterior overjet by measuring the distance between the radiographic mark at the palatal face of the central upper incisors and the bars. The magnitudes of possible premature contacts of the upper bar's distal portions with the opposite arch that require a correction of this bar can also be estimated on the radiograph. Thus this radiographic examination enables the clinician to evaluate the clinical and laboratory outcomes induced by such a situation and decide if this protocol should or should not be considered a contraindication for the patient or if the platform's axis

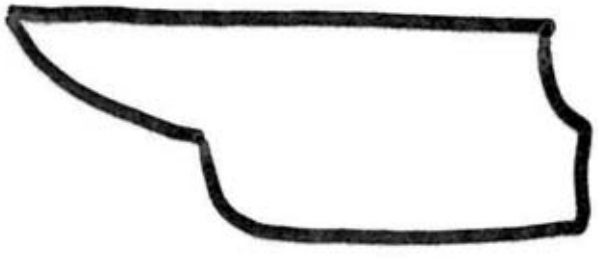

Figure 3 Representation of the lower and upper bars in sagittal view used on a transparent sheet.

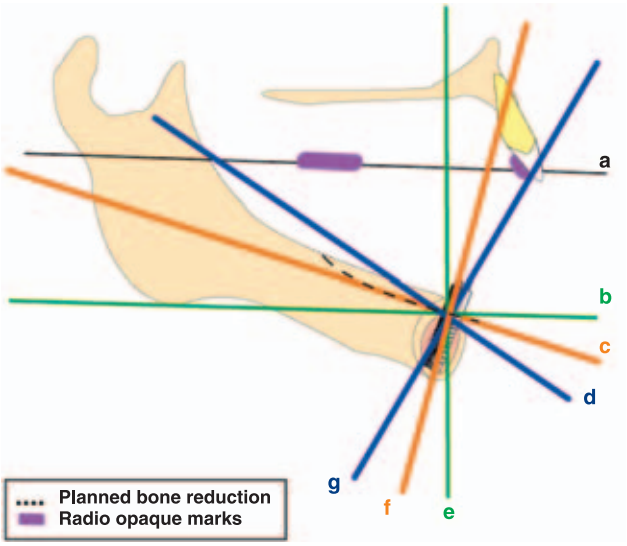

Figure 4 Determination of a "compromise axis." Letter markers indicate the occlusal plane (a), the line parallel to the occlusal plane passing through the neck of the implant (b), the "compromise axis" of the mandibular plane (c), the ideal mandibular platform axis (d), the perpendicular line to the occlusal plane (e), the "compromise axis" of the central implant (f), and the ideal central implant axis (g).

between the occlusal curve and the IMPA will allow an acceptable prosthetic compromise (Figure 4). In such a case the angle formed by the resulting axis of the platform with the occlusal plane (which is the reference for the technician) is calculated.

Height and Width of the Bone Platform. Once the axis is chosen, the height of crest reduction can be determined. To determine the height of bone reduction, the specific transparent sheet representing the Brånemark Novum implants is superimposed on the lateral cephalometric radiograph. Then the virtual implant is oriented with its neck in the buccal and lingual cortical layers for bicortical stabilization and (if possible) with the apex of the implant in the inferior cortical layer. At this stage the jaw's anatomy (at least close to the midline) and possible concavities of the mandible must be carefully observed. This factor may influence the length of the implants to be used (ie, 11.5 mm or 13.5 mm). The level of the mandibular platform in relation to the implant is placed at the level of the neck of the implant, which is visible on the transparent sheet. At this stage it is important to verify that the prefigured mandibular platform has a width of at least 7 mm (for implants 5 mm in diameter) and that there is at least 1 mm of bone facially and lingually to the implant, according to Brånemark and colleagues.[18] Then the interarch space is measured; it must be sufficient to harbor the system (15–16 mm, according to Parel and colleagues).[21] At this stage the specific transparent sheet representing the bars in lateral view can be useful (see Figure 3). The width and height of the predetermined crestal reduction are measured on the radiograph and transmitted to the dental technician (Figure 5). The height calculated on the radiograph, which is a bone measurement, must be increased. In fact the thickness of the mucosa (previously measured with a probe at the top of the crest, buccally and lingually, at each assumed implant site and with the patient under local anesthesia) must be added to this bone value since the dental technician has mucosal reference marks on the plaster cast. The radiographically measured width must also be overvalued by at least 2 mm in order to have at least a 1 mm margin both lingually and buccally. It is interesting to situate this segment anteroposteriorly in relation to the summit of the crest; for example, for a platform of 10 mm in width, it would be positioned 4 mm buccally and 6 mm lingually from the crest's summit.

Technical Procedure and Laboratory Protocol

After impressions of both maxillas are made and bite registration is performed, casts are set in an articulator. If the patient presents a total removable prosthesis, a cast of the edentulous maxilla (and not of the prosthesis) must be set in the articulator. To that end the

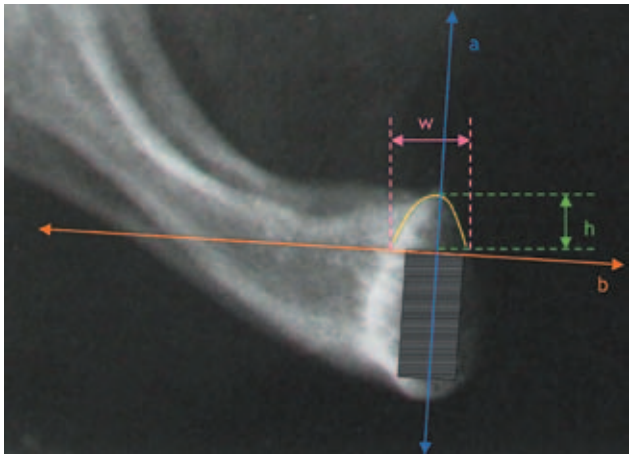

Figure 5 Superimposed diagram shows the axis of the central implant (a) and the axis of the plane of bone reduction (b). (h = measured height of the mandibular platform; w = measured width of the mandibular platform)

registration of the vertical dimension of occlusion is performed with the help of a lower occlusal rim and the superior removable prosthesis. To achieve a superior model on which it will be possible to put back the superior prosthesis, an impression of the superior jaw is made while using the patient's prosthesis as for a relining, with the help of low-viscosity silicone, simultaneously with the bite registration. The entire piece (superior removable prosthesis and lower occlusal rim) is transferred to the dental technician, who will cast a superior model and set both casts in the articulator. The patient's prosthesis is handed to him or her as quickly as possible.

Based on the above information (axis, height, and width; see Figure 5), the dental technician is able to prefigure the mandibular platform on the cast of the mandible while gouging the plaster cast. In the frontal direction, of course, the platform's axis must be parallel to the occlusal plane. This platform must be sufficiently extensive to allow the use of the first prefabricated template of the Brånemark Novum kit (Figure 6). Afterwards the dental technician can make a surgical splint in transparent acrylic resin to allow the reduction of the mandibular crest through a window. This splint is stabilized in the mouth by the retromolar mandibular tuberosities and by fitting it to the upper jaw so as to guarantee perfect stability in use. (In the case of a fully edentulous upper jaw, the splint is fit to the patient's maxilla, not to the superior complete prosthesis, to avoid cluttering the mouth during the surgery.) The part of the splint that corresponds to the mandibular platform is pierced to obtain a window

Figure 6 Mandibular platform simulated in a plaster cast.

Figure 7 Arms of the splint around the simulated platform.

(Figure 7). The upper part of the arms of the splint surrounding this window must be reinforced with metallic wires that will protect the splint when in use (Figures 8 and 9).

Surgery

During the surgery, when the flaps have been reflected, the guide is introduced into the mouth, applied against the mandible, and correctly stabilized on the mandibular retromolar tuberosities and on the upper jaw. The bone crest that juts out over the two arms of the open part of the splint in the anterior region is eliminated with twist reamer drills to shape the mandibular

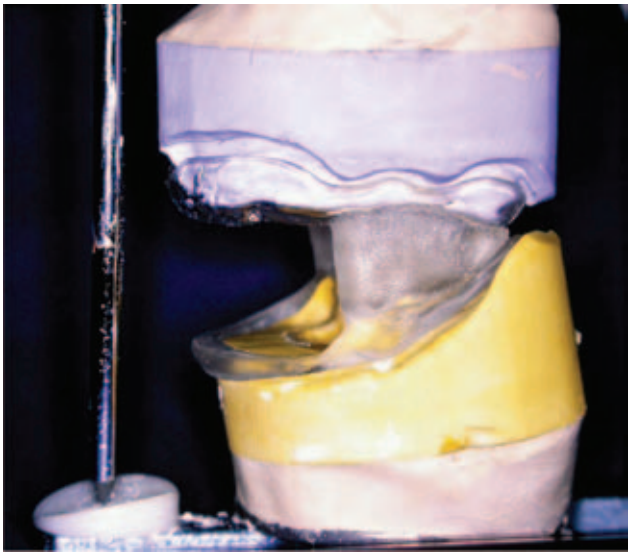

Figure 8 The fabrication of the guide is based on the interarch relation. This splint rests on the posterior parts of the mandible and is stabilized by the adaptation on the upper jaw.

Figure 9 Arms of the splint, reinforced by metallic wires to protect it when the twist reamer drill is used.

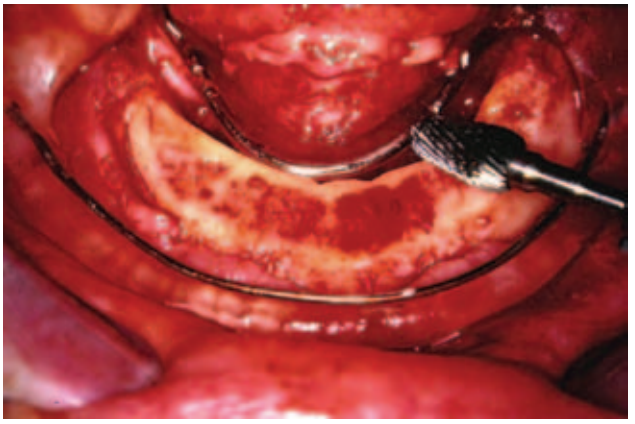

Figure 10 The bony crest jutting out of the window of the splint has been eliminated to shape the mandibular platform.

platform. This procedure is done with profuse saline sterile irrigation. The metallic wires of the splint's arms protect the stent during its use, to prevent the formation of acrylic remnants during the surgery that could later create inflammatory reactions (Figure 10). Once the bone reduction is done using this stent, the classic surgical procedure with the prefabricated Brånemark Novum protocol templates completes the surgery for the placement of the three implants.[18] The conventional prosthetic protocol is then followed as usual (Figures 11 and 12).

Clinical Evaluation

Predictability. To evaluate the predictability potential of the present procedure, predetermined and actually obtained measurements were compared for the test group of patients. The predicted measurements were obtained on a preoperative lateral cephalometric radiograph by determining the angle between the occlusal plane and the predetermined axis of the central implant. Postoperative lateral cephalometric radiography with radiopaque marks to visualize the occlusal plane was performed in occlusion to measure the actual angle between the two above-mentioned axes. A scatterplot representation and correlation analysis between the predicted and the obtained angles were carried out to evaluate the predictability potential of the procedure. These statistical analyses were performed with *STATISTICA*® analysis software (StatSoft, Inc., Tulsa, OK, USA).

Prosthetic Outcomes. We compared two factors concerning respectively the anterior and posterior parts of the prostheses in the control and test groups to estimate the prosthetic outcomes and eventual laboratory complications: (1) the width of the prosthesis at the level of the interincisor center as measured with calipers (Figure 13) and (2) the number of adjustments

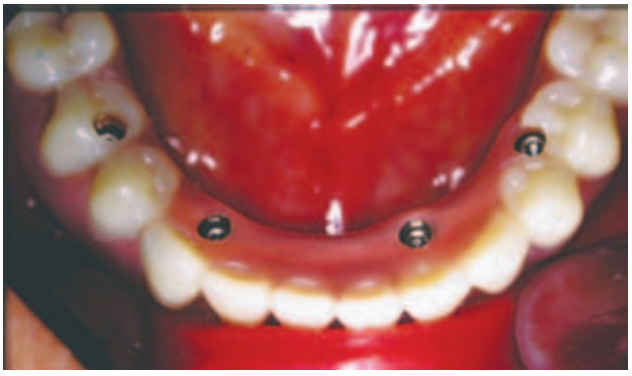

Figure 11 Final result: optimal design of the prosthesis and ideal spatial position of the prosthetic framework for the teeth setting as predetermined before surgery.

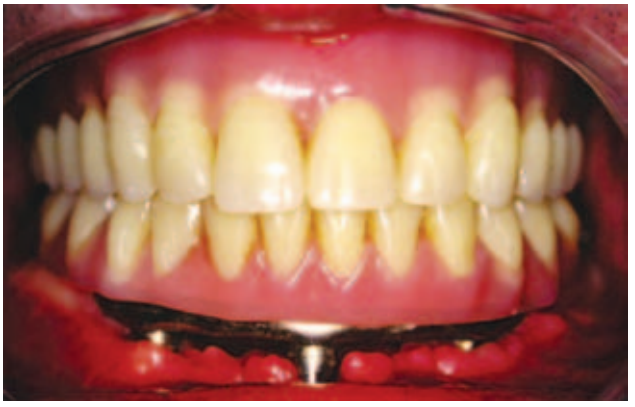

Figure 12 Final result: correct occlusion of the prosthesis.

Figure 13 Measurement of the prosthetic dimension in the anterior area with calipers.

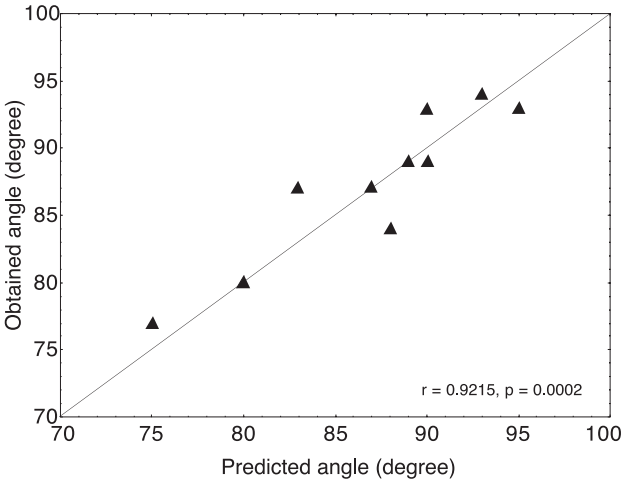

Figure 14 Scatterplot crossing the predicted and measured angles for each patient. Three values are ideally distributed (ie, on the line).

of the distal parts of the upper bar. The data distributions of the prosthetic anteroposterior dimensions measured in each patient group were also compared.

RESULTS

Predictability

In the test group the mean difference between the predicted and measured angles formed by the axis of the central implant and the occlusal plane was 1.9° (range, 0°–4°). The statistical analyses revealed a high correlation between the predicted and obtained angles (r = 0.9215), without any systematic bias (Figure 14). Those results suggested that the surgical template gives the surgeon the opportunity to predetermine the axis of the implants and therefore that of the framework, with a high predictability potential (Figure 15).

Prosthetic Outcomes

From a prosthetic point of view, the mean dimension of the prostheses in the anterior area was 32% higher for the control group than for the test group (12.7 mm vs 9.6 mm). The test group was characterized by a narrow range (8–12 mm) of this dimension in comparison with the broad range in the control group (8–21 mm). Furthermore, the highest value measured in the test group was lower than the median for the control group (Figure 16). Thus when using the stent, it is possible to avoid bulky prostheses and to obtain a more predictable prosthetic width in light of the narrow range observed in our test group.

For the posterior parts of the prosthesis, 12 adjustments of the distal parts of the upper bar were required

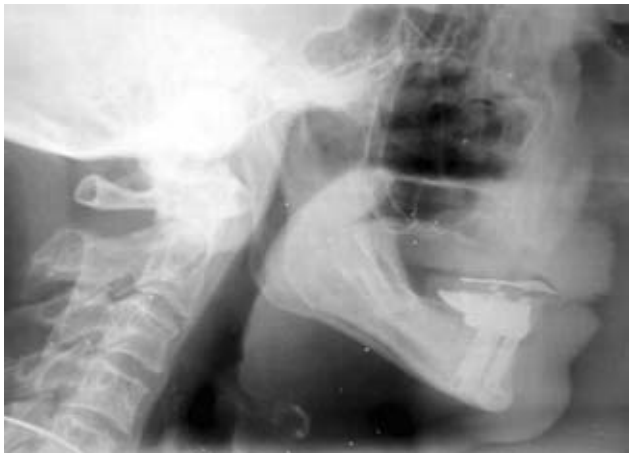

Figure 15 Postoperative lateral cephalometric radiograph. Parallelism between the occlusal plane (visible thanks to a radiographic mark) and the prosthetic framework can be determined.

