JRD

EVALUATION OF HEXAGON DEFORMATION OF DENTAL IMPLANT REGARDING TO THE INSERTION FORCE

Gustavo Otoboni Molina[1], Dimas João Rodrigues Neto[2], Marcelo Tomás de Oliveira[3], Marcelo Matos Rocha[4], Carla Miranda Santana[2], Kaue Angeramis[4]

1 Department of Periodontics, University of Southern Santa Catarina, Tubarão, SC, Brazil
2 Department of Prosthodontics, University of Southern Santa Catarina, Tubarão, SC, Brazil
3 Department of Dental Materials, University of Southern Santa Catarina, Tubarão, SC, Brazil
4 Department of Oral & Maxillofacial Surgery, University of Southern Santa Catarina, SC, Brazil
4 University of Southern Santa Catarina, Tubarão, SC, Brazil

CORRESPONDING AUTHOR: gustavo.molina@unisul.br

ABSTRACT

The aim of this study is to evaluate hexagon deformation of dental implant regarding to the insertion force, verifying the external hexagon platforms before and after each torque performed. Thereunto, 25 implants were selected and divided into 5 groups with 5 implants each one; every group received different torque 10N, 20N, 30N, 40N and 100N. A Surgical torque wrench was used, with the implant installation key, what established the insertion force for each group. The platform measurements were carried out before and after apply the torque by analyses of images acquired through implant platforms. We conclude, by this study methodology, 100N forces were able to cause changes on hexagon dimensions; however, it did not damage the prosthesis platform adaptation.

KEYWORDS: external hexagon, implants, deformation
http://dx.doi.org/10.19177/jrd.v4e62017145-149

INTRODUCTION

Early studies on Dental Implant[1] followed the osseontegration process of machined implant, their predictability and biomechanical factors. However, aesthetic requirements were not considered in their studies.[2,3,22.]

The search for aesthetics on edentulous ridge reconstruction constitutes a challenge for surgeon dentists and prosthodontics, considering the aesthetic effect that progressive alveolar bone reabsorption may cause on the final result in a rehabilitation [4-7,17,18,19,23].

On the modern Dental Implant, achieving a good prognosis on osseointegration and obtaining primary stability is Paramount. The implants immediate loading requires high initial stability levels, measured through torque carried out during their installation or by resonance frequency analysis.[1,8,20,21.]

It is known that as higher stability, as lower the micro mobility presented by the implant, and better the interface bone-implant, no matter the place it is inserted. The torque control has been excellent clinical parameters for implant stability. Indexes above 35N are considered acceptable, measured through electric motor used during the milling process and installation, or through pre-calibrated ratchets[8,9,20,24].

Implant macro geometrical aspects act as favorable factors to obtain primary stability, like thread diameter and design, subfreshment surgical techniques and bone condensation by osteotomy, further the professional experience to identify the bone nature in the implantation place[8,9]. These factors can lead to achieve high stability levels demanding elevated torques on the implants, what makes the insertion very difficult. These trends, as well as the evolution on the systems obliged changes, including on the alloy to circumvent the implants. Alloys that are more resistant were adopted, keeping similar biological properties. Likewise, devices used also changed.[8-12]

The appropriate scientific evidence on the successful osseointegrated implants stimulated new alternative implant systems arise, with variable prosthetic geometry and connections. Implants with External Hexagon Connection (EH), developed by Branemark, still are the most evident and science case-by- [25-30]. As the big advantage, this system is very simple and its great variety of prosthetic components facilitates the choice for the appropriate solution for the case. Initially, implant installation with EH occurred by assemblers set to the hexagon. However, nowadays the installation keys of most implants are internal connections, increasing the resistance of implants/platforms to the elevated torques to preserve hexagon dimensions for future prosthetic adaptations[13,14,16]. Nevertheless, hexagon failures and deformation can occur when the implants installation due to factors like installation key maladaptation or excessive torque.[25,26,27]

Implants with internal hexagon connection (IH) and morse were also developed in order to improve the force distribution and crown/prosthetic pillars stability, besides presenting some biological advantages and less bone loss (saucerization) around the implants[15,25,26,27].

Based on the above considerations, the aim of this research was evaluate *in vitru* EH platform deformation before and after application of different torque to the implant installation.

MATERIAL AND METHODS

To perform this work, 25 platform implants 4.1 brand Implalife® (Jales, São Paulo, Brazil)were used (Figure 1) divided into 5 groups with 5 implants each one (n=5), depending on the torque value applied (10, 20, 30, 40 and 100N). The specimens were set in a metal bowl (Figure 2) connected with colorless acrylic resin using a liner (Figure 3) to obtain parallel between the implant set, and to they could be submitted to the forces until 100N. After fixed on the block, they were photographed before and after each torque performed 10, 20, 30, 40 and 100N with implant installation key (Figure 4) connected to a Surgical torque wrench (Figure 5). Posteriorly these images were analyzed in the Clinical Laboratory of Marine Sciences at UNISUL using a software(HP300 DEMO 1.20) together the stereoscope brand Zeiss® (Figure 6) connected to a magnifying glass 200x; the hexagon measures of implants were written down and compared between them before and after the torque wrench application. Then, there was a verification if the structure dimensions presented changes through the software Image J. All the measures were compared and the t-Student test was applied.

