TISSUE RESPONSE AROUND MORSE TAPER AND EXTERNAL HEXAGON IMPLANTS: PRELIMINARY RESULTS OF A RANDOMIZED SPLIT-MOUTH DESIGN

Resposta tecidual ao redor de implantes cone Morse e hexágono externo: Resultados preliminares de um estudo em boca dividida

Sueli Sumiyassu[1]
Ana Cláudia Moreira Melo[2]
Ivete Aparecida de Mattias Sartor[2]
Flávia Noemi Gasparini Kiatake Fontão[2]
Edilson José Ferreira[3]
Geninho Thomé[4]

[1]Graduate student, Latin American Institute of Dental Research and Education (Curitiba, Paraná, Brazil)

[2]Assistant Professor, Latin American Institute of Dental Research and Education (Curitiba, Paraná, Brazil)

[3]Professor, IMPPAR DENTISTRY (Londrina, Paraná, Brazil)

[4]Director, Latin American Institute of Dental Research and Education (Curitiba, Paraná, Brazil)

Recebido em: 08/12/2012
Aceito em: 29/04/2013

SUMIYASSU, Sueli *et al.* Tissue response around morse taper and external hexagon implants: preliminary results of a randomeized split-mouth design. *SALUSVITA*, Bauru, v. 32, n. 1, p. 09-24, 2013.

ABSTRACT

Introduction: the rehabilitation of **e**dentulous mandible by four interforaminal implants with the distal ones inserted tilted in order to avoid proximity with the mentual foramen as well as improving prosthesis support have been argued as an adequate design for implant supported fixed prosthesis. **Objective**: the aim of this study was to compare tissue response around immediately loaded mandibular dental implants with two different prosthetic connections. **Methods**: a total of 48 implants were inserted in the anterior region of the mandible of 12 edentulous patients following a randomized split-mouth design. Morse Taper and External Hexagon implants were equally divided into each patient. Distal implants were tilted and central implants axially positioned in relation to the alveolar crest. Standardized intraoral radiographs were taken immediately after implant placement and after 6 months. Periodontal parameters (probing depth and keratinized tissue width and height) were recorded at the same times. Wilcoxon test was used. **Results and Discussion**: It was observed stability of the gingival margin and decrease in probing depth around Morse taper implants and increase in external hexagon implants. There was marginal bone increase in the mesial face (0.27 mm) and decrease at the distal face (-0.87 mm) of Morse taper and at both proximal faces of external hexagon implants (-1.06 mm and -0.80 mm, respectively). Morse taper tilted implants showed maintenance of bone height (0.03 mm and -0.02mm, mesial and distal) while external hexagon implants showed resorption (-1.82 mm and -0.75 mm, mesial and distal). Axially positioned implants showed bone loss, either Morse taper (-0.72 and -0.67mm, mesial and distal) or external hexagon (-0.69 and -0.83 mm). There was no correlation between availability of keratinized tissue and bone behaviour. **Conclusion**: these findings suggest that Morse taper implants showed better results than external hexagon ones, nevertheless it should be emphasized that these are preliminary results and longer evaluations are suggested.

Key words: Dental implants. Immediate loading. Implant supported prostheses. Oral rehabilitation.

RESUMO

Introdução: *Tem sido sugerido que a reabilitação de mandíbulas edêntulas por meio de quatro implantes interforaminais, sendo os implantes distais instalados inclinados com o objetivo de evitar proximidade com o foramen mentual assim como melhorar o suporte da prótese, é um desenho adequado para próteses fixas implantossuportadas. Objetivo: o objetivo deste estudo foi comparar a resposta tecidual ao redor de implantes dentários mandibulares com dois diferentes tipos de conexões. Métodos: quarenta e oito implantes foram instalados na região anterior da mandíbula de 12 pacientes edêntulos segundo desenho experimental em boca dividida. Implantes cone Morse (CM) e hexágono externo (HE) foram igualmente distribuídos entre os pacientes. Os implantes distais fo-*

ram instalados inclinados e os centrais axiais à crista óssea alveolar. Radiografias intrabucais padronizadas foram tomadas após a instalação dos implantes e após 6 meses. Parâmetros periodontais (profundidade de sondagem e altura e espessura de tecido queratinizado) foram registrados nos mesmos tempos. Resultados e discussão: observou-se estabilidade da margem gengival ao redor dos implantes CM e aumento nos implantes HE. Houve ganho ósseo em altura na face mesial (0,27 mm) e diminuição na face distal (-0,87 mm) dos implantes CM e em ambas as faces dos implantes HE (-1,06 mm e -0,80 mm, respectivamente). Implantes CM inclinados mostraram manutenção da altura óssea (0,03 mm e -0,02mm, mesial e distal) enquanto os HE mostraram perda em altura (-1,82 mm e -0,75 mm, mesial e distal). Implantes axiais, CM (-0,72 e -0,67mm, mesial e distal) e HE (-0,69 e -0,83 mm) mostraram perda óssea. Não houve correlação entre a disponibilidade de gengiva queratinizada e o comportamento ósseo. Conclusão: esses resultados sugerem melhores resultados nos implantes CM que nos HE, contudo, cabe ressaltar que é um resultado preliminar, o acompanhamento a longo-prazo deve ser realizado.

Palavras-chave: *Implantes dentários. Carga imediata. Prótese implantossuportada. Reabilitação oral.*

INTRODUCTION

The rehabilitation of **e**dentulous mandible by four interforaminal implants with the distal ones inserted tilted in order to avoid proximity with the mental foramen as well as improving prosthesis support have been argued as an adequate design for implant supported fixed prosthesis (KREKMANOV *et al.*, 2000; MALÓ *et al.*, 2003; AGLIARDI *et al.*, 2010; HINZE *et al.*, 2010; NAINI *et al.*, 2010). Nevertheless, after implant placement and function establishment, it's known that there's active remodelling of the peri-implant alveolar crest (ALBREKTSON *et al.*, 1986; LINDQUIST *et al.*, 1988; FRIBERG e JEMT, 2010; LAURELL e LUNDGREN, 2011). Many parameters that may affect this process and are not yet comprehensively clarified (PROSPER *et al.*, 2009). The distance from the implant/abutment joint to the bone crest (HERMANN *et al.*, 2000; CHOU et al., 2004), gingival biotype and response (BERGLUNDH e LINDHE, 1996; EVANS e CHEN, 2008; GALLI et al., 2008; GERBER *et al.*, 2009; PIERI *et al*, 2011), occlusal stress generated in the peri-implant bone tissues (MAEDA et al., 2007;

CAPPIELLO *et al*, 2008), type of implant (FRIBERG e JEMT, 2010; MANGANO *et al*., 2010; WENG *et al*., 2011) and platform switching concept (PROSPER *et al*., 2009; LAZZARA e PORTER, 2006; BAFFONE *et al*, 2011; BAFFONE *et al*., 2012) are some of the aspects considered.

The influence of gingival biotype has been argued as an important parameter in implant success criteria. Some authors (BLOCK e KENT, 1990; ADIBRADI *et al*., 2009) consider that the presence of adequate width of keratinized tissue may be related even to mechanical stability of peri-implant tissue and provides more vascularisation and resistance to mechanical irritation (FU *et al*., 2011). Nevertheless, the importance of keratinized tissue around implants generating a conjunctive collar is still a controversial topic (ADIBRADI *et al*., 2009).

Considering the above, the aim of the present study was: (1) to evaluate soft tissue response around immediately loaded dental implants with two different prosthetic connections; (2) to compare the bone response around immediately loaded dental implants with two different prosthetic connections; (3) to compare bone response around tilted or axially inserted implants (4) to evaluate the role of keratinized mucosa around dental implants in bone tissue response.

MATERIAL AND METHODS

Patients

Edentulous subjects wearing removable upper and lower prosthesis that looked for implant treatment in IMPPAR (Implant Clinic of Paraná, Londrina, Brazil) were invited to participate in the study. After an initial clinical examination, 12 patients were selected according to the following inclusion criteria: good general health and bone availability (at least 11 mm of residual bone height) for dental implants insertion in the anterior interforaminal area of the mandible. Exclusion criteria included non-compensated diabetes, under bisphosphonate treatment and radiation therapy on head and neck in the last 5 years and smoking patients that are conditions that could interfere with the treatment results.

The study was approved by the ethical committee of the State University of Londrina (UEL, Paraná, Brazil) and that all patients signed a written informed consent form.

SUMIYASSU, Sueli *et al.* Tissue response around morse taper and external hexagon implants: preliminary results of a randomeized split-mouth design. *SALUSVITA*, Bauru, v. 32, n. 1, p. 09-24, 2013.

Experimental design

This study was designed as a randomized split-mouth clinical trial to compare two different implant prosthetic connections (Morse taper (MT) and external hexagon (EH)). Each patient received 4 interforaminal implants (two with each prosthetic connection). The subjects were randomly divided into 2 groups according to the side of each prosthetic connection installation. The group allocation was performed with the aid of two envelopes in which papers containing MT or EH and R (right side) or L (left side). The patients were asked to pick one paper from each envelope indicating the type of prosthetic connection and the side of installation. The picked papers were thrown away after being selected.

Interventions

Prosthetic planning and preparation

Prosthetic preparation consisted of obtaining cast models, adjustment of wax plans, transferring semi-adjustable articulators, mounting of the teeth and functional and aesthetic evaluation. Then the lower teeth were also mounted the same way, duplicated and a multifunctional surgical stent was obtained (BORGES *et al*., 2010).

Measurement of the amount of keratinized gingiva before surgery

Immediately before surgery the amount of keratinized gingiva in the interforaminal area was measured. The mental foramens were identified and marked, with a biologic ink, with the aid of panoramic X-ray and clinical palpation. The measurements of width and height were done in 4 specific sites (5 mm away from the right and left mental foramen and equidistantly positioned considering these two first measurements).

The width of keratinized gingiva was measured in mucogingival line using an endodontic lime and a rubber stop and the distance was measured using a manual calliper. All measurements were performed by the same researcher.

Dental implants insertion

Releasing incisions and flap elevation were performed in order to expose the mental foramens, and a distance of 3.5 to 5 mm away from the foramen was advocated for distal fixations. The position of the middle implants was determined according to the distal ones. All the surgeries were performed by experienced surgeons with the use of the multifunctional stent.

Surgical sites were prepared according to Adell et al. (1981) protocol in which the surgical alveolus is gradually increased according to bone density in order to achieve adequate primary stability. Implant diameter and length was determined according to bone availability. All implants used MT and EH were of the same manufacturer (Neodent, Curitiba, Paraná, Brazil). Primary stability was measured with the aid of a manual wrench and in all cases the value was at least 45 Ncm.

The distal implants were inserted tilted and the central implants axially positioned to the alveolar crest.

Implant abutments (Neodent, Curitiba, Brazil) specific for each prosthetic connection (Figure 1) were selected at gingival level and a torque of 32 Ncm, as recommended by the manufacturer, was applied. After suture with mononylon 4.0 (Polysuture, Brussels, Belgium) all implants were loaded after 48 hours.

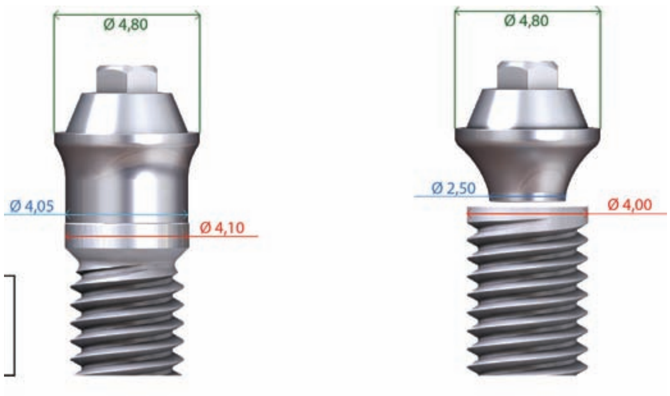


Figure 1 – Implant abutments. Observe the mismatching between implant diameter and abutment diameter. Left - Slim fit abutment (Neodent, Curitiba, Brazil) for external hexagon Implant. Right - Conical abutment (Neodent, Curitiba, Brazil) for Morse Taper implant.

Soft tissue assessment

Clinical evaluation included the presence of plaque and signs of inflammation.

With the aim of verifying the stability of the gingival margin around the implant, the distance between the gingival margin and the abutment was identified in 3 implant faces (Mesial, Distal, and Buccal). A periodontal probe was used and the reference point was the implant/abutment junction. When the gingival margin was under the reference point a positive value was registered, and when the gingival margin was over the point a negative value was registered. The measurements were done immediately after suture (T0) and after 6 months (T1) and were all performed by the same professional with the same instrument.

Marginal bone response

Periapical digital radiographs were obtained always with the same device and the aid of EVA® sensor (Image Works, USA) for each implant using the parallelism technique with the use of guides specially developed for clinical researches. The radiographs were taken ten days (T0) and 6 months after implant insertion (T1).

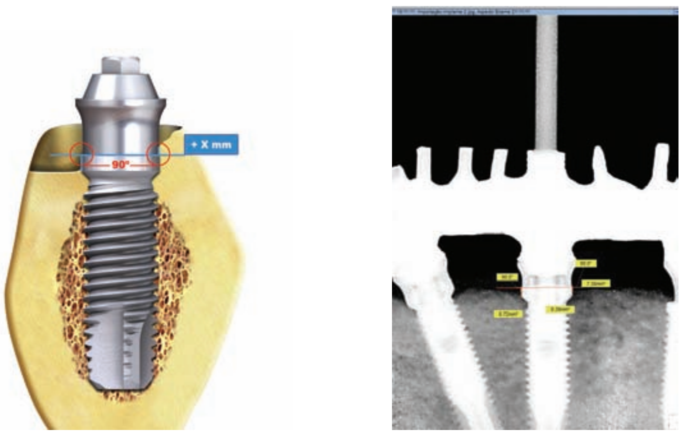
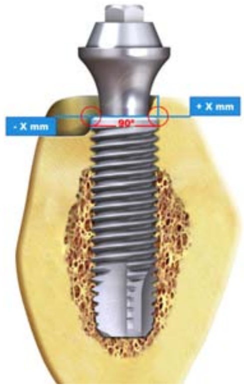
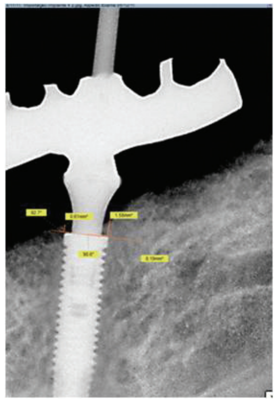


Figure 2 - Bone level measurement of external hexagon implant. A. Schematic view. B. Periapical X-ray.





SUMIYASSU, Sueli *et al.* Tissue response around morse taper and external hexagon implants: preliminary results of a randomeized split-mouth design. *SALUSVITA*, Bauru, v. 32, n. 1, p. 09-24, 2013.

Bone level measurements were obtained on the mesial and distal aspect of each implant, considering the distance from a horizontal line drawn at the implant/abutment junction to a second line, parallel to the first one at the level of the alveolar crest (Figure 2 and 3). The software used was SIDEXIS XG (Sirona, Beshein, Germany). All measurements were done by one examiner that was maintained blinded for the treatment time.

The data were analysed using Statistica v 8.0 software and the normality of data was tested by Kolmogorov-Smimov test. Non parametric Wilcoxon test was used for comparison between implant design and the evaluated parameters. Spearman coefficient was used to evaluate the association between keratinized tissue width and height and bone response. The level of significance was set at $p<0.05$.

RESULTS

Twelve edentulous patients (6 women and 6 men), from 38 to 82 years (mean age, 61.9), and mean time of edentulousness of 27.9 years participated of this study and received a total of 48 implants. The patients were followed-up for a period of 6 months. All patients were edentulous before treatment and were rehabilitated according to a lower implant-supported full bridge and an upper removable prosthesis. The implants used are described in Table 1.

One patient decided not return at the 6-month evaluation, for personal reasons, and two implants were lost, both in the same patient and with the same prosthetic connection (External Hexagon).

Table 1 - Distribution of implants according to diameter and length.

Type of connection	Diameter (mm)	%	Length (mm)	%
Morse taper	3.75 4 5	91.6 4.1 4.1	11 13 15 17	37.5 20.83 33.3 8.3
External hexagon	3.75 4 5	87.5 12.5 -------	11 13 15 17	29.16 25 29.16 16.6

Soft tissue assessment

Table 2 shows the behaviour of the gingival margin around both implant designs.

Table 2 - Distance from the abutment to the gingival margin measured in the mesial, buccal and distal faces.

Design	Distance from abutment to gingival margin	T0 (baseline) (mm)	T1 (6 months) (mm)	Difference (mm)	P value
Tilted Morse Taper	Mesial	1.64	0.08	-0.82	0.052
	Distal	-0.05	-0.27	-0.23	0.463
	Buccal	1.09	0.82	-0.27	0.345
Axial Morse taper	Mesial	0.73	0.82	0.09	0.715
	Distal	0.64	0.45	-0.18	0.594
	Buccal	0.82	1.14	0.32	0.310
Tilted External Hexagon	Mesial	0.80	0.80	0,00	0.893
	Distal	-0.70	-0.60	0.10	0.889
	Buccal	-0.20	0.20	0.40	0.345
Axial External Hexagon	Mesial	0.65	0.50	-0.15	0.465
	Distal	0.20	0.00	-0.20	---
	Buccal	0.85	1.10	0.25	0.575

Wilcoxon test, *Statistically significant difference

Marginal bone response

Descriptive data obtained at T0 and T1 for Morse taper and external hexagon implants are presented in Table 3.

The marginal bone loss of implants considering tilting or not is presented in Table 4.

Table 3 - Descriptive data obtained at baseline and after 6 months.

T0 – baseline			
Marginal bone		Average (mm)	SD (mm)
Mesial face	Morse taper	0.89	0.83
	External Hexagon	0.56	0.63
Distal face	Morse taper	1.44	0.85
	External Hexagon	0.18	0.85
T1 – 6 months			
Mesial face	Morse taper	1.16	0.94
	External Hexagon	-0.76	0.95
Distal face	Morse taper	0.57	1.02
	External Hexagon	-0.62	0.58

Table 4 - Peri-implant bone response after 6 months at the mesial and distal faces.

Mesial Face					
Design	Bone level	Mean (mm)	Median (mm)	SD (mm)	P value
Tilted Morse Taper	T0 (baseline)	0.33	0.39	0.928	0.959
	T1 (6 months)	0.36	0.76	0.868	
	Difference	0.03	000	0.486	
Axial Morse taper	T0 (baseline)	1.49	1.86	1.20	0.026*
	T1 (6 months)	0.77	1.56	1.47	
	Difference	-0.72	-0.74	0.86	
Tilted External Hexagon	T0 (baseline)	0.72	-0.36	1.42	0.005*
	T1 (6 months)	-1.10	-1.05	1.16	
	Difference	-1.82	-0.23	1.52	
Axial External Hexagon	T0 (baseline)	0.43	0.20	1.00	0.007*
	T1 (6 months)	-0.26	-0.39	1.32	
	Difference	-0.69	-0.50	0.50	
Distal Face					
Design	Bone level	Mean (mm)	Median (mm)	SD (mm)	P value
Tilted Morse Taper	T0 (baseline)	1.51	1.86	1.317	0.959
	T1 (6 months)	1.49	1.20	1.004	
	difference	-0.02	-0.11	1.372	
Axial Morse taper	T0 (baseline)	1.51	1.35	0.98	0.041*
	T1 (6 months)	0.84	0.63	1.29	
	difference	-0.67	-0.60	0.93	
Tilted External Hexagon	T0 (baseline)	-0.22	0.58	0.75	0.285*
	T1 (6 months)	-0.97	-0.84	1.76	
	difference	-0.75	-1,12	1.95	
Axial External Hexagon	T0 (baseline)	0.41	0.55	1.25	0.007*
	T1 (6 months)	-0.43	-0.67	1.42	
	difference	-0.83	-0.57	0.75	

Correlation between width and height of the keratinized gingiva and bone response:

The association between keratinized gingival and bone response obtained with Spearman test for each implant is described in Table 5 and 6.

Table 5 - Correlation test between width and height of the keratinized gingival and bone response, for Morse taper implants.

Distal Morse Taper				
Variable in T0	Difference T0-T1 RX D		Difference T0-T1 RX M	
	Spearman Correlation Coefficient	p value	Spearman Correlation Coefficient	p value
Height	-0.17	0.622	0.33	0.317
Width	0.01	0.967	0.15	0.657
Axial Morse Taper				
Variable in T0	Difference T0-T1 RX D		Difference T0-T1 RX M	
	Spearman Correlation Coefficient	p value	Spearman Correlation Coefficient	p value
Height	0.19	0.566	-0.27	0.418
Width	0.50	0.116	-0.38	0.252

Table 6 - Correlation test between width and height of the keratinized gingival and bone response, for External hexagon implants.

Central External Hexagon				
Variable in T0	Difference T0-T1 RX D		Difference T0-T1 RX M	
	Spearman Correlation Coefficient	p value	Spearman Correlation Coefficient	p value
Height	0.31	0.390	-0.53	0.117
Width	-0.14	0.704	-0.12	0.732
Distal External Hexagon				
Variable in T0	Difference T0-T1 RX D		Difference T0-T1 RX M	
	Spearman Correlation Coeficient	p value	Spearman Correlation Coeficient	p value
Height	-0.50	0.145	0.13	0.717
Width	-0.22	0.550	-0.89	<0.001*

DISCUSSION

In the present study bone and soft tissue response around immediately loaded dental implants supporting fixed mandibular prosthesis was assessed. Two different prosthetic connections were used, Morse taper and external hexagon, in a split-mouth design. The randomized split-mouth design to compare two different prosthetic connections, is very important to avoid bias of allocation of the sample, nevertheless, a trial limitation was the small number of the sample that should interfere with external validity of the results.

There was no statistically significant difference when comparing distance from the abutment to the gingival margin independent of prosthetic connection and tilting or not, which indicates a stability of the gingival tissue during the evaluated period. Galli *et al.* (2008)

also observed gingival stability in a 14 month study with external hexagon implants and Mangano *et al.* (2010) reported good soft tissue healing in 87.41% of a sample of 307 Morse taper implants.

Morse taper implants showed better crestal bone response than the external hexagon ones. It was found bone increase at the mesial face of Morse taper implants (0.27 mm) and loss ate the distal face (-0.87 mm). Bone resorption was found at the mesial (-1.32 mm) and distal (-0.80 mm) faces of external hexagon implants. It agrees with Hermann *et al.*, who compared implants with and without platform switching and observed average bone reduction of 0.95 ± 0.32 mm and -1.67 ± 0.37 mm, respectively. Cappiello *et al.* (2008) also observed more bone loss around implants with abutments matching implant platform (average 1.67 ± 0.37 mm) when compared to platform switching concept (average 0.95 ± 0.32 mm). Prosper *et al.* (2009) reported 40 to 60% less bone loss and Pieri *et al.* (2011), crestal bone loss lower than 0.3mm in implants with enlarged platforms after a 1-year follow-up. The effect of platform switching was also studied considering the different amounts of mismatching abutments on implants with wider platforms. Baffone *et al.* (2011) showed no statistically significant difference in bone loss between experimental and control (same implant and abutment diameter) groups when a mismatching of 0.25 mm was used. On the other hand, with greater difference (0.85 mm) between the two diameters, it was found statistically significant better results for the experimental group. It's important to observe that in the present study even in the external hexagon implants there was a slight mismatch between the diameter of implant platform and abutment (Figure 2) which could have improved the results for external hexagon implants.

An important point to consider is the tilting of the implants. In this study, the distal implants were tilted while the central implants were axially positioned in relation to the alveolar crest. It was observed maintenance of crestal bone level in tilted Morse Taper implants (mesial: .03mm; p = 0.959 and distal: - 0.02 mm; p = 0.959). Axially positioned Morse Taper presented statistically significant bone loss at the mesial face (- 0.72mm; p = 0.026) and at the distal face (- 0.67mm; p = 0.041). Tilted external hexagon also presented statistically significant bone resorption at the mesial face (- 1.82 mm; p = 0.005) and non statistically significant at the distal face (- 0.75 mm; p = 0.285). Finally external hexagon implants showed statistically significant resorption at both faces (mesial: - 0.69 mm; p = 0.007 and distal: - 0.83mm; p = 0.007). It's in accordance with Hinze *et al.* (2010) results, that observed, after 12 months, more bone loss in the central implants (0.82 ± 0.31 mm) than in the distal ones (0.76 ± 0.49 mm). Lindquist et al. (1988), after a 6-month follow-up of morse Taper implants observed more bone loss in axial implants (mesial: - 0.72 mm; p = 0.026 and distal: - 0.67mm; p = 0.041) than in the tilted ones (mesial: 0.03 mm; p = 0.959 and distal: 0.02 mm; p = 0.959). Agliardi *et al*. (2010) found 1.2 ± 0.9 mm of bone loss in the mandible after one year in function and no statistically significant differences between tilted and axially placed implants. Naini *et al*. (2011) in a finite element analysis observed increased stress in the anterior area.

The presence of keratinized gingival around dental implants has been suggested as necessary to the maintenance of peri-implant health (LINDQUIST *et al*., 1988; MAEDA *et al*., 2007; GALLI *et al*., 2008) and its absence is frequently associated to inflammation (LINDQUIST *et al*., 1988; BLOCK e KENT, 1990). In the present study it was not found correlation between keratinized tissue height and width and bone response, which is in accordance with Adibradi *et al*. (2009) that compared implants supporting overdentures and observed no statistically significant difference considering keratinized tissue width. Differently, Berglundh and Lindhe (1996) and Galli *et al*. (2008) suggested that when there is less than 2mm of soft tissue width it's more prone to bone loss around dental implants.

