# A 5-year Life Table Analysis on Wide Neck ITI implants with prosthetic evaluation and radiographic analysis. Results from a private practice.

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## Abstract

This paper reports a 5-year life table analysis on Wide Neck (WN) ITI implants placed in a private practice. In 212 patients, 263 implants were placed in the posterior region, 97.0% rehabilitated the molar area. Implants in the mandible and in the maxilla were 61.2% and 38.8%, respectively; mean implant length was 9.7 and 8.9 mm, respectively. 89.0% sites had both vestibular and buccal bone lamellae $\geq$ 1 mm, 9.1% had one of them < 1 mm and 1.9% had both lamellae < 1 mm. Sinus perforation during surgery happened for 52.0% of the maxillary implants. Prosthetic information was available for 249 implants; implants were involved in 157 single crowns (SC) and 80 fixed partial dentures (FPD). Radiographic analysis was performed on 102 implants that reached the 2 year-control and crestal bone loss (CBL) was measured. Results showed that 5 implants failed; the 5-year cumulative survival rate was 97.89%. The 1-year survival rate based on 259 implants was 98.8% and the 2-year survival rate based on 174 implants was 97.7%. In this 5-year timeframe, 94.3% of the SCs and 96.2 % of the FPDs were free of complication. The mean CBL at the mesial and distal sides was 0.71 and 0.60 mm respectively; bone losses > 1.0 mm and > 2 mm were recorded for 29.7% and 2.5 % of the sides, respectively. This mid-term study showed that the WN ITI implants were highly predictable in private practice and that prosthetic complication in the molar area was an infrequent event.

# Introduction

Implants with a diameter in the 3.75-4.1 mm range have been extensively used as standard implants for a broad span of indications. In the 90's, narrower and wider implants have been developed to meet more adequately specific indications. The first wide diameter implant of 5.0 mm was launched in 1993 (Langer et al. 1993) by the Brånemark system (Nobel Biocare, Göteborg, S). It was designed as a rescue implant for non-integrated and fractured standard implants as well as an implant to be placed in compromised situations where the available bone height and quality were limited (Langer et al. 1993). Wider implants were also considered to be more suitable in the molar area because of, 1) their greater surface area in contact with bone (Langer et al. 1993, Le Gall et al. 1994, Scacchi 2000), 2) a more adequate emergence profile (Polizzi et al. 2000, Khayat et al. 2001, Krennmair & Waldenberger 2004). Similarly, their use was advocated in fresh extraction sockets in order to minimize the gap between the socket walls and the implant surface (Prosper et al. 2003).

For wider implants in the 5.0-6.0 mm diameter range, conflicting clinical data have been related in the published literature. It has been repeatedly stated that wider implants are less predictable than standard implants (Ivanoff et al. 1999, Renouard et al. 1999, Eckert et al. 2001, Mordenfeld et al. 2004, Shin et al. 2004) while other groups reported survival and success rates similar to standard implants (Khayat et al. 2001, Friberg et al. 2002, Tawil et al. 2002, Krennmair et al. 2004). For example, Renouard et al. (1999) reported for 98 consecutively placed implants a survival rate as low as 91.8 % after 1 year of loading. In a retrospective study on 1263 implants,

Minsk et al. (1996) stressed a noticeably higher failure rate of 15 to 16 % for the large diameter implants, different than the 1 % failure rate observed for standard diameter implants. In a 4-year life table analysis, Aparicio & Orozco (1998) reported a cumulative success rate of 97.2 % in the maxilla and 83.4 % in the mandible. In contrast, Tawil et al. (2002) found no difference between standard diameter and wide diameter implants; for the latter the 4 year cumulative success rate was 100 % in the mandible and 96.7 % in the maxilla. In a mean follow-up of 2 years and 8 months, Friberg et al. (2002) compared the failure rates of Ø 3.75, 4.0 and 5.0 mm implants; no significant difference was found between implant types; failures were 5.5 %, 3.9% and 4.5%, respectively.

The ITI implant system includes standard implants of Ø 4.1 mm, narrow implants of 3.3 mm and wide implants of 4.8 mm. The latter implant type was launched in 1999 with the SLA surface treatment (Sand-blasted, Large and Acid etched); it exists with a 4.8 mm regular neck as well as with a 6.5 mm wide neck, in order to meet prosthetic requirements. Some authors followed up the narrow implant type (Zinsli et al. 2004) because a possible mechanical weakness was suggested (Scacchi 2000). However, since the market launch of the ITI wide neck implants no mid-term data has been available on their prognosis, particularly when issued from a private practice. The aim of the present clinical study was to report on the follow-up of ITI wide neck implants in a 5-year life table analysis, including the prosthetic outcome. In addition, the crestal bone loss after 2 years was radiographically assessed.