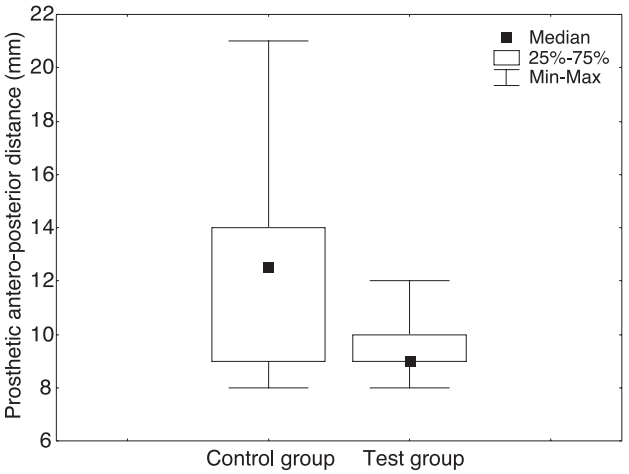

Figure 16 Distributions of prosthetic dimensions in the anterior area for each patient group. (Max = maximum; Min = minimum)

Table 4 Number of Required Adjustments of Upper Bar

	Patients Requiring Adjustments			
	No Adjustment	1 Adjustment	2 Adjustments	Total Adjustments
Control group	3	2	5	12
Test group	5	4	1	6

among 7 patients in the control group versus only 6 such adjustments in 5 patients in the test group. Bilateral bar adjustments were necessary for 5 control patients and for only 1 of the test patients (the latter was expected before the surgery) (Table 4). All these adjustments were due to premature contacts with the antagonist. Those upper bar adjustments had no repercussions on the final posterior prosthetic design; in all cases it was possible to set 12 teeth (ie, from first molar to first molar) on the bar with correct occlusion. Nevertheless, 100% of the definitive prostheses for the test group were delivered on the day of the surgery as compared with only 70% ($n = 7$) of the prostheses for the control group. Indeed, in 30% ($n = 3$) of the control group prostheses, the prosthetic complications were so important that the dental technician was unable to finish the prosthesis on the same day.

DISCUSSION

A platform axis with high buccal divergence from the occlusal curve can lead to premature contacts of the distal portions of the upper bar with the upper premolars or molars. A similar situation where prosthetic complications occurred was reported by Vasconcelos and Francischone.[22] Their case report stated that the posterior portion of the upper bar was extremely inclined toward the superior teeth, hindering its use. In those authors' opinion, "the problems in this case were caused by the faulty osteotomy on the alveolar border, which caused the vestibular incline of the fixtures." Otherwise, an important lingual divergence of the platform with the occlusal curve will lead to a posterior shift (overjet) of the framework as compared with the opposite arch (Figure 17). The consequence from a prosthetic point of view should be the existence of a prosthetic overjet between the teeth and the framework, the teeth being too distant from the framework on which they are mounted. Such a prosthetic situation could create considerable clutter in the mouth, leading to an aesthetically awkward construction that could result in difficulties in hygiene and speech, as noticed by Lekholm.[19] The axis of the crest platform is a critical point for the prosthetic outcome. The surgical template described in this report offers the advantage of helping the surgeon perform a predetermined alveolar crestal reduction related to the prosthetic stage. We obtained a high predictability for the procedure and a marked decrease of the mean width of the prostheses in the anterior area although our groups were too small to reveal any statistical significance.

Furthermore, this template seems to facilitate the Brånemark Novum laboratory protocol. We were able to deliver the prostheses on the day of the surgery for all the patients in whom the stent was used but for only 70% of the patients in whom the stent was not used.

Like the splint proposed by Parel and colleagues,[21] this technique is based on a preoperative simulation of the mandibular platform on a plaster cast. For this report, however, a preoperative radiographic evaluation was done before this simulation, for increased accuracy. Another important difference between the two techniques is that the splint proposed in this report was kept in the mouth during the whole bone reduction procedure; so during the twist reamer drilling,

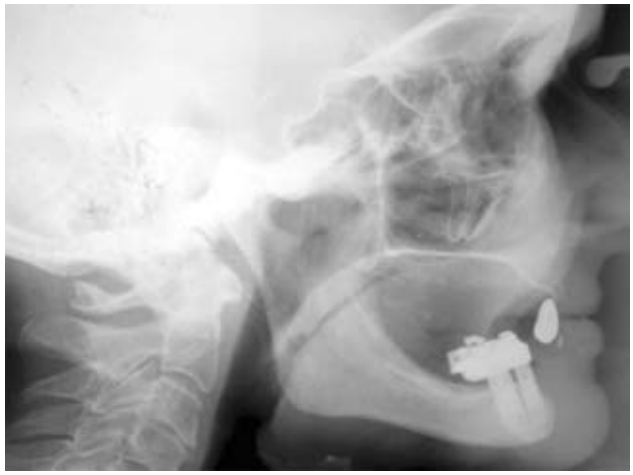

Figure 17 Lingual tilt of the implants, resulting from a faulty sagittal crestal platform reduction, dragging a posterior overjet of the upper bar with the superior teeth in the anterior area.

the surgeon could still see the indications given by this stent. This factor reduces the time needed to perform this surgical step and can increase its accuracy. However, one must always keep in mind that whatever the ideal bone plane may be, the anatomic conditions determine what it is possible to do when reducing the alveolar crest. Lingual concavities or various positions of the mental nerve may force the surgeon to make adjustments in regard to the bone reduction.

