Effect of different torque levels on the implant/abutment interface using castable “UCLA” abutments

Abstract
The abutment/implant interface has been reported as a significant factor on tensile transfer, adverse biological responses or prosthetic restoration complications. The abutment/implant junction success is directly related to pre-load attained during torque application. The purpose of this work was to assess the vertical fit/misfit degree on abutment/implant interface, when castable “UCLA” type abutments are used on fixed prosthesis process on implants, after different torque levels applications. Four three-unit fixed prosthesis were manufactured by the same laboratory. Torque was applied on the same framework using initially a 10 Ncm (T1) and later, a 20 Ncm torque level (T2) with a screwdriver hand Torquimeter. Through scanning electronic microscope (SEM), it was obtained two photographs corresponding to mesial and distal regions of each prosthesis unit, summing 24 assessed regions to each applied torque value. After submitting the results to statistical analyses Paired T-Test (p<0.05), a significant difference was seen between the average vertical fit/misfit degree: T1 = 23.53mm ± 20.20; T2 = 9.01m ± 11.69 (p=0.000). The misfit degree decrease when applied manufacturers recommended torques, could decrease mechanical (loosening or fracture of the screw) complications.

Key Words:
dental implants, prosthetic adjustment, torque
Introduction
The abutment/implant interface has been reported as a significant factor on stress transfer, adverse biological response or prosthetic restoration complications. Michalakis et al. reported two likely complications types inherent to a misfit of the prosthetic framework: a) biological – increased load transfer to bone, bone loss, and microflora development in the micro-gap between implant and abutment; and b) prosthetics – loosening or fracture of the screw and implant loss.

Due to periodontal ligament absence, implants are incapable to readily adapt to misfit restorations induced stresses. It should than, have a relative precision on fit between prosthesis and abutments, as also between prosthesis and implants, to the implant-supported restorations long term success. However, there’s no perfect fit, and thus, the clinicians should accept certain misfit level, which doesn’t affect the bone/implant interface health. According to early information about osseointegration, it is considered that an acceptable fit, values less than 10µm.

The screw tightening aim to maintain the union between components. However, during function, micro-gaps could be formed on the abutment/implant interface due to an untight abutment fixture, favoring bacterial invasion, as well as mechanical problems.

On every implant system the fixture joint system efficiency depends on several factors: the component design; connection geometry between implant and abutment; mechanical adjustment between fixture and its set surface on abutment; the mechanical and physical component properties and torque application.

The tension needed to maintain two parts of the same junction tightly united, either under static or dynamic conditions, is referred as preload. Surface imperfections lead to friction rising and to decreasing of such pre-load. Increasing the same is due to screw take off and consequent tightening. During abutment screw tightening, a compressive strength is generated to keep implant and abutment surfaces in touch. This joint success is directly related to attained pre-load during torque and for this preload maintenance with time. The fixture untightening, as also the pre-load reduction to critical levels, can compromise the joint stability, making a clinical failure more powerful.

Regarding to the screw tightening, some authors report that increasing the torque applied on screws, the compression between the facing surfaces is also increased, producing a greater stability on the joint.

In one study comparing the micro-leakage level on abutment/implant interface of five implant systems, varying the torque between 10 Ncm and 20 Ncm, the authors observed significant differences on micro-leakage between applied torques. There was a significant decrease when the torque was near to recommended values.

Due to a great misfit presented by UCLA abutment, this study aims to evaluate the vertical fit/misfit degree on abutment/implant interface, when using castable “UCLA” type abutments, with different torque levels.

Material and Methods
Four three unit fixed prosthesis were manufactured from a metallic matrix with three compatible Brånemark implants (3,75x10mm) (Conexão Sistemas de Prótese, Sao Paulo, SP, Brazil). Those were made of castable UCLA type abutments (Conexão Sistemas de Prótese, Sao Paulo, SP, Brazil), with nickel-chrome alloy (Verabond II, Albadent Inc., USA). The frameworks were united with conventional solder method. They were placed on the matrix, first with 10 Ncm torque (screwdriver hand Torquimeter, Conexão Sistemas de Prótese, Sao Paulo, SP, Brazil) (Treatment 1 – T1) so the first analyze could be done, using the scanning electronic microscopy (SEM, LEO 435 VP, GERMANY), at a x500 magnification. Later, the same frameworks were placed, with a 20 Ncm torque (Treatment 2 – T2), to the last analyze.