# Material and Methods

## Surgical procedures

Between August 1999 and February 2004, 212 patients have been treated with 263 WN ITI implants placed by 2 surgeons (MB and RN) in a private practice environment, under clean but not sterile conditions as defined by Scharf & Tarnow (1993). This represented 18.2 % of the 1443 implants placed during this period. All implants passed the 1-year control. The patient population consisted of 121 females (57.1 %) and 91 males (42.9 %). Age at implant placement ranged between 22 and 88 years; the mean age was 49.9 ± 12.7 years. Patients younger than 30 years hosted 14 (5.3 %) implants, patients younger than 50 years received 137 (52.1 %) implants. All implants were placed in the posterior region; the distribution of premolar and molar sites in the mandible and in the maxilla is given in **table 1**. Only 8 (3.0 %) implants were placed in the premolar area of the maxilla and none in this region of the mandible. Implants in the mandible and in the maxilla were 61.2 % and 38.8 %, respectively.

Implant length was decided on the basis of peri-apical radiographs or orthopantomographs. In the mandible, a 2 mm security margin above the mandibular canal was considered. In the maxilla, sinus perforation was not avoided, penetration of 1-2 mm was tolerated (Nedir et al. 2004); standard insertion was performed when 5 mm of bone height were available. Esthetic plus implants (with the implant neck textured over 1 mm, providing therefore 1 additional mm of rough surface) were used when the esthetic situation required a deeper placement of the implant-crown junction in the sulcus (Buser & von Arx 2000) but not in order to enhance the anchoring length. Implant tilting to place a longer implant was not considered. The length of the inserted implants neither influenced nor modified the type or dimension

of the prosthetic rehabilitation; no extra implant was placed as compensation. Implant length was distributed into 6 mm (1.5 %) implants, 8 mm (30.0 %), 9 mm (Esthetic Plus 8 mm, 7.2 %), 10 mm (54.0 %), 11 mm (Esthetic Plus 10 mm, 3.4 %) and 12 mm (3.8 %) as shown in **table 2**. The mean implant length in the posterior mandible and in the posterior maxilla was 9.7 and 8.9 mm, respectively. The mean available bone height was recorded for each implant length and jaw (**table 2)**.

During surgery, implant sites were categorized into dense bone (n= 34, 12.9 %), normal bone (n= 173, 65.8 %) and soft bone (n= 56, 21.3 %), according to Trisi & Rao (1999). Of the 56 implants placed in soft bone, 48 implants were ≤ 10 mm and 20 were ≤ 8 mm. The width of the vestibular and buccal bone lamellae were also evaluated at implant placement, 234 (89.0 %) sites had both lamellae ≥ 1 mm, 24 (9.1 %) had one of them < 1 mm and 5 (1.9 %) had both lamellae < 1 mm. Sinus perforation happened during placement of 53 (52.0 %) implants out of the 102 maxillary ones; 3 (1.1 %) implants were placed with fenestration of the vestibular table. Bone augmentation was performed simultaneously to implant placement for 37 (14.1 %) sites; they were divided into 28 (83.8 %) vertical augmentations while performing osteotome mediated sinus floor elevation and 9 (17.2 %) lateral augmentations. Prior to implant surgery, 2 patients underwent sinus grafting for 3 (1.2 %) sites.

A specific delay between tooth extraction and implant placement was not introduced, 3 (1.1 %) implants were placed consecutively to tooth extraction, 11 (4.2 %) within 3 months, 117 (44.5 %) after 3-6 months, 41 (15.6 %) after 6-12 months and 91 (36.4 %) after 1 year or more. At placement, a slightly detectable mobility was recorded for

20 implants (7.6 %) while all others (92.4 %) achieved firm stability. The mean healing time was 3.7 months.

