EVALUATION OF SOME FACTORS THAT MAY AFFECT THE ACCURACY OF IMPLANT TRANSFER IMPRESSION

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ABSTRACT

Three implants were vertically arranged in a straight line parallel to one another in an acrylic block. Three impression transfers were manually tightened to the implants by 10 different operators and by a 30 N/Cm torque as a control. The distance between the transfers was measured under microscope from top and side views.

Three abutments were connected to the implants and an electroformed bridge was constructed to fit them. Four groups of impressions were made for the implants using abutments as an impression transfers and the ordinary transfers; both were tightened manually and by 30 N/Cm torque. Impressions were poured into stone using new implant analogues. Another two groups of impressions were made using abutments that were tightened manually and by torque, but the stone models were made using old implant analogues.

The abutments were connected to each stone model and the electroformed bridge was placed over them. The bridge seating was evaluated using a travelling microscope.

Conclusions: Within the limitation of this study:

1- On a microscopic scale, the tightening force of the transfer screw does affect its relation to the implant.

2- There is no practical difference between using the transfers or the actual abutments while making impression for implants, whether they were manually tightened or tightened with a controlled torque ratchet.

3- The repeated use of implant analogues for several times may affect the clinical accuracy of the transfer impression.
INTRODUCTION

Implants are more conservative than fixed bridges as it does not destroy healthy tooth structure. Since implants are indirectly restored, the relationship between the implants and the surrounding hard and soft tissues should be accurately transferred to the working models. Errors in transfer during the impression procedure reduce the possibility of the prosthesis passive fit. In addition, problems with articulation of the working cast, axial contour and interproximal contacts, open margins, lack of retention and resistance to displacement, and errors in occlusal relationships of the frameworks may occur. Several factors affect the accuracy of the transmission of this relationship: accuracy of impression and cast materials as well as the implant impression techniques. As a result of inaccurate transfer, two main clinical problems may develop, the poor marginal fit of the impassive framework and the abutment screw loosening.

In the majority of the implant systems, the abutment is fastened to the fixture by an abutment fixation screw. The recommended torque values are based on each manufacture system. The optimum preload is the tightening torque above the level of the initial contact force and falls within the material elastic range of the abutment screw. The screw is either tightened manually or mechanically. The amount of torque placed on the dental implant screw manually is operator dependent, under-torque and over-torque may occur. Moreover, experienced operators deliver varying amounts of torque to a dental implant screw. Under-torquing leads to screw loosening and over-torquing have been recommended to maintain better retention of the abutment screw. However, this might lead to fracture of the joint.

Screw loosening in implant dentistry is a problem facing many operators experienced or inexperienced. During tightening of an implant screw, a force is exerted causing a preload stress in the abutment screw within its elastic range. During function the abutment is subjected to external forces and stresses. It is at this point that the screw joint is said to be protected against external load applications as long as these external loads do not exceed the preload. When the preload is achieved, the screw will transmit the entire external load applied during function to the clamped parts. This protection is beneficial to the fatigue performance of the screw. However, when the total external load experienced by the screw is greater than the yield strength of the screw, then the protection afforded by the preload is lost and the joint becomes unstable, the potential for screw loosening and/or fracture exists.

Many factors affect the precision of fit between the framework and the implant structure as: the structure and properties of the different types of the implant materials, the accuracy during the transfer of the relationship of the implants to the working cast, the techniques and types of framework constructed, the dentist’s skill, and the torquing between the implant and the abutment that may affect the screw joint itself. The exact transfer of the implants’ position to the working cast may be considered of the most important factors. Any minute variation in this relationship, or any defect or deformation of the used materials, affects the framework’s accuracy of fit. Errors that result from the transfer of implant position during the impression procedures often make it necessary to section and solder metal frameworks repeatedly. Some operators modified the copings during recording the impression to decrease the possibility of inaccuracy.

The precision of fit of the framework is more important when fixed prostheses are connected to implants than to natural teeth as natural teeth have the ability to adjust to the misfit because of the mobility of the periodontal ligament. To insure long-term service precise fit must be present. Poor fit of frameworks leads to failure of the restoration as well as the supporting structures as a deformation of the surrounding bone in the form of compression between the implants.

This study was designed to
1. Evaluate the effect of the tightening force of the implant-transfer screw on the accuracy of recording the relationship between implants in the working cast.
2. Estimate the clinical acceptance of the fitness of a bridge framework to the implant abutments with the following variables:
   a. Manual torque versus controlled torque ratchet to fasten the transfers.
   b. Using the definitive abutment as transfers versus the regular transfers while making the impression.
   c. The repeated use of the implant analogues.

MATERIALS AND METHODS

1. Effect of tightening force of the impression abutment on their position in relation to implants

Three implants were vertically arranged in a straight line parallel to one another and secured in this position. Self cure Acrylic resin was poured on the assembly. This resulted in an acrylic block with 3 implants fixed in position (Figure 1). Three impression transfers were tightened to the implants. Using a sharp lancet, the transfers were marked with a fine scratch at the middle of the side corresponding to the buccal surface. The mark was extended to the top surface of the transfer (Figure 2). Marks on the first, second and third transfer were referred to as a, b, and c respectively. They were confirmed to be visible under a stereomicroscope with an electronic camera, specially designed for digital photomicrography, which was connected to a computer (Figure 3). On the computer’s monitor, three measurements were made to measure the distances between the transfers from both the lateral and top views (Figure 4):
   • Measurement 1, