

**Charles University in Prague
Faculty of Medicine in Hradec Králové
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Soft Tissue Esthetics in Implant Dentistry

Rakesh V. Somanathan, B.D.S.

Ph.D. Thesis in Dentistry

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Contents

Summary.....	6
Souhrn.....	6
1.Introduction.....	7
1.1 Interdental papilla and esthetics.....	7
1.2 Implant positioning for optimal esthetics.....	8
1.3 Surgical options for papillary esthetics.....	9
1.4 Integration of titanium implants in the bone.....	9
2.Aims of the study.....	11
3.Materials and methods.....	12
3.1 Patient enrollment.....	12
3.2 Study design.....	13
3.3 Surgical technique.....	15
3.3.1 Preoperative managements.....	15
3.3.2 Surgery.....	15
3.3.3 Radiographic evaluation.....	16
3.4 Statistical analysis.....	16
4.Results.....	17
4.1 Study 1.....	17
4.2 Study 2.....	21
5.Discussion.....	22
5.1 Soft tissue esthetics in flapless immediate loading.....	22
5.2 Interproximal papilla and esthetic factors.....	22
5.3 Interproximal papilla vs. osseous crest.....	24
5.4 Stability of implants in grafted sinus.....	24
6. Conclusions.....	26

7. References.....	27
8. Publications and activities of the author related to the subject.....	33
8.1 Publications.....	33
8.2 Exams attended.....	35

SUMMARY

The proposed study compared the esthetic success of immediate flapless implantation (ILA), to immediate implant loading with the need for flap (ILB) and delayed loading (DSL) in single tooth restorations in the anterior maxilla. Index used for measurement was the Papilla Index (PPI) given by Jemt (1997). The other aim of the study was to find out if any relation exists between the interproximal crestal bone height and papilla length. Analysis was done irrespective of treatment procedure in the same study group using periodontal sounding and radiographs to find out the relation. Another goal was to assess the stability of implants in grafted areas in posterior maxilla.

From the study involving 106 participants, including 21 ILA, 22 ILB and 63 DSL cases, we received highest PPI score of 2.6 average from group ILA, followed by ILB and DSL, after 3 months of prosthetic loading. From the periodontal sounding and radiographic study it was evident that, when the distance between the base of the contact point of crowns and height of interproximal bone was ≤ 5 mm, the papilla was present 100% of the time, but when the distance increased to 6 and ≥ 7 mm, the papilla was present only 46.5 and 24.0 percentage of the time respectively.

Experimental part: The stability of implants inserted into two-stage sinus lifts were measured using resonance frequency analyzer (RFA) at an interval of six months. Sixteen implants from 13 patients were subjected to RFA test. It also proved that, the stability values during this period converge to a value, which is more or less the average of their initial stabilities.

To conclude, immediate flapless implants inserted into the extraction socket is esthetically a better treatment option compared to implantation with the need of a flap in healed ridges and delayed loaded implants. There exists an indirectly proportional relationship between the distance from the crestal bone level to the contact point of the crowns and the length of interproximal papilla.

SOUHRN

Předložená studie srovnává estetický výsledek imediátní flapless implantace (ILA), imediátního zatížení s odklopením mukoperiostálního laloku (ILB) a odloženého zatížení (DSL) při náhradě jednoho zubu ve frontálním úseku maxily. Pro posouzení byl použit Papilla Index (PPI) (Jemt 1997). Druhý cíl studie bylo prozkoumat souvislost mezi výškou interproximální alveolární kosti a výškou slizniční papily. Analýza byla provedena nezávisle na léčebné metodě pomocí sondáže a z rentgenogramu. Dalším cílem studie bylo zkoumat vývoj stability implantátů v augmentované oblasti dorzálních úseků maxily.

Sledovaný soubor zahrnoval 106 pacientů, z toho 21 bylo léčeno metodou ILA, 22 metodou ILB a 63 metodou DSL. Nejvyšší PPI skóre (2,6) po 3 měsících protetického zatížení implantátů bylo zaznamenáno u skupiny ILA, následovala skupina ILB a DSL. Ze sondáže a z radiografického vyšetření vyplývá, že pokud byla vzdálenost mezi kontaktním bodem korunek a alveolární kostí 5 mm a méně, papila byla vytvořena vždy. Pokud tato vzdálenost činila 6 mm resp. 7 mm či více, papila se vytvořila jen v 46,5 % resp. 24,0 % případů.

Experimentální část: Pomocí rezonanční frekvenční analýzy (RFA) byla v intervalu šesti měsíců vždy dvakrát měřena stabilita implantátů zavedených do kosti augmentované dvoudobým sinus liftem. Sledováno bylo 16 implantátů třinácti pacientů. Bylo prokázáno, že stabilita implantátů během šestiměsíčního období konvergovala k hodnotě, která je přibližně průměrem jejich iniciačních stabilit.

Závěrem lze říci, že imediátní flapless implantace, při které je implantát zaveden do čerstvé extrakční rány, je z estetického hlediska lepší léčebnou modalitou ve srovnání s implantací doprovázenou odklopením laloku a s implantací odloženou. Byl nalezen nepřímý vztah mezi vzdáleností kontaktního bodu korunek od alveolární kosti a délkou papily.

1 INTRODUCTION

Dentistry has evolved considerably in last few decades. Brånemark initiated the present surge in dental implantology in the year 1952 (Brånemark 1983). Now dental implants has become an integral part in restorative dentist's armamentarium. The predictability of dental implants has been proved beyond doubt. The recent concepts of implant dentistry is not restricted to the basic needs, but newly applied surgical and prosthetic techniques are enabling dentists to approach patients' esthetic expectations. The anterior maxillary teeth in the 'esthetic zone' usually extend from first premolar to first premolar, but in some individuals can extend as far distally as the first molar (Elias & Sheiham 1998). The judgment of esthetics is subjective, and difficult to test or evaluate in a scientific way. Patient and clinician may have different perspective to a successful esthetic result (Chang et al. 1999; Locker 1998). The surgical procedure used can be divided into three techniques depending on the clinical situation.

Immediate flapless procedure (ILA): This procedure was indicated when there was a tooth indicated for extraction, which remain in the socket. The tooth shall be extracted and an implant to be placed immediately and prosthesis is placed over it.

Immediate implant loading by flap elevation (ILB): This procedure was done when the site to be implanted was without tooth. Implant was loaded immediately.

Delayed loading (DSL): Here the procedure is same as ILB, but prosthetic loading was done after 2 months in mandible and 3 months in maxilla. The flaps were approximated over a cover screw and implant is allowed to remain in the bone for that period.

1.1 Interdental papilla and esthetics

Esthetics is, to a great extent, determined by the level and appearance of the periimplant soft tissues, including the shape of the papillae. Maintaining the interdental papilla and bone height following implant placement has been a challenge for the restorative dentist. The presence or absence of the interdental papilla associated with multiple adjacent implants may be affected by the amount of alveolar bone loss prior to implant placement, distance between adjacent implants, position of implants in relation to adjacent teeth, as

well as the subgingival contours of the implant-supported restoration (Grossberg 2001). In many instances, the loss of 2 or more maxillary anterior teeth results in flattening of edentulous segments and resorption of interproximal bone crests (Lam 1960). The placement of implants may result in additional bone loss following bone remodeling and the establishment of biological widths (Hermann 2000). Inadequate interimplant spacing (less than 3 mm) may result in exaggerated bone loss and increased distance from proximal contact points to the associated alveolar bone crests (Tarnow et al. 2000). In modern dentistry, various surgical and non-surgical techniques have developed to achieve optimal results in the preservation and regeneration of interdental papilla.

1.2 Implant positioning for optimal esthetics

Optimal implant positioning in relation to the adjacent teeth is another important factor to be considered when restoring multiple adjacent missing teeth. Implants must be placed in the so-called 'safe zone' for best esthetic result. In an apical-coronal position, it is recommended that the implant be positioned 2 – 3 mm below the cemento-enamel junction of adjacent teeth (Kan & Rungcharassaeng 2001). Bucco-lingually, an implant that is positioned too far to the lingual may result in ridge lapping of the definitive restoration and compromise esthetic results (Biggs 1996). When optimal implant positioning is achieved, the transitional tissue could be altered using a customized abutment to create an emergence profile that mimics natural teeth and provides adequate support to the surrounding soft tissue. This can be performed with a provisional restoration at the time of uncovering the implant (Biggs 1996, Reiser et al. 1992) and could be transferred at a later stage to the definitive restoration (Hinds 1997). When a diminished mesial-distal space exists, the clinician should consider placing implants with smaller diameters. Alternatively, fewer implants with cantilevered fixed partial dentures may be considered. In each instance, the intent is to maximize the interimplant distance, minimize alveolar bone loss, and maintain acceptable soft tissue height for optimum esthetic results.

1.3 Surgical options for papillary esthetics

Creation of a soft tissue contour with intact papillae and a gingival outline that is harmonious with the gingival silhouette of the adjacent dentition is the most difficult factor in achieving an optimal esthetic result. Mismanagement of the soft tissue often results in esthetically unacceptable restorations, and such situations are difficult to correct (Grunder et al.1996). Considerable knowledge has been gained in surgical management of facial gingival recession. The procedures described in the literature include free gingival grafts (Miller Jr. 1982), coronally positioned flaps (Harvey 1973), free gingival grafts combined with coronally positioned flaps (Bernimoulin 1975), different types of pedicle grafts (Grupe & Warren 1956, Corn 1964, Pennel et al. 1965), free connective tissue grafts combined with pedicle grafts, and the guided tissue regeneration procedure. Although these techniques give predictable solutions to the coverage of denuded roots, they are not directed to the reconstruction of truncated papillae (Yehouda 1997).

1.4 Integration of titanium implants in bone

In a clinical situation, it is mandatory to assess the prognosis of the implant placed in a patient. Resonance frequency analysis to measure the stability of the implants is an accepted modality (Balleri et al. 2002, Barewal et al. 2003, Meredith et al. 1996). This is because of the fact that implant stability in the bone at the time for placement is one of the most important factors for osseointegration (Meredith 1998; Marco et al. 2005; Raghavendra et al. 2005). In situations with reduced implant stability, micromotions can occur which increase the risk for fibrous healing instead of osseointegration. The stability results from direct contact between the surrounding bone and the surface of the implant and can be divided into primary and secondary stability (Sennerby & Roos 1998). The surgeon has several possibilities to improve the primary stability of the implant. An adapted preparation technique with reduced drill diameter can also be used; it will induce compression and thereby increase implant stability. Secondary stability is achieved after primary healing and is determined by bone formation and remodeling in the interface between the implant and the surrounding bone.

The surgeon has the possibility to improve the bone remodeling and bone formation in the interface by a prolonged healing time for the implant (Friberg 1999). The healing mechanisms behind osseointegration of an implant placed in bone are very similar to the mechanisms of bone fracture repair (Marco et al. 2005). The bone tissue response to unloaded, screw-shaped titanium implants has been studied in several animal studies (Sennerby et al. 1993; Masuda et al. 1997). After the implant is placed in the bone, a mixture of bone fragments, fibrin clot and red blood cells will surround it. During the first week mesenchymal cells and multinuclear giant cells are present in the area around the implant. After 7 days newly formed woven bone develops from the endosteal surfaces towards the implant. Newly formed woven bone is also found as solitary islands within the implant threads.

In implants placed in the sinus lifts, the relation between the implant stability between stage 1 (measured at the time of implant placement into a healed grafted sinus) and stage 2 (measured after 6 months of implantation) was a question awaiting interest. It is believed that a higher value indicates a better stability and so a better prognosis for the implant. This kind of relation can also be expected from implants inserted in sinus lifts.

2 AIMS OF THE STUDY

The study was done to obtain answers to some questions that are still controversial in implant dentistry. Although there have been several reports with regard to clinical outcomes of immediate loading and/or flapless implant surgery on single-tooth implants (Campelo & Camara 2002, Rocci et al. 2003, Lorenzoni et al. 2003, Andersen et al. 2002, Cooper et al. 2001), limited controlled data have been available for the evaluation of soft tissue profiles of flapless implants surgery on single-tooth implants. Therefore, the purpose of this study was to examine the soft tissue profile changes of single-tooth implants in the premaxillary region after flapless implants surgery, comparing immediate loading with delayed loading.

The general aim of the present study was to evaluate and compare soft tissue esthetics of immediate flapless implant surgery, immediate loaded implantation with flap raising and delayed loaded implantation.

The secondary aims were:

1. To assess and evaluate the relation between interproximal papilla length and interdental bone height.
2. To assess the stability of implants inserted in a grafted areas in maxilla (maxillary sinus).

3 MATERIALS AND METHODS

3.1 Patient enrollment

One hundred and six patients, partially edentulous in the maxilla in the region from first premolar to first premolar (esthetic zone) were enrolled in this cross-sectional study. One hundred and eighty-five interdental and interimplant papillae were evaluated using Papilla Index (PPI) and one hundred and fifty sites were evaluated radiographically. The rest of twenty-seven papillae (either mesial or distal) were either involved in infection from adjacent tooth or were discarded due to other reasons. The patients were informed of the options for tooth replacement including the risks and benefits of dental implants. Following a thorough review of medical and dental histories, description of the clinical procedures, and financial arrangements, informed consent was obtained. The study was approved by Ethical body of the University Hospital of Hradec Králové, Czech Republic. Eighty-two endosseous screw-form implants were inserted in various locations in the esthetic zone in maxilla, at Implantology Center, in the University Medical Hospital, Hradec Králové, Czech Republic. The lengths and diameters of the individual implants vary depending on the amount of available bone. Patients were divided in three categories according to clinical presentation and type of treatment provided – Immediate reconstruction (ILA), which included patients presented with a single tooth indicated for extraction, when only the tooth is compromised and not the soft tissue and surrounding osseous structure, which was loaded immediately. The second group included patients with healed/partially healed edentulous area with good bone quality and was treated with immediate loading, implants placed by raising a flap (ILB). The third category of patients included the delayed loading cases, which were loaded after 3 months from the date of implantation (DSL). In the mean time the implant was secured in place with a cover screw and flaps with tension free sutures. In a second stage surgery a punch technique was performed to expose the fixture and a healing abutment was placed.

Inclusion criteria for study included:

- adequate oral hygiene
- subjects older than 16 years

- do not smoke more than 20 cigarettes per day
- absence of residual root and local inflammation
- no history of local radiation therapy
- adequate bone volume and absence of any serious systemic diseases, which would jeopardize bone healing.

3.2 Study design

The present study was a unicentric, observational, non-interventional cohorts study including three different cohorts for analyzing esthetics and a different cohort for analyzing implant stability in grafted sinus. Patients were recalled after 3 months after crown delivery (provisional or definitive). A single blind clinicians was employed to assess the esthetic outcome using Jemt's Papilla Index (Jemt 1997). The papillary index designates five different levels of papilla height (0 = no papilla, 1 = papilla present below one third of interdental space, 2 = papilla fill till two third of the interdental space, 3 = interdental area filled with papilla, 4 = papillary hypertrophy). Measurements were made from the reference line connecting the highest gingival curvatures of the implant crown restoration and the adjacent tooth or crown on the buccal side. The mesial and distal papillae were evaluated for completeness, incompleteness, or absence. A photograph of the area was taken and kept for future reference.

In order to understand the relation of papilla fill and crestal bone level, a few patients were enrolled into the second part of the study. In those cases periodontal sounding was done after administration of anesthesia for measurement of the level of crestal bone. In most of the cases a control radiograph was taken. The distance from the base of contact point of crown and the crest of the crestal bone was also measured from the radiograph to reduce margin of error. The criteria of success set for this study were chosen according to modified Albrektsson criteria (Albrektsson et al. 1986) and included the following: absence of persistent subjective complains, such as pain, foreign body sensation, and/or dysesthesia; absence of peri-implant infection with suppuration; absence of mobility; except for the fourth criterion, absence of a continuous radiolucency around the implant; and vertical bone loss less than 1.5 mm in the first year of function.

Experimental part:

The experimental part of the dissertation was prospective study including one cohort at a time. For the implant stability measurement in grafted sinus, twelve patients (7 males and 5 females of ages 42 to 67, mean age 54.7) who received two-stage sinus lift surgery were involved in the study. All those who were enrolled smoked less than 15 cigarettes per day, had no debilitating diseases and had a minimum of 3 mm of bone below the maxillary sinus. All patients were examined for bone height by panoramic X-ray and in case of suspected compromise in the quantity of bone; a reformatted computer tomogram was used to finalize the decision.

Six out of the twelve sinus lifts were done with a composite graft. It was a mixture of autogenous bone from the maxillary tuber with β -tricalciumphosphate (Cerasorb[®], Curasan AG GmbH, Kleinostheim, Germany) in the ratio 1:8 – 1:5, respectively. The rest of the sinus lifts were done only with β -tricalciumphosphate. The lift was allowed to heal for nine months and then hydroxyapatite coated, Implants[®] screw form implants (Lasak, Prague, Czech Republic) were inserted using a manual torque wrench. The first ISQ reading (ISQ1) was taken (Osstell[™] device, Integration Diagnostics AB, Sävedalen, Sweden). The flap was repositioned and sutured over the implants as a two-stage surgery. After six months of healing, during the second stage surgery, the second ISQ was measured (ISQ2). For each measurement the transducer was placed perpendicular to the long axis of the alveolar process and secured with a tight screw to 10 – 15 Nm torque as per manufacturer instructions. Based on ISQ values implants were divided into 3 groups. Group A included those with ISQ falling in the range 71 – 77, Group B between 64 and 70 and Group C those between 59 and 63. All procedures were done under local anesthesia, on outpatient basis and sterile conditions. Patients were given details of the surgical procedure and the study and were made to sign surgical release forms. All treatments were done in compliance with Helsinki Declaration 1994.

3.3 Surgical technique

3.3.1 Preoperative managements

Panoramic radiographs were taken for all patients and those for sinus lifts were further screened with Waters projection and CT scan. Amoxicillin and clavulinic acid (Augmentin) was prescribed 3 times daily from the day before the operation and advised to continue for five days after surgery. Patients for sinus lift further received an intravenous injection of 8 mg of dexamethasone before the procedure and continued with five doses of 0.75 mg dexamethasone tablets post-operatively at 12 hour intervals. Patients were advised to rinse their oral cavity with 0.12% chlorhexidine for 2 minutes before each procedure.

3.3.2 Surgery

All procedures were performed under local anaesthesia (Articaine hydrochloride 4% with 1: 120,000 epinephrine hydrochloride). In case of a need to raise a flap, general principles were followed. The base of the flap was kept wider than the crest and no flap was raised severing the interdental papilla.

All implants were placed in a similar manner. Briefly, implants were placed in the optimal three-dimensional position: apico-coronally, 2 – 3 mm below the adjacent CEJ line (Saadoun & Landsberg 1997); bucco-lingually, 3 – 4 mm from the outside buccal flange (Kazor et al. 2004); and mesio-distally, ≥ 1.5 mm away from adjacent teeth (Adell et al. 1990). Immediate implantation was performed when the site was devoid of any crush injuries and alveolar bone fractures. If only the tooth is compromised and not the soft tissue and surrounding osseous structure, a flapless surgery with immediate implant placement was performed (Tarnow et al. 1992). In case of a fractured root or periodontally involved tooth, the tooth was extracted with a periotome. The socket was then cleaned with curette and made sure that all granulation tissue was removed. Drilling was done as the manufacturers instructions and implants were inserted. Initial stability was calculated with an Osstell device/Periotest for all those subjects included in the

immediate loading category, a provisional crown was manufactured in the laboratory. After sufficient adjustments the crown was cemented on the provisional abutment. The patient is advised not to bite hard objects directly using the provisional crown. No suturing was done in most cases. In case of delayed loaded implants a definitive crown was placed after 2 months in mandible and 3 months in maxilla.

In sinus lift surgery, a bony window was prepared on the lateral wall of the maxillary sinus using a round bur and copious irrigation. Sinus mucosa elevation was done using blunt sinus curettes (Hu-Friedy, USA). In case of any perforations a small piece of hemostat absorbable fabric (Surgicel®, Ethicon, Johnson & Johnson) was used to cover the defect. It was standard to perform Valsalva maneuver in all sinus lift surgeries, to confirm the absence of any sinus mucosal perforations.

3.3.3 Radiographic evaluation

A standard digital intraoral periapical radiograph was taken in almost all the cases as a routine procedure. On the day of implant placement, a panoramic radiograph was taken. Later for follow up only a baseline standardized periapical radiograph was taken (after 3 months of crown placement). Exposure parameters and processing of radiographs were conducted according to manufactures recommendations and by standard clinical protocols (X-ray machine was set at 15 mA, 70 kV). Distortion of radiographs was taken into account using the known implant dimensions as the measurement guide. Digital radiographic dimension was kept at optimum 640 x 480 pixels. Prior to capturing the image, transillumination was adjusted to best visualize the radiographic bone levels with respect to the implant.

3.4 Statistical analysis

Evaluation of contingency table obtained from the papilla index measurements was done by Fisher's test. Significance was determined by a p-value less than 0.05. For implant stability part, statistical study included regression analysis to find out any relevant relation between ISQ1 and ISQ2.

4 RESULTS

4.1 Study I

The mean age of the subjects was 29 ± 15.5 (mean \pm SD) years ranging from 17 to 68 years. 51 females and 55 males took part in the study. Most implants (76 of 106) were placed in maxillary incisor region, 21 in canine region and 9 in premolar region. Size of implants ranged from 3.7 mm diameter to 5.0 mm diameter and length from 12 mm to 16 mm irrespective of site. The overall implant survival rate was 100% in each group. The results from implant survival rates and other demographics are given in Table 1.

Table 1. Demographics and survival rates (mean \pm SD)

Group	ILA (N = 21)	ILB (N = 22)	DSL (N = 63)
Age (years)	26.3 ± 17.8	27.2 ± 13.2	36.3 ± 15.4
Gender	10 ♀	12 ♀	29 ♀
	11 ♂	10 ♂	34 ♂
Tooth type	14 i	16 i	46 i
	5 c	4 c	12 c
	2 p	2 p	5 p
Implant survival rate (in %)	100	100	100

(♀ = females, ♂ = males, i = incisors, c = canines, p = premolars)

Number of papillae measured was 177 (86 mesial and 91 distal) and number of marginal gingival level measured was 64 (DSL 28; ILA 20; ILB16). The ILA group showed the highest score with a maximum 3 and minimum 2 score. The lowest score was recorded in the DSL category. Table 2 represents maximum and minimum PPI index scores obtained by different groups.

Table 2. Highest and lowest scores secured by mesial and distal papillae

Group \ Score	ILA Mesial	ILA Distal	ILB Mesial	ILB Distal	DSL Mesial	DSL Distal
Highest score	3	3	3	3	3	3
Lowest score	2	2	2	1	0	0

Relationships between the groups, ILA mesial (ILAM), ILA distal (ILAD), ILB mesial (ILBM), ILB distal (ILBD), DSL mesial (DSLm) and DSL distal (DSLd) were evaluated using the Fisher exact test. It was found that, except for groups ILBM vs. DSLM, all other groups showed distinct probabilities. The similar relation shown by group ILBM vs. DSLM was not considered significant.

As expected, the ILA group secured a high PPI score compared to other two cohorts (mean 2.6 for mesial papilla and 2.7 for distal) and DSL secured the least (mean 1.52 for mesial papilla and 1.73 for distal papilla). The respective scores are given in Table 3 and Figure 1. The group ILA secured a mean papilla score (30%) much higher than the group average (25%). Other cohorts secured score 27% (ILB) and 25% (DSL) respectively (Fig. 2). Mesial and distal papillae secured similar scores according to Fisher's test or in other terms the probabilities to obtain a similar score for mesial and distal papilla were the same ($p = 0.74939$). Therefore when mesial and distal PPI scores were compared against different groups of crestal bone levels, i.e., distance between heights of the crestal bone to the base of the contact point of the restoration (X), a definite relationship between them could be elucidated. 92 sites were evaluated and 31 of them scored ≤ 5 mm from crestal bone height to the base of contact point, 31 scored 6 mm, and the remaining 30 had distances exceeding or equal to 7 mm. Respective data are given in Table 4. The values of "X" were rounded off to the nearest integer.

Table 3. Mean values of Papilla indices (PPI) for different groups

Group	ILA	ILB	DSL	Total
Mean				
Mean of PPI (M)	2.6	2.4	1.5	2.2
Mean of PPI (D)	2.7	2.3	1.7	2.2

M= mesial; D= distal

Figure 1. Mean Papilla index

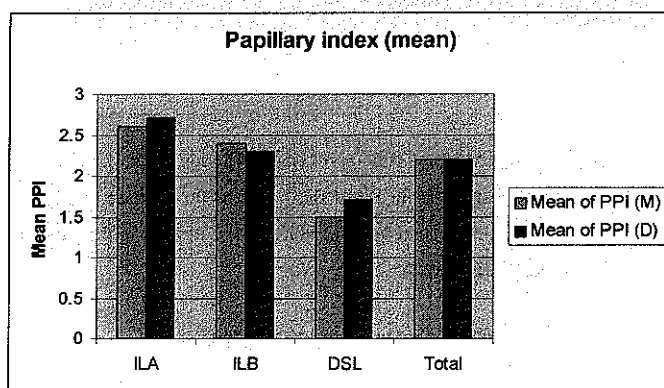


Figure 2. Percentage of total presence of papilla in whole cohort and subgroups (Groups ILA and ILB has secured higher percentage scores compared to the total mean of all the groups, proving their higher esthetic effect compared to DSL)

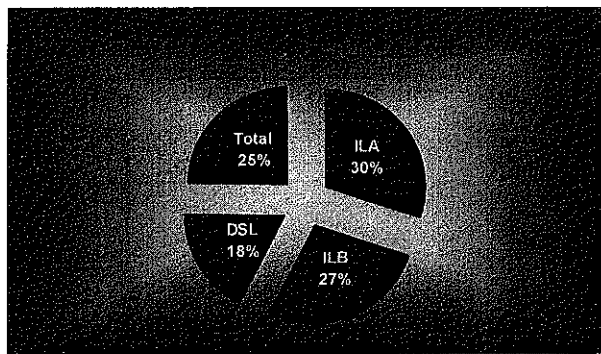
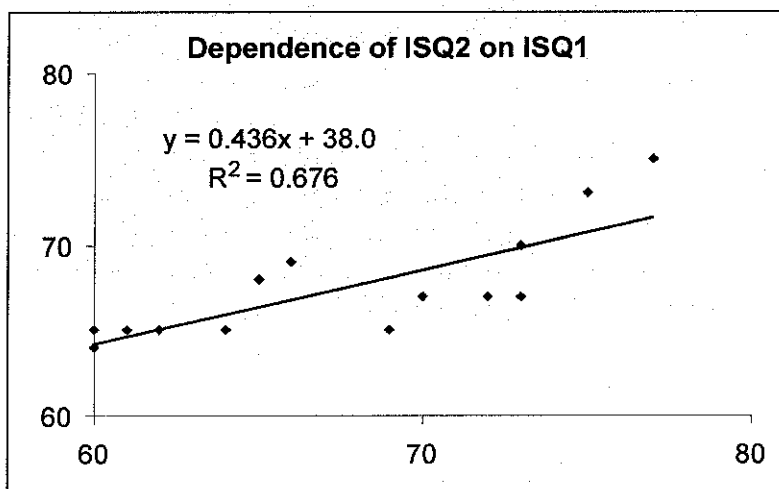


Table 4. Relationship between crestal bone level and PPI index score (Crestal bone level vs. papilla fill). (X (mm) – distance between the bases of the contact point of implant supported crown and crown of adjacent tooth in millimeters. PPI – papillary index scores. Results given in percentage value (%)).

X (mm) \ PPI	≤ 5	6	≥ 7
3	100	46.5	24
0-2	0	53.5	76

4.2 Study II

All surgeries were done with no complication and RFA was measured. Out of the 16 implanted fixtures all were successfully osseointegrated radiographically after a 6-month healing interval. Implant success rate was found to be 100%. ISQ1 ranged from 59 to 77 and ISQ 2 from 64 to 75. Using regression analysis it was seen that ISQ2 depends on ISQ1 (graph 1). The intercept was 38.0 and the regression coefficient was found to be 0.436. ISQ of implants in group A after 6 months decreased from 74.0 to 70.4 on the average and in group C the ISQ increased from 60.1 to 64.3. The change in group B was not statistically significant.