RESULTS

Results obtained were analyzed through statistical analysis T-Student test, and showed there was significant statistical deformation ($p<0.05$)only in the group 5, according to the graphs 1, 2, 3, 4 and 5 and table 1.

Figure 1. Specimens set on the metal bowl filled with colorless acrylic resin.

Figure 2. Liner Bio-Art.

Figure 3. Key top place the implant.

Figure 4. Surgical torque wrench.

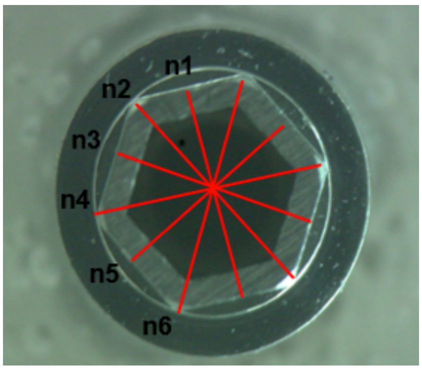
On the group 5, the torque carried out was 100N on each implant, showing there was significant statistically deformation between them. The average was 3.080±2.972.

DISCUSSION

Geometry deformation on the hexagon connection caused by torque during the implants installation lead researchers to develop internal connections type internal hexagon and cone morse[27,30]. In this study, the implants were inserted in self-curing acrylic resin rigid plates in pattern way using liners. It enables a specimen evaluation with appropriately fixed on the acrylic in order to decease external variables that could interfere on the results, as bone type and quality, implant thread macro and micro geometry and eve implant surface treatment[25-30].

Figure 5. Stereoscope.

Figure 6. Stereoscope.



Several factors can interfere on the torque for implant insertion, like bone density, implant design, subfreshment surgical techniques, use of osteotome capacitors and even professional experience[8,9,20,21]. When high values of implantation insertion torques are used, some mechanical complications may occur in the hexagon region, and increase rotation of free rotation of pillar. Any deformation in external hexagon area can unfeasible the future prosthetic rehabilitation, mainly in single cases which depends on antirational prosthesis[8-12].

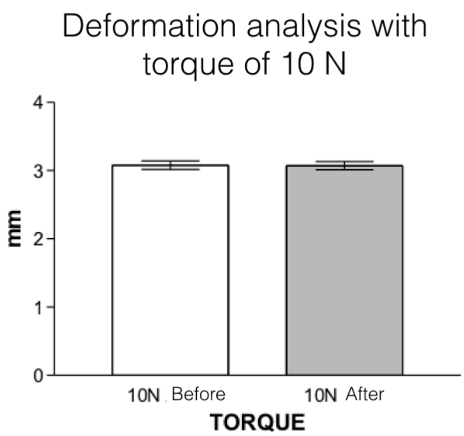
This study showed when excessive torque is applied, dimensional changes could occur on the external hexagon surface. This information confirms the need to respect and standardize the implants installation with maximum torque 40-45N in order to prevent future failures on the prosthesis, what can cause increase the maladaptation and excessive micro movements pillar/implant, or even impossibility pillar adaptation, favoring bacterial penetration and increase the risk of perimplantite [15,29,30].

Almost all the groups evaluated pre and post torque (1, 2, 3 and 4) did not present significant changes on deformation of hexagon platform; it indicates capacity of the models to resist torque loads applied by the operator during implants installation. Only one group (5) presented significant difference on hexagon deformation; this model received 100N torque, suggesting future problems like pillar prosthesis loosening and/or maladaptation.

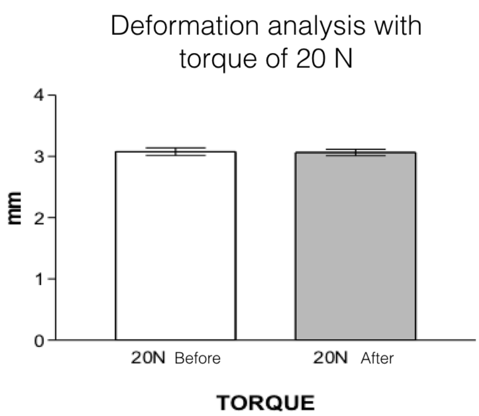
Passive adaptation between bolted prosthesis and external hexagon is Paramount for mechanical stability of osseointegrated implant, which is negatively affected by changes on the external surface[8,9]. In this study, despite the torque application have caused dimensional changes on the hexagon surface, most of torques applied did not showed significant change. However, it is known that when there is significant change, pillar implant adaptation can be directly affected and some studies have showed a close relation between prosthesis mismatch and bolts loosening[25-29].