CONCLUSION

According to soft tissue, the distance from the abutment to the gingival margin showed stability in both prosthetic connections;

Morse taper implants presented less bone loss than external hexagon implants;

Tilted implants showed better results considering bone response;

There was no correlation between keratinized tissue presence and bone response.

Acknowledgements

We would like to thank Neodent donated all the implants and prosthetic components used in this research and the Department of Computer Graphics of Neodent, especially Mr Andre Luiz Sterchille for designing the figures presented in this paper.

REFERENCES

ADELL, R.; LEKHOLM, U.; ROCKLER, B.; et al. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. **International Journal of Oral Surgery**, Copenhagen, v. 10, n. 6, p. 387-416, dec. 1981.

ADIBRAD, M.; SHAHABUEI, M.; SAHABI, M. Significance of the width of keratinized mucosa on the health status of the supporting tissue around implants supporting overdentures. **Journal of Oral Implantolology**, Abington, v. 35, n. 5, p. 232-237. 2009.

AGLIARDI, E.; PANIGATTI, S.; CLERICÓ, M.; et al. Immediate rehabilitation of the edentulous jaws with full fixed prostheses supported by four implants: interim results of a single cohort prospective study. **Clinical Oral Implants Research**, Copenhagen, v. 21, n. 5, p. 459-465, may. 2010.

ALBREKTSON, T.; ZARB, G.A.; WORTHINGTON, P.; et al. The long-term efficacy of currently used dental implants: A review and proposed criteria for success. **The International Journal of Oral Maxillofacial Implants**, Lombard, v. 1, n. 1, p. 11-25, summer, 1986.

BAFFONE, G.M.; BOTTICELLI, D.; CANULLO, L.; et al. Effect of mismatching abutments on implant with wider platforms – an experimental study in dogs. **Clinical Oral Implants Research**, Copenhagen, v. 23, n. 3, p. 334-339, mar. 2012.

BAFFONE, G.M.; BOTTICELLI, D.; PANTANI, F.; et al. Influence of various implant platform configurations on peri-implant tissue dimensions: an experimental study in dog. **Clinical Oral Implants Research**, Copenhagen, v. 22, n. 4, p. 438-444, apr. 2011.

BERGLUNDH, T.; LINDHE, J. Dimension of the periimplant mucosa. Biological width revisited. **Journal of Clinical Periodontology**, Malden, v. 23, n. 10, p. 971-973, oct. 1996.

BLOCK, M.S.; KENT, J.N. Factors associated with soft- and hard tissue compromise of endosseous implants. **Journal of Oral Maxillofacial Surgery**, Philadelphia, v. 48, n. 11, p. 1153-1160, nov. 1990.

BORGES, A.F.S.; PEREIRA, L.A.V.D.; THOMÉ, G.; et al. Protheses removal for suture removal after immediate load: success of implants. **Clinical Implant Dentistry and Related Research**, Hamilton, v. 12, n. 3, p. 244-248, sep. 2010.

CAPPIELLO, M.; LUONGO, R.; DI LORIO, D.; et al. Evaluation of peri-implant bone loss around platform-switched implants. **International Journal Periodontics and Restorative Dentistry**, Chicago, v. 28, n. 4, p. 347-355, aug. 2008.

CHOU, C.T.; MORRIS, H.F.; OCHI, S.; et al. AICRG - Part II: Crestal bone loss associated with the Ankylos implant: loading to 36 months. Journal of Oral Implantology, Abington, v. 30, n. 3, p. 134-143. 2004.

EVANS, C.D.; CHEN, S.T. Esthetic outcomes of immediate implant placements. **Clinical Oral Implants Research**, Copenhagen, v. 19, n. 1, p. 73-80, jan. 2008.

FRIBERG, B.; JEMT, T. Clinical experience of TiUnite™ implants: A five year cross sectional, retrospective follow up study. **Clinical Implant Dentistry and Related Research**, Hamilton, v. 12, n. 1, p. e95-e103, may. 2010.

FU, J.H.; LEE, A.; WANG HL. Influence of the tissue biotype on implant esthetics. **International Journal of Oral Maxillofacial Implants**, Lombard, v. 26, n. 3, p. 499-508, may-jun. 2011.

GALLI, F.; CAPELLI, M.; ZUFFETTI, F.; et al. Immediate non-occlusal vs. early loading of dental implants in partially edentulous patients: A multicentre randomized clinical trial. Peri-implant bone and soft-tissue levels. **Clinical Oral Implants Research**, Copenhagen, v. 19, n. 6, p. 546-552, jun. 2008.