Nevertheless, this technique allows one only to shape the bone reduction platform. It gives no indication as to the implants' locations in the frontal direction on this mandibular platform. The central implant should ideally be placed exactly in the middle of the mandible to be in accordance with the radiographic study, but the relationship between the site of the lateral implants and the nerve location must still be carefully observed. The other types of radiography (panoramic radiography and intraoral occlusal radiography) used in the classic Brånemark Novum protocol remain important for obtaining a presurgical idea of the implants' locations on the mandibular platform in the frontal direction. The anatomy of the mandible can be seen close to the midline on the lateral cephalometric radiograph. The spatial position of the central implant in the bone can be predetermined. For the two lateral fixtures, the anatomy of the mandible must still be considered preoperatively with complementary radiography and observed during the surgery just as in the classic Brånemark Novum protocol. A much more precise technique would be to perform a computed tomography scan of the mandible to obtain a stereolithographic reconstruction of the mandible, but treatment costs would then increase. Nevertheless, the low cost of this treatment when compared with that of a more conventional treatment (a fixed prosthesis supported by implants) is a criterion of choice for some patients. To that end various cost-effective treatments have been proposed.[24–29] The technique presented in this report requires at least one additional appointment but does not substantially increase treatment cost.

In this pilot study preoperative analysis and planning allowed the fabrication of a surgical guide to facilitate and increase the efficacy of implant placement by the Brånemark Novum surgical technique. The directly implied benefit of this protocol is better fabrication of the prosthesis, with accommodation of the prefabricated components. The outcome of this comparative study of a control group and a test group shows the advantage of the technique.

Implant placement is a critical moment that depends on the surgeon's skill and on the residual bone anatomy. Preoperative radiography and/or the use of a wax-up to adapt a surgical guide has been advocated to solve aesthetic problems, increase functional prosthetic efficacy, respect biomechanics, accommodate the prefabricated components, and facilitate decisions about the need for site developments.[2–17] As a result of the refinement of this planning technique, it is now possible to create the final prosthesis before surgery, place the implants with a surgical guide that respects the prosthetic planning, and deliver the prosthesis at the end of the surgery.[17]

The Brånemark Novum concept is a simplified protocol based on the use of prefabricated components. Due to the size, height, and requirements of the components in this concept, the surgery is quite challenging. On the one hand the major vital anatomic structures must be preserved and respected; on the other hand the orientation of the prosthetic bars must be anticipated. If this is not done, the surgeon may have to grapple with a conflict between the bone anatomy and the orientation of the prosthetic bars during surgery. Such three-dimensional perioperative attention is a challenge and may create some surprise when the prosthesis is made, at which point some minor or major adjustments in the acrylic teeth or even the prosthetic bar may have to be made.

The aim of this study was to seek a simplified solution to planning the orientation of the implants' ideal axis so as to respect the bone anatomy and the prosthetic requirements. A preliminary preoperative study of the radiograph and the transparent surgical guide sheet showed that an ideal implant placement was possible. Nevertheless, this ideal placement might have required the creation of a recipient host bed crafted by planar bone reduction. The use of a preoperative study was a great help in anticipating the bone reduction. Once the information was obtained, the data were transmitted to the laboratory to make the guide. Surprisingly the results were improved with that technique.

CONCLUSION

The technique presented here for constructing and using a surgical template has been developed to create a link between the surgical and prosthetic stages of the

Brånemark Novum procedure. With a preoperative study, it enables one to predetermine the ideal implant axis and (if necessary) to predetermine bone reduction and suppress arbitrary assessment, during the surgery, of the critical relationship between the prefabricated framework of the prosthesis and the opposite arch. Thanks to this simple and cost-effective method, possible clinical and laboratory complications can be anticipated and therefore avoided or minimized much more easily.

The preoperative analysis has proven to be an effective tool, and comparison of the experimental and clinical results has shown a promising correlation. This technique may be recommended for preoperative analysis and to help decide whether to use a surgical template.

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