Graph 1. Dependence of ISQ2 on ISQ1

5 DISCUSSION

5.1 Soft tissue esthetics in flapless immediate loading

Soft tissue management is one of the many factors that have a heavy impact on the final esthetic result, with the need to harmonize color, form, and contour with that of the adjacent tissues (Croll 1981). In the study the factors, which affected the clinical outcome, were mainly the labial bone integrity and height (in flapless immediate loading especially) and soft tissue level. Bone resorption, as much as 3 to 4 mm occurs during the first 6 months post-extraction, compromising the bone and gingival tissue levels for the implant placement and subsequently leading to loss of peri-implant papillae (Chiche et al. 1989, Atwood et al. 1971). Therefore, the most effective means to recreate a papilla was to prevent the loss of the underlying bone at the time of tooth removal. For single-tooth replacement, the interproximal level of the bone is important in the maintenance of the interproximal papilla. We did atraumatic extraction of the tooth by means of forceps rotation and periostomes, without damaging the surrounding bony wall followed by immediate placement of a root form implant (Wheeler 2000) and gave provisional restoration in case of immediate loading, which exerts slight lateral pressure on the tissues, preserves the original shape and location of the soft tissue as the preextracted shape and thereby prevents collapse of the tissue. Moreover, provisional restoration helps in reforming the gingival peaks and emergence profile.

5.2 Interproximal papilla and esthetic factors

Interproximal esthetics was measured using papilla presence index given by Jemt (1997). Our study included screening of 106 potential implant sites for papilla score and marginal gingival height. From the results it was evident that immediate flapless implantation secured a high score compared to other two groups, making it the most successful treatment strategy. Placement of implants at the time of extraction has become a predictable method (Becker et al. 1999, ten Bruggenkate et al. 1992, Gelb 1993, Schwartz-Arad & Chaushu 1997). A hundred percent survival rate of implant in our study

support the above statement. In the study, selected cases (ILA) were treated with immediate implantation without the need of raising a flap. However, since the early start of this century flapless surgery has been suggested as a treatment modality for the preservation of the soft tissue and for increasing patient comfort and satisfaction (Campelo & Camara 2002, Rocci et al. 2003). It was shown that after extraction of natural teeth, the greatest reduction of the alveolar bone occurs in the first 6 months to 2 years (Araujo & Lindhe 2005; Araujo et al. 2005). An estimate of 25% decrease in faciopalatal width occurs within the first year (Tallgren 1972; Misch 1990; deLange 1995). For this reason, within the last decades, the 'gold standard' implant treatment protocol has been challenged by experiments, which aimed at shortening the treatment period and by reducing the number of surgical procedures. The literature has demonstrated that it is no longer needed to wait for complete healing of the extraction socket before implant placement (Lazarra 1989, Knox et al. 1991, Lundgren et al. 1992). All the cases included in the ILA category, had enough bone volume for implantation and good marginal soft tissue level. Clinical studies demonstrated that the immediate implant placing reduces alveolar resorption (Lazzara 1989, Wheeler 2001). Moreover, this surgical procedure also allows a better final rehabilitation because it facilitates both morphological ridge contour preservation and accurate prosthetic implant installation, maintaining the natural tooth angle (Werbitt et al. 1992). There are also important benefits because the treatment time is reduced. Indeed, alveolar wound healing coincides with implant osseointegration and the patient can achieve the reinstatement of his edentulousness swiftly and by means of a single surgical exposure (Saadoun et al. 1990).

The reason that the immediate flapless protocol secured a high esthetic score can also be pertained to other factors. There has been a report of postsurgical tissue loss from flap reflection, implying that flap surgery for implant placement may negatively influence implant esthetic outcomes, especially in the anterior maxilla. It was speculated that the tissue loss might have resulted from flap reflection (van der Zee et al. 2004). Furthermore it is now an agreed fact that flapless implant surgery is a treatment modality for the preservation of the soft tissue and for increasing patient comfort and satisfaction (Auty & Siddiqui 1999, Campelo & Camara 2002, Rocci et al. 2003).