GERBER, J.A.; TAN, W.C.; BALMER, T.E.; et al. Bleeding on probing and pocket probing depth in relation to probing pressure and mucosal health around oral implants. **Clinical Oral Implants Research**, Copenhagen, v. 20, n. 1, p. 75-78, jan. 2009.

HERMANN, J.S.; BUSER, D.; SCHENK, R.K.; et al. Crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged and submerged implants in the canine mandible. **Journal of Periodontology**, Chicago, v. 71, n. 9, p. 1412-1424, sep. 2000.

HINZE, M.; THALMAIR, T.; BOLZ, W.; et al. Immediate loading of fixed provisional prostheses using four implants for the rehabilitation of the edentulous arch: A prospective clinical study. **International Journal of Oral Maxillofacial Implants**, Lombard, v. 25, n. 5, p. 1011–1018, sep-oct. 2010.

KREKMANOV, L.; KAHN, M.; RANGERT, B.; et al. Tilting of posterior mandibular and maxillary implants for improved prosthesis support. **International Journal of Oral Maxillofacial Implants**, Lombard, v. 15, n. 3, p. 405-414, may-jun. 2000.

LAURELL, L.; LUNDGREN, D. Marginal bone level changes at dental implants after 5 years in function: A meta-analysis. **Clinical Implant Dentistry and Related Research**, Hamilton, v. 13, n. 1, p. 19-28, mar. 2011.

LAZZARA, R.J.; PORTER, S.S. Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels. **International Journal of Periodontics and Restorative Dentistry**, Chicago, v. 26, n.1, p. 9-17, feb. 2006.

LINDQUIST, L.W.; ROCKLER, B.; CARLSSON, G.E. Bone resorption around fixtures in edentulous patients treated with mandibular fixed tissue-integrated prostheses. **Journal of Prosthetic Dentistry**, St Louis, v. 59, n. 1, p. 59-63, jan. 1988.

MAEDA, Y.; MIURA, J.; TAKI, I.; et al. Biomechanical analysis on platform switching: is there any biomechanical rationale? **Clinical Oral Implants Research**, Copenhagen, v. 18, n. 5, p. 581-584, oct. 2007.

MALÓ, P.; RANGERT, B.; NOBRE, M. "All-on-four" Immediate-function concept with Branemark System® implants for completely edentulous mandibles: A retrospective clinical study. **Clinical Implant Dentistry and Related Research**, Hamilton, v. 5, n. 1, p. 2-9. 2003.

MANGANO, C.; MANGANO, F.; PIATELLI, A.; et al. Prospective clinical evaluation of 307 single-tooth Morse taper-connection implants: A multicenter study. **International Journal of Oral Maxillofacial Implants**, Lombard, v. 25, n. 2, p. 394-400, mar-apr. 2010.

NAINI, R.B.; NOKAR, S.; BORGHEI, H.; et al. Tilted or parallel implant placement in the completely edentulous mandible? A three dimensional finite element analysis. **International Journal of Oral Maxillofacial Implants**, Lombard, v. 26, n.4, p. 776–781, jul-aug. 2011.

PIERI, F.; ALDINI, N.A.; MARCHETTI, C.; et al. Influence of implant-abutment interface design on bone and soft tissue levels around immediately placed and restored single-tooth implants: a randomized controlled clinical trial. **International Journal of Oral Maxillofacial Implants**, Lombard, v. 26, n. 1, p. 169-178, jan-feb. 2011.

PROSPER, L.; REDAELLI, S.; PASI, M.; et al. A randomized prospective multicenter trial evaluating the platform-switching technique for the prevention of postrestorative crestal bone loss. **International Journal of Oral Maxillofacial Implants**, Lombard, v. 24, n. 2, p. 299-308, mar-apr. 2009.

WENG, D.; NAGATA, M.J.H.; BOSCO, A.F.; et al. Influence of microgap location and configuration on radiographic bone loss around submerged implants: An experimental study in dogs. **International Journal of Oral Maxillofacial Implants**, Lombard, v. 26, n. 5, p. 941:946, sep-oct. 2011.

SUMIYASSU, Sueli *et al.* Tissue response around morse taper and external hexagon implants: preliminary results of a randomeized split-mouth design. *SALUSVITA*, Bauru, v. 32, n. 1, p. 09-24, 2013.