Once this study evaluated prosthesis platform deformation of implants with external hexagon connection *in vitru* and some changes were found in one of the groups tested, we suggest new methodologies and new tests to investigate dynamic or clinical conditions.

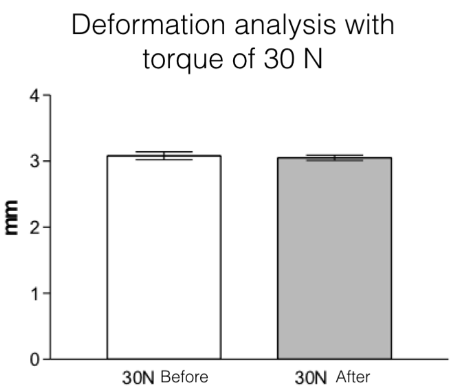
Graph 1. Platform measures performed before and after the 10N torque on the implants.



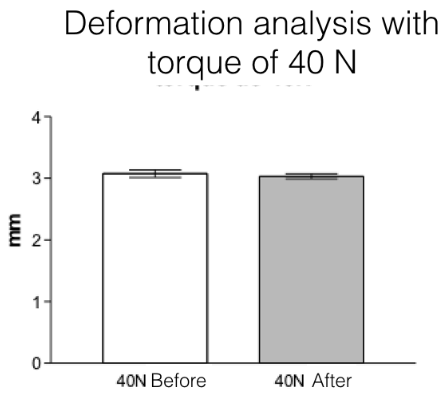
Graph 2. Platform measures performed before and after 20N torque on the implants.



Graph 3. Platform measures performed before and after 30N torque on the implants.



Graph 4. Platform measures performed before and after 40N torque on the implants.



Graph 5. Platform measures performed before and after 100N torque on the implants.

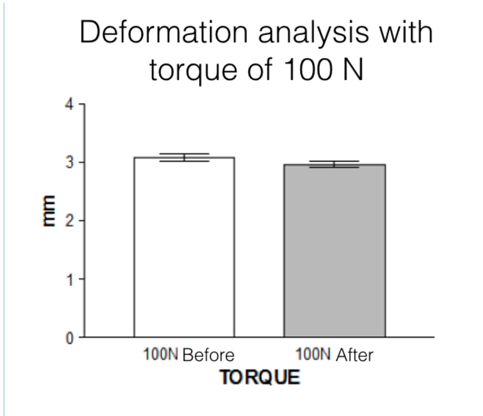


Table 1. Averages and standard deviations of groups 1, 2, 3, 4 and 5.

Groups	N	Average before	Average after	P value
1	5	3.079±0.1534	3.073 ±0.1469	0.1174
2	5	3.079±0.1519	3.066 ±0.1303	0.2287
3	5	3.081±0.1475	3.051 ±0.0981	0.2075
4	5	3.077±0.1538	3.033 ±0.1044	0.0870
5	5	3.080±0.1534	2.972 ±0.1177	0.0008

CONCLUSIONS

According to the methodology applied in this study, there was no deformation on the hexagon dental implants with torque 10, 20, 30 and 40N. However, applying 100N torque, dimensional changes showed up, but it did not damage the prosthetic components adaptation.

The work also suggests new methodologies and test types should be applied for better evaluation.

REFERENCES

1. Brånemark PI, Adell R, Breine U, et al. Intraosseous anchorage of dental prostheses. Experimental studies. Scand. J. Plast. Reconstr.Surg 1969;3:81-100.

2. Adell R, Lekholm U, Gröndahl K, et al. Reconstruction od severely resorbed edentulous maxillae using osseointegrated fixtures in imeddiate autogenous bone grafts. Int J Oral Maxillofac Implants 1990;5:233-46.

3. Isaksson S, Ekfeldt A, Alberius P, et al. Early results from reconstruction of severely atrphic (Class VI) maxillas by immédiate endosseus implants in conjunction with bone grafting and Le Fort I osteotomy. Int J Oral Maxillofac Surg 1993;22:144-8.

4. Jemt T. Regeneration of gingival papillae after single-implant treatment. In J Periodontics Restorarive Dent 1997;17:326-33.

5. Kay HB. Esthetic considerations in the definitive periodontal prosthetic management of the maxillary anterior segment. Int J Periodontics Restorative Dent 1982;2:44-59.

6. Wolffe GN, Van der Weijden FA, Spanauf AJ, et al. Lengthening clinical crowns- A solution for specific periodontal, restorative, and aesthetic problems. Quintessence Int 1994;25:81-8.