5.3 Interproximal papilla vs. osseous crest

In the presurgical planning stage, the decision to proceed with any soft tissue grafting should be made before or after implant placement depending on the presence of a stable keratinized band. Holmes observed, "interdental papilla does not regenerate after loss of its osseous support". Surgical techniques using soft tissue management alone to reproduce the interimplant papilla do not give a predictable result (Holmes 1965). The presence of interdental papilla between two teeth is related to the distance between the contact point and the interdental alveolar crest (Tarnow et al. 1992, Salama et al. 1998). In the present study also, a definite relation between the two was found. A classic study conducted by Tarnow et al. (1992) correlated the presence or absence of the interproximal papilla with the distance from the contact area to the crest of the bone in human dentition. Later, Salama et al. (1998) suggested a similar relationship in implant therapy. The data from these studies demonstrate that the presence of papilla drops significantly and papilla cannot be recaptured as the distance exceeds 5 mm in natural teeth and 3 mm in implants. In our study also, a similar relation was found. When the distance between the base of the contact point of crowns and height of interproximal bone (X) was ≤ 5 mm, the papilla was present 100% of the time, but when the distance increased to 6 mm and then ≥ 7 mm, the papilla was present only 46.5 and 24.0 percentage of the time. Therefore in the literature and the present study it can be said, that the presence of papillae is affected by the level of the alveolar crests below in the interdental space and the relationship between the vertical dimension of the interdental space and the presence of papillae (Tarnow 1992, Salama et al. 1998, Choquet et al. 2001).

5.4 Stability of implants in the grafted sinus

Initial implant stability obtained after implant insertion is regarded as critical for the prognosis of the implant (Sennerby 2001). According to Huang (2003), implants with better initial stability would osseointegrate better and would result in higher secondary stability. They therefore require reduced healing period than those with low initial

stability. From our results it is evident that all the implants placed in the sinus lift after nine months of healing osseointegrated in six months. The initial measurement of average 66.56 indicates acceptable primary stability. In the next six months of healing in the bone the implants gained a competitive secondary stability with those implanted in non-augmented areas. As RFA readings can be implemented in evaluating the success of osseointegration in implants (Nedir et al. 2004, Meredith 1998, Meredith et al. 1996), it also refers to the success of sinus lift indirectly. It has been proved in this study that all the implants placed into the sinus lift achieved an optimal ISQ and at the same time showed acceptable histomorphometrical picture of the biopsied area from the grafted sinus using trephine drill (data not given).

In the study the coefficient of determination (R^2) was found to be 0.646, which means a strong relation between the two values. It is obvious that ISQ2 depends on ISQ1 (Graph 1). The calculated regression equation is $y = 38.0 + 0.436 x$, where y stands for the dependent and x for independent variable. The regression coefficient 0.436 is less than one that indicates the type of dependence of ISQ2 on ISQ1. It has been noticed that implants with lower values of ISQ1 (group C) showed a higher value of ISQ2 and those with higher ISQ1 (group A) reached a lower value of ISQ2. Nedir et al. (2004) reported a similar finding in non-augmented areas. They reported an increase in ISQ values with initial value (during insertion) less than 60 and those with initial values between 60 and 69 tend to decrease their values after the first 2 months. In our experiment the values, which tend to increase were from 59 to 63 and those found decreasing their values were between 71 and 77. The values in group B didn't show a substantial change and the average of the group in six months remained the same. Therefore it is evident that there is a possibility of a platform of values in which there is the least possible fluctuation or if the implants reach a certain value of stability during their insertion then there is a small chance of change of stability in the future. So there is no need of a high initial stability value to ascertain a better prognosis for the implant, as values with a high magnitude by time reaches a lower value and vice versa. But the lower limit of the value is yet to be determined.

6 CONCLUSIONS

1. Immediate loading of implants is a successful treatment modality.
2. Implant treatment whether it is immediate loading or delayed does not have any significance in implant success pertaining to function.
3. Flapless immediate loading provides the best treatment procedure for optimum esthetics pertaining to interproximal area for single tooth replacement in anterior maxilla. This was followed by immediate loading with a need to flap and then delayed loading treatment protocol.
4. Interproximal bone level has directly proportional relation to the presence and height of interproximal papilla between an implant and a natural tooth.
5. Implants inserted into the grafted maxillary sinus is a successful treatment protocol.
6. Implant stability in grafted maxillary sinuses show a tendency to reach a particular stability value in the healing time, which coincide with average value of initial stability measurements.

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8. Publications and activities of the author related to the subject

8.1 Publications

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5. Somanathan RV. Pilot study design of esthetic aspects in interdental papilla height and mode of treatment in implantology. Postgraduate presentation in Dental Faculty, University Hospital, Hradec Králové, Czech Republic, 07/05/2006.
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9. Šimůnek A, Kopecká D, Brázda T, Somanathan RV. Augmentační postupy – teorie versus praxe, Seminar at Lasak, Prague, 26/01/2007.

8.2 Exams attended

1. International qualifying exam A, General Dental Council, United Kingdom, 04/05/2006. Passed with 90%.
2. Awarded by Membership Diploma of Royal College of Surgeons (MFDS-A), London, United Kingdom, 12/10/2006.
3. Admitted for final exam in the Royal College of Australia, Sydney, Australia, 05/05/2007.