## Inclusion / exclusion criteria

Inclusion/exclusion criteria are given in **table 3**. Before surgery, evaluation of the general health and local examination were performed without complementary biologic tests, which may have revealed immunological or hemostatic deficiency. When required, implant treatment was decided after a benefit/risk analysis with the patient. This patient pool included bruxing patients (56 implants, 21.3 %), smokers (53 implants, 20.2 %) and medical risk patients (46 implants, 17.5 %) like HIV+, controlled diabetes, malignant pathology other than in the cervico-facial area, heart disease or patients with coagulation deficiency. Light or heavy smokers were included without distinction; smoking cessation was not requested either before or after surgery. Bruxers received 1 implant per rehabilitated unit; in case of multiple implant rehabilitation, these patients were encouraged to wear night-guards to avoid prosthetic complications. All surgical procedures were performed under antibiotic prophylaxis (Amoxibasan®, Schönenberger Pharma, Schönenwerd, CH, 750 mg, 3x/d during 6 days or Dalacin C®, Pfizer, Zürich, CH, 300 mg, 3x/d during 5 days, in case of penicillin allergy). All patients were instructed to attend at least a yearly routine hygienist session.

## Prosthetic procedures

Single missing molars were replaced by single crowns (SC) supported by a single implant. Larger edentulous spaces were rehabilitated by bridge works, with either 2 splinted crowns (28), fixed partial dentures with pontics (42) and/or 1 unit extensions (10) (FPD). In bruxing patients, metallic occlusal surfaces were proposed but not

always accepted. Special care was paid to reinforce the metallic framework and to flatten the occlusal surfaces. Cementation was preferred over screw-retention; it represented the fixation mode for the large majority of the prostheses (95.4 %). For single crowns, cementation was performed with zinc oxy-phosphate (De Trey Zinc®, Dentsply, Konstanz, D) rather than with glass ionomer cements. The reason is that the latter tends to adhere to metallic surfaces and excess cement removal in the inter-proximal and sub-gingival regions is difficult. To retain the FPDs, a provisional cement (Tempbond® NE, Kerr, Salerno, I) was chosen when the abutment height was > 4 mm; otherwise zinc oxy-phosphate was used. Screw-retention was applied when the available vertical dimension left for the crown rehabilitation was < 6 mm or when the implant-shoulder was more than 2 mm below the gingival margin.

Of the 263 inserted implants, 10 implants were placed in 8 referred patients and were not rehabilitated in our practice; 4 implants remained unloaded for financial reasons. Therefore, prosthetic information was available for 249 implants. These implants were involved in 157 SC (66.2 %) and 80 FPD (33.8 %) rehabilitations as detailed in **table 4;** only 2 prostheses were tooth-implant supported.

## Prosthetic rehabilitation follow-up

Assessment of the prosthetic reconstructions included the following information: position in the oral cavity, number of implants, number of prosthetic units, presence of extension and/or pontics and fixation mode *i.e*. screw-retained or cemented.

Complications included prosthesis retention loss, abutment loosening and screw

loosening, abutment fracture, fracture of the metallic framework as well as fracture of the porcelain veneer. Fracture of the porcelain veneer was divided into minor and major fractures. A fracture was considered a major one when either one or several of the following events were recorded: affected esthetics, visible metallic framework, missing inter-proximal contact point and patient complaining about tongue or mastication discomfort; all these led to prosthesis replacement. Fracture was considered as minor when esthetics was not affected, when the metallic framework was not visible, when the inter-proximal contact point was not involved and when the patient did not complain about tongue or mastication discomfort; these did not lead to prosthesis remake.

**Prosthetic parameters**

To determine the factors that may predispose to a prosthetic problem, the following occlusal and functional parameters were assessed: prosthesis type (SC or FPD), fixation mode (cemented or screw-retained), presence of an extension cantilever; location in the oral cavity.

## Radiographic analysis of crestal bone loss at 2 years

Peri-implant marginal bone change was evaluated by analyzing the radiographs with a computerized measuring technique. Radiographs were taken with the long cone technique after implant placement and at the 2 year control.

The radiographs were scanned in a digital format by a flatbed scanner (Epson Expression 1680 Pro, Wädenswil, CH) at a resolution of 600 dpi. Evaluation of the

marginal bone level around implants was made with an image analysis software (Digora®, Soredex, Helsinki, Finland) that allows measurement of the distance between two points. Internal calibration was performed for each radiograph on 3-4 inter-thread distances (3.75-5 mm) given that tips of 2 consecutive threads are separated by 1.25 mm. The vertical distance between the most apical thread and the most coronal bone-to-implant contact was measured on the mesial and the distal sides of the radiographs. A decrease of the vertical distance between the reference point and the most coronal bone-to-implant contact in consecutive radiographs was considered to be indicative of crestal bone loss. An increase of this distance was considered as bone gain. Precision of the measuring system is 0.01 mm. To facilitate the measurements, the images were slightly rotated electronically to have the major axis in the vertical direction. In order to improve the visual contrast between bone and implant, an image processing procedure (sharpening) was performed when necessary (only in poorly contrasted images).