For each framework “dental unit”, two images were obtained, one mesial and other distal, making a total of 24 images. The images were printed using a laser printer (Laser Jet 1500L, Hewlett Packard, USA). From the printed photos, a ruler was built with the micrometers scale existing on the lower portion of the images, by a rule of three.

Tracing a line paralleled to the implant platform and other parallel to lower surface of the abutment the vertical fit/misfit value can be obtained, if it’s present. Looking for a better view of the results, the measurement site received a number (Table 1). Factors as visual accuracy, view angle, light and professional experience, were described by Kan et al., as the factors that could interfere on the accurate determination of misfit. To minimize those interference factors, three examiners were trained to the measurements. Statistical processing was done using the SPSS data program (SPSS/PC for Windows Inc., Chicago, IL). Parametric statistical test were used, with the Paired T-test for paired samples. A p-value less than 0.05 was considered statistically significant.

Results and Discussion
The three examiners mean values for vertical misfit after two torque levels apply (T1 and T2) are expressed in µm, on Table 2. As showed on table 2, all misfit values were larger when 10 Ncm load was applied, decreasing, in some cases, more than 35µm after applied torques of 20 Ncm load (as show regions 13 and 19, table 2). After 20 Ncm torque application sixteen analyzed regions presented values less than 10µm and figures 1 and 2 exemplify the best fit obtained with this torque level. The statistical analysis (Paired T-test) presented significant difference in the vertical fit among the two levels of applied torques (p=0.000), being lower when used 20 Ncm.
In the present study, a misfit until 10µm was considered as clinically acceptable\textsuperscript{9}, because an absence of perfect fit between abutment and implant\textsuperscript{9}.

A relative precision on the fit between prosthesis and abutment, as well as prosthesis and implant\textsuperscript{7}, is important for the long term success of implant-supported restorations\textsuperscript{1,8}. Because of the absence of ligament between bone and implants the restorations misfit could induce stresses on the marginal bone\textsuperscript{4}. An abutment-implant interface misfit could produce mechanical and biological problems\textsuperscript{2-5,11}.

Factors such as torque application were described like important characteristics for the efficiency of screw junction on implant systems\textsuperscript{12}. The casting process could change the mechanical performance and structural properties of the contacting surfaces during screws tightening, changing either, the frictional resistance value of the applied torque\textsuperscript{12}.
It could also compromise the junction stability, increasing to possibility of clinical failure\textsuperscript{15}. In the present study, when the castable UCLA and the casting process were used, the fit degree was significantly modified in relation to torque level. The present study observed a significant difference on fit degree between abutment/implant interface related to the screw applied torque. When applying different torque levels (10 and 20 Ncm), a lower misfit was observed when 20 Ncm was used. In this torque level, sixteen regions presented values clinically acceptable (less than 10\(\mu\)m), while 10 Ncm torque level presented thirteen regions with larger values than 10\(\mu\)m (table 2). Jörnéus et al.\textsuperscript{16} observed that when increasing the applied torque level on screws, the compression between the contacting surfaces also increases producing a greater stability on the junction and lower misfit. Screwed junctions with torques exceeding the recommended lower micromovement, without apparent system commitment\textsuperscript{11,14}. However, it agrees in part with such affirmative since in the situation of 10 Ncm torque greater misfit were observed. Nonetheless, applying torque greater than recommended can produce an exacerbated stress on screws. Still on the presence of a misfit in which the tow faces (implant platform and abutment base) are not in ideal screws. On another study varying torques between 10 Ncm and 20 Ncm, the authors observed that fluids and small molecules have the capacity of penetrating the abutment/implant interface of all studied systems. However, there are significant differences on micro-leakage between the 10 Ncm and 20 Ncm torques, decreasing significantly when the torque was near to the recommended values\textsuperscript{17}. In the present study, a lower misfit is observed when applying manufacturers recommended torques (20 Ncm), and it could difficult the microorganisms penetration on abutment/implant interface, decreasing the potential of biological risks to restorations. According to the results obtained in this study, the application of appropriate torques can decrease implant/abutment misfit, and thus could decrease mechanical (loosening or fracture of the screw) complications.

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References