7. Ingber JS. Forced eruption. In: Marks, M. H.; Corn, H. (eds). Atlas of adult Orthodontics: functional and esthetic enhancement. Philadelphia: Lea & Febiger; 1989.

8 Degidi M, Daprile G, Piattelli A, et al. Evaluation of factors influencing resonance frequency analysis values, at insertion surgery, of implants placed in sinus augmented and nongrafted sites. Clin Implant Dent Relat Res 2007;9:144-9.

9. Turkyilmaz I, Sennerby L, McGlumphy EA, et al. Biomechanical aspects of primary implant stability: a human cadaver study. Clin Implant Dent Relat Res 2009;11:113-9.

10. Irinakis T, Wiebe C. Initial torque stability of a new bone condensing dental implant. A cohort study of 140 consecutively placed implants. J Oral Implantol 2009;35:277-82.

11. Alsaadi G, Quirynen M, Michiels K, et al. A biomechanical assessment of the relation between the oral implant stability at insertion and subjective bone quality assessment.J Clin Periodontol 2007;34:359-66.

12. Fanuscu MI, Chang TL, Akça K. Effect of surgical techniques on primary implant stability and peri-implant bone.J Oral Maxillofac Surg 2007;65:2487-91.

13. Tarnow DP, Margner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. J Periodontol 1992;63:995-6.

14 Stevão ELL. Implantes de hexágono externo e interno - uma breve revisão. Implantnews 2005;2:570-1.

15 Pimentel GHD, Martins LM, Ramos MB, et al. Perda ossea peri-implantar e diferentes sistemas de implantes. Innov Implant J, Biomater Esthet 2010;5:75-81.

16 Lenharo A, Luiz NE, Ciuccio RL, et al. Implantes de torque interno TRYON®. Boletim Informativo. Innov Implant J, Biomater Esthet 2010;5:70-4.

17. Mendes MTM, Ottoni J. Parâmetros para a formação de papila periimplantar. Implant News 2005;2:237-42.

18. Todescan FF, Bechelli A, Romanelli H. Implantodontia Contemporânea: Cirurgia e Prótese. Rio de Janeiro: Artes médicas; 2005.

19. Cano-Sánchez J, Campo-Trapero J, Sánchez-Gutiérrez JJ, et al. Mecanobiología de los huesos maxilares: II. Remodelación ósea. Av. Odontoestomatol 2008;24:177-86.

20. Trisi P, Todisco M, Consolo U. et al. High versus low implant insertion torque: a histologic, histomorphometric, and biomechanical study in the sheep mandible. Int J Oral Maxillofac Implants 2011;26:837-49.

21. Campos FE, Gomes JB, Marin C, et al. Effect of drilling dimension on implant placement torque and early osseointegration stages: an experimental study in dogs. J Oral Maxillofac Surg 2012;70:e43-e50.

22. Neves JB. Implantodontia oral, otimização da estética; uma abordagem dos tecidos mole duro. Belo Horizonte: Traccio Arte e Desing; 2002.

23. Feller C, Gorab R. Atualização na clínica odontológica. São Paulo: Artes Médicas, 2000. In: Neves JB. Implantodontia oral, otimização da estética; uma abordagem dos tecidos mole e duro. Belo Horizonte: Traccio Arte e Desing; 2002.

24. Gonzáles-Martín O, Lee EA, Veltri M. CBCT fractal dimension changes at the Apex of immédiate implants placed using undersized drilling. Clin Oral Impl Res 2012;23:954-7.

25 Davi LR, Golin AL, Bernardes SR, et al. In vitro integrity of implant external hexagon after application of surgical placement torque simulating implant locking. Braz Oral Res 2008;22:125-31.

26. Lang LA, Wang RF, May KB. The influence of abutment screw tightening on the screw joint configuration. J Prosthet Dent 2002;87:74-9.

27. Theoharidou A, Petridis HP, Tzannas K, et al. Abutment screw loosening in single-implant restorations: a systematic review. Int J Oral Maxillofac Implants 2008;23:681-90.

28. Malaguti G, Denti L, Bassoli E, et al. Dimensional tolerances and assembly accuracy of dental implants and machined versus cast-on abutments. Clin Implant Dent Relat Res 2011;13:134-40.

29. Carvalho MA, Queiroz CM, Molena CCL, et al. Estudo clínico da relação do torque de inserção dos implantes e sua osseointegração. Rev Bras Cir de Cabeça Pescoço 2008;37:202-5.

30. Karoussis IK, Bragger U, Salvi GE, et al. Effect of implant design on survival and success rates of titaniumoral implants: A 10-year prospective cohort study of the ITI_ dental implant system. Clin Oral Implants Res 2004;15:8-17.