## Survival criteria

The survival criteria proposed by Buser et al. (1997) and Cochran et al. (2002) were followed at each recall. They included: 1) absence of clinically detectable implant mobility, 2) absence of pain or any subjective sensation, 3) absence of recurrent peri-implant infection, 4) absence of continuous radiolucency around the implant. Patients that did not attend the last recall were considered as drop-out.

## Statistical analysis

Life table analysis with cumulative success rates and survival rates at 1 and 2 years were calculated. The mean and standard deviation were calculated for the crestal bone loss measured after 2 years of loading.

# Results

## Survival implant follow-up

No sensory disturbance was recorded following surgery. Four implants were not loaded for financial reasons. Five patients (2.4 %) with 7 implants (2.7 %) were lost to follow-up. Five (1.9 %) failures were recorded, distributed into 2 early failures (0.76 %) before loading and 3 late failures (1.14 %) after loading as shown in **table 5**. The early failures were recorded in 2 patients in the maxilla; both displayed a slight mobility at placement. Of the late failures observed in 3 patients, 2 were in the mandible and one in the maxilla **(table 5)**. Of the 20 implants (7.6 %) that did not display primary stability at implant placement, 18 (90 %) integrated. The healing period was not especially altered for these implants.

The 5-year cumulative survival rate was 97.89 % (**table 6**). The 1-year survival rate based on 259 implants was 98.8 % and the 2-year survival rate based on 174 implants was 97.7 %.

## Prosthetic rehabilitation follow-up

The 15 prosthetic complications are displayed in **table 7**. These events were more concerning the SC group (11/15, 73.3 %) than the FPD group (4/15, 26.7 %). In this 5-year timeframe, 93.0 % of the SCs and 95.0 % of the FPDs were free of complication.

One abutment supporting a SC became loose after 21 months; the abutment and the crown had to be replaced. Prosthesis loosening was recorded for 1 SC after 9 months and 1 FPD after 4 months. None of the 11 screw-retained prostheses underwent screw loosening. Eleven prostheses (11pat/11impl) had a porcelain fracture, all were cemented. Six prostheses in 5 patients, 4 SCs and 2 FPDs, had a minor fracture, all in the mandible. They happened after 2, 3, 13(x2), 21 and 46 months of function. Five major fractures were recorded, 3 in the mandible and 2 in the maxilla; all happened in the SC group after 3(x2), 13, 17 and 18 months. In the mandible, 6.8 % of the implants had a complication, whereas in the maxilla there were 3.9 %. Parafunction habits were identified for 3 patients that had a complication, however patients with parafunction (3/40, 7.5 %) were not found to be at higher risk than the others (10/159, 6.3 %). No FPD with an extension had a complication.

## Radiographic analysis

Of the 107 implants that reached the 2 year control, records were available for 102 implants. On the mesial side, 100 sites out of 102 were readable; on the distal side

all sides were readable. The mean CBL at the mesial side was 0.71 ± 0.62 mm, it was 0.60 ± 0.64 mm at the distal side, the highest CBL was 2.2 and 2.3 mm on the mesial and distal side, respectively. The distribution and frequency of bone losses are given in **table 8**, 29.7 % of the sides had a CBL > 1.0 mm, 2.5 % of the sides showed a CBL > 2 mm.

# Discussion

In this study, the WN implant was mostly (97.0 %) used in the molar area. The aim was to achieve a better distribution of the occlusal forces exerted in the posterior area, an esthetic emergence profile and adequate ongoing medium-to-long term function. No implant was used as a rescue implant. This implant type was found to be particularly suitable for the replacement of single molars (Bischof et al. 2002, Levine et al. 2002), an indication that has recently grown in our clinical activity. Preventive measures such as higher levels of dental hygiene and greater attention paid to tooth care, have decreased the percentage of the totally edentulous population and increased in parallel the proportion of partially edentulous patients. Rehabilitation of 1-3 missing teeth is becoming a more frequent indication, especially in the posterior area (Nedir et al. 2004). Extraction of the first molar often initiates the partially edentulous state; it is generally due to an endodontic failure or to a fracture of a non-vital tooth that does not permit further classical prosthetic rehabilitation. In the same private practice environment, patients treated with WN implants were younger in average than patients treated with standard implants, 49.9 vs. 57.5 years; patients under 50 years received 52.1 % of the WN implants while they were 33.3 % for the

standard implants (Nedir et al. 2004).

A missing single molar leaves a limited space of 8-11 mm (Le Gall et al. 1994), placement of 2 standard implants of Ø 4.1 mm is inappropriate though suggested (Balshi et al. 1996, Blatz & Strub 1998) because the minimal distance of 3 mm between 2 implants or 1.5 mm between teeth and implants cannot be kept (Tarnow et al. 2000). Therefore, placement of a single wide diameter implant in replacement of a molar answers best the rehabilitation requirement; this was the case for 63.1 % (166) of the placed implants.

The placement philosophy for the large diameter implants was similar to the standard implants; implant length selection was not altered because of the wider diameter. This appears when implant length and the local available bone are compared (**table 2**). In the mandible, the security distance above the mandibular canal was ≥ 3 mm in average for all implants, whatever implant length. In the maxilla, for the 6-10 mm long implants, the average available bone beneath the sinus was inferior to implant length, up to 1 mm. For the 11-12 mm long implants, the available bone exceeded 1 mm in average. This shows that limited implant length was not considered as a risk situation despite the high occlusal load exerted in this area, especially because the available bone was not sought to be fully occupied. Over the period, the survival rate for the short (≤ 10 mm) implants was 98.0 % compared to 100 % for the longer implants. Mericske-Stern et al. (2001) suggested to avoid using the 8 mm standard implant for single crown reconstruction in the posterior region; in the present study, however, the 8 mm WN implants showed a high survival rate of 97.5 % and proved to be highly predictable. Unfortunately, no conclusion could be drawn on the reliability of the 6

mm implant in this indication because of the limited number of implants (only 4 implants). As for standard implants (Bernard et al. 2001, Nedir et al. 2004), bone type did not appear to play a critical role since the survival rates in normal and soft bone were 98.3 % and 96.4 %, respectively. When short implants where placed in soft bone, *i.e*. with 2 combined risks, the survival rate was still 95.8 %.

The 2-year survival rate of the wide neck ITI implant was 97.7 %. For standard ITI implants placed by the same practitioners (Nedir et al. 2004), the 2-year survival rate was 99.6 %. Mericske-Stern et al. (2001) reported a 5-year cumulative survival rate of 99.1 % for standard ITI implants placed in the posterior area and supporting single crowns. The high predictability of the Ø 4.8 mm WN implants contrasts with the results published on the Ø 5.0 mm Mk II wide implant. Several authors reported a lower predictability for this wide implant when compared to the standard Ø 3.75 mm one. In a 3 to 5 year report, Ivanoff et al. (1999) compared the failure rates of the Ø 3.75, Ø 4.0 and Ø 5.0 mm implants; they found a significant relationship between failures and implant diameter. The failure rates were 5 % for the standard implants and 18 % for the widest ones. Similarly, Eckert et al. (2001) reported that this wide implant was less predictable in their hands than the Ø 3.75 mm implant of the same system. The 1-year cumulative success rate was more than 94 % for the standard implants and 73.8 % for the wider implants. This feature was confirmed by Shin et al. (2004) on the longer term; the 5-year cumulative success rate for the standard and the wider implants were 96.8 % and 80.9 % respectively, the difference was statistically significant.

It has been suggested that a longer learning curve was necessary to place the wider

implant type (Ivanoff et al. 1999, Eckert et al. 2001) and that it might be related to the need to minimize the thermal and mechanical damage done to the cortical bone portion during preparation of the osteotomy (Renouard et al. 1999, Polizzi et al. 2000). Subsequently, introduction of a drilling sequence less traumatic to the cortical bone was advocated (Renouard et al. 1999, Tawil et al. 2002). Several other reasons have been set forth to explain this difference; they are linked to the specific indications of the wider implants, *i.e*. their use as rescue implants to failing implants (Renouard et al 1998, Polizzi et al. 2000), their use in the posterior area where poor bone quality and quantity are often encountered in conjunction with high occlusal stresses (Mordenfeld et al. 2004) and impaired primary stability (Mordenfeld et al. 2004, Shin et al. 2004).

More recently however, Eckert et al. (2001) suggested an alternative hypothesis to explain the diameter effect on implant predictability. They proposed that the wide implants may have encroached upon the residual volume of bone that is necessary to establish and maintain osseointegration. This hypothesis of a critical residual bone volume was further investigated by Shin et al. (2004) among others variables like implant length, implant diameter, bone quality, bone quantity, implant site (molar vs. premolar) and the relative ratio of implant volume to remaining bone volume. Parameters predictive of implant failure were identified; they were: the ratio of implant volume to bone volume and the ratio of removed bone to the remaining bone volume. The authors speculated that removal of cancellous bone during placement of the wider implants may have tended to encroach upon a critical relative volume of cancellous bone needed for normal bone metabolism and remodeling in achieving and maintaining osseointegration. In line with that, it should be stressed that the

implant diameter at the crestal bone emergence of the ITI WNI is 4.2 mm while it is 5.0 mm for the wide implants that showed an increased failure rate (Ivanoff et al. 1999, Renouard et al. 1999).

Noteworthy, in the present study, 89.0 % of the implants had both their vestibular and oral lamellae larger than 1 mm; this might be the reason for the high survival rate of the wider ITI implant. Interestingly, other studies that reported high success rates for wide implants (Khayat et al. 2001, Griffin & Cheung 2004) have also stressed the importance of sufficient alveolar ridge width for implant placement. Khayat et al. (2001) reported a 95 % success rate for Ø 4.7 mm implants when followed-up for a mean loading period of 17 months; a lack of sufficient bucco-lingual space (< 6.5 mm) was considered an exclusion criteria. Griffin & Cheung (2004) found a 100 % success for Ø 6.0 mm HA-coated implants that have been followed-up for a mean of 34.9 months; inclusion criteria stressed a minimum of 1 mm thickness of both buccal and lingual plates. On the other hand however, all failed implants in the present study had their both lamellae larger than 1 mm. No implant with a narrower ridge, having either one lamella smaller than 1 mm (24, 9.1 %) or both lamellae smaller than 1 mm (5, 1.9 %) failed. A relationship between limited alveolar width and failure, as suggested by other authors (Eckert et al. 2000, Shin et al. 2004), could not be presently evidenced. It might be that limitation of the available bone width is more critical for the machined surface because the surrounding bone may need more room to remodel into corticalized bone than for the roughened surface that remodels through bone trabeculization (Szmukler-Moncler et al. 2004).

To place the WN implants, the drilling sequence was not altered in order to undersize

implant bed and obtain an increased primary stability as described by other authors for the MkII wide implants (Polizzi et al. 2000). However, it was noticed that the drilling sequence recommended by the manufacturer is lacking in an intermediate drill between Ø 3.5 mm and Ø 4.2 mm. Wobbling was experienced when introducing the last Ø 4.2 mm drill in the osteotomy site, this often led to a more than desired widening at the cortical level. To overcome this drawback, the Ø 4.1 mm profile drill was used in the mandible to create an easier access for the last drill. In the maxilla, the last drill was not used in type III and IV bone, the cortical site was widened with expansion-osteotomes (Ø 3.5 to 4.2 mm). Therefore, introduction of an additional drill of intermediate diameter is urged, in order to optimize the drilling sequence and ease the WN implant placement.

A higher rate (7.6 %) of slightly mobile implants was recorded for the WN implants when compared to a previous study (Nedir et al. 2004) with standard implants (2.4 %). This might be due to a higher number of soft bone sites, 21.3 % vs. 14.6 % as well as a consequence of the wobbling action of the Ø 4.2 mm drill.

Both the screw-retained and the cement-retained prostheses showed a low level of complications; this means that the argument of prosthetic retrievability advocated to favour the screw-retained solution is of low relevance as previously suggested (Levine et al. 2002, Vigolo et al. 2004, Nedir et al. submitted). The SC group was affected with more complications than the FPD group; they were, however, of marginal importance because the vast majority remained free of complications as reported by Levine et al. (2002) for single crowns in the posterior area. Mericske-Stern et al. (2001) reported screw loosening in the posterior region to be a

complication for standard implants during the first year that thereafter abated. In this survey, however, none of the 11 screw-retained prostheses suffered this complication.

The average crestal bone loss recorded after 2 years for 102 implants was 0.71 mm on the mesial side and 0.60 mm on the distal side (**fig 1**). This is in line with other studies (Behneke et al. 1997, 2000, Brägger et al. 1998, Meriscke-Stern et al. 2001, Hartman & Cochran 2004) dealing with standard implants. Gain of bone was recorded at 8.6 % of the sides, similar to the range reported by Behneke et al. (2000). Nevertheless, a high proportion of implant sides (29.7 %) showed a crestal bone loss > 1 mm. This might reflect bone adaptation to high loads down to the first thread level (**fig 2**), however it might be also due to a deliberate deeper placement of the WN implants. Indeed, extractions are now performed with extra care to avoid vertical and horizontal bone loss in prevision of an implant-supported rehabilitation of the edentulous space. The vertical dimension left between the bone level and the antagonist teeth has to accommodate the implant neck (2.8 mm), the abutment height (4-5.5 mm) and a sufficient ceramic thickness for the crown (> 2 mm). When the vertical bone loss is minimal, the only way to accommodate the artificial rehabilitation within this space, at a more affordable cost than with a screw-retained solution, is to deepen the implant at placement and/or to reduce the crestal cortical bone, sometimes reaching the cancellous bone. Subsequently, the smooth-rough boundary lies beneath the bone level and a physiological crestal bone loss occurs down to the smooth-rough limit (Pilliar et al. 1991, Hämmerle et al. 1996, Hartman & Cochran 2004). Moreover, the peri-implant crestal bone may have to undergo corticalization.

After a 5 year experience with WN ITI implants, the present study shows that the major drawbacks of single molar implant rehabilitations have been overcome, *i.e.*; implant function jeopardized by overloading in the posterior jaws, non-aesthetic emergence profile due to the insufficient diameter of 4.1mm. Furthermore, the cost/effectiveness ratio seems favorable to the implant treatment, in comparison with a conventional three-unit bridge (Brägger et al. 2005).

In conclusion, this study showed that the WN ITI implants were highly predictable when supporting molar SCs and posterior 2-3 unit FPDs supported by 2 implants. There were very few prosthetic complications in both rehabilitation groups. The average bone loss at 2 years was similar to standard implants; a specific CBL was not evidenced. The safe and predictable use of wide implants in a private practice environment simplified implant treatment, confirming the tendency towards simpler implantology involving simple rehabilitation schemes for modern and routine dental medicine.

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## Captions

Table 1

Implant distribution according to the jaw and the region. Note that most of them have been placed in the molar area.

Table 2

Implant length distribution and mean available bone height in the mandible and in the maxilla.

Table 3

Inclusion / exclusion criteria.

Table 4

Detail of the prosthetic rehabilitations in the mandible and in the maxilla.

Table 5

Failure analysis.

Table 6

Life table analysis showing the implant cumulative survival rate.

Table 7

Detail of the prosthetic complications.

Table 8

Crestal bone loss distribution after 2 years.

Fig 1

Radiograph of a WN implant supporting a SC, after 57 months of loading.

Fig 2

Radiograph of a WN implant with a CBL down to the first thread, after 61 months of loading.

**Table 1**

| | PM | Mol | Sum |
|---|---|---|---|
| Maxilla | 8 (3.0 %) | 94 (35.8 %) | 102 (38.8 %) |
| Mandible | - | 161 (61.2 %) | 161 (61.2 %) |
| Sum | 8 | 255 (97.0 %) | 263 (100 %) |

**Table 2**

| | Implant Number | | Avaible bone height in the Maxilla | | Avaible bone height in the Mandible | |
|---|---|---|---|---|---|---|
| 6 mm | 4 | (1.5 %) | 5.0 | (n=4) | - | |
| 8 mm | 79 | (30.0 %) | 7.4 | (n=47) | 11.0 | (n=32) |
| 9 mm | 19 | (7.2 %) | 8.0 | (n=9) | 12.7 | (n=10) |
| 10 mm | 142 | (54.0 %) | 9.0 | (n=32) | 13.6 | (n=110) |
| 11 mm | 9 | (3.4 %) | 12.6 | (n=5) | 14.3 | (n=4) |
| 12 mm | 10 | (3.8 %) | 13.3 | (n=4) | 15.0 | (n=6) |

**Table 3**

Patient inclusion criteria

1. Patient aged at least 18 years,
2. Patients needing a posterior rehabilitation,
3. Sufficient alveolar ridge width, that the implant can be placed within the confines of the existing bone,
4. Smokers with moderate or heavy smoking (more than 10 cigarettes / day) or tobacco chewing,
5. Bruxers (however treated with 1 implant /rehabilitated unit),
6. Medical risk patients (HIV+, controlled diabetes, malignant pathology other than in the cervico-facial area).

Patient exclusion criteria

1. Pregnancy,
2. History of alcoholism or drug abuse within the past five years,
3. Untreated periodontitis,
4. Patient at risk during the surgical procedure,
5. Presence of local inflammation or mucosal diseases such as lichen planus,
6. Patient at riskf or endocarditis,
7. Uncontrolled diabetes,
8. Current hematological disorder,
9. History of leukocyte dysfunction and deficiencies,
10. Metabolic bone disorders,
11. History of systemic disease like renal failure or liver disease,
12. Current chemotherapy,
13. History of radiation at the cervico-facial area,
14. Any psychiatric contraindication,
15. Use of any investigational drug or device within the 30-day period immediately prior to implant surgery.

**Table 4**

| | Maxilla | Mandible | Sum |
|---|---|---|---|
| Single Crowns | 50 | 107 | 157 |
| Fixed Partial Dentures | 41 | 39 | 80 |
| Sum | 91 | 146 | 237 |

**Table 5**

| Sex | Patient age (years) | Medical condition | Site | Bone type | Implant length (mm) | Rehab. type | Time of failure | Reason for failure | Implants status |
|---|---|---|---|---|---|---|---|---|---|
| F | 57 | Heart Disease Bruxer | 16 | Soft | 8 | - | 0.7 m | Mobility (no primary stability) | Early failure |
| M | 44 | Smoker Bruxer | 15 | Soft | 6 | - | 2.1 m | Mobility (no primary stability) | Early failure |
| F | 36 | Local peri-apical cement displasy | 46 | Normal | 10 | SC | 15.2 months post loading | Mobility | Late failure |
| F | 61 | - | 16 | Normal | 8 | FDP | 27.0 months post loading | Overloading | Late failure |
| M | 43 | - | 43 | Normal | 10 | SC | 8.4 months post loading | Mobility | Late failure |

**Table 6**

| Time interval | Implants at interval start | Drop-out during interval | Failures during interval | Survival rate on interval | Cumulative survival rate |
|---|---|---|---|---|---|
| 0-1 y | 263 | 4 | 3 | 98.84 % | 98.84 % |
| 1-2 y | 256 | 3 | 1 | 99.60 % | 98.45 % |
| 2-3 y | 174 | 0 | 1 | 99.43 % | 97.89 % |
| 3-4 y | 107 | 0 | 0 | 100.00 % | 97.89 % |
| 4-5 y | 41 | 0 | 0 | 100.00 % | 97.89 % |

**Table 7**

| Fixed prostheses | |
|---|---|
| Events | Implants / Prosthesis / Patients |
| **Complications** | |
| Abutment loosening | 1 i / 1 proth / 1 pat |
| Abutment fracture | |
| Prosthesis screw loosening | |
| Prosthesis retension loss | 2 i / 2 proth / 1 pat |
| Metallic framework fracture | 1 i / 1 proth / 1 pat |
| Minor ceramic veneer fracture | 6 i / 6 proth / 6 pat |
| Major ceramic veneer fracture | 5 i / 5 proth / 5 pat |
| Prosthesis replacement | 8 proth / 8 pat |

**Table 8**

| CBL | | Mesial Side | Distal Side | Sum |
|---|---|---|---|---|
| Gain | 0-1 mm | 6 (6.0 %) | 11 (10.8 %) | 17 (8.4 %) |
| | 0-0.5 mm | 33 (33.0 %) | 41 (40.2 %) | 74 (36.6 %) |
| | 0.5-1.0 mm | 30 (30.0 %) | 21 (40.6 %) | 51 (25.2 %) |
| | 1.0-1.5 mm | 22 (22.0 %) | 21 (40.6 %) | 43 (21.3 %) |
| | 1.5-2.0 mm | 6 (6.0 %) | 6 (5.9 %) | 12 (5.9 %) |
| | >2.0 mm | 3 (3.0 %) | 2 (2.0 %) | 5 (2.5 %) |
| Sum | | 100 (100 %) | 102 (100 %) | 202 (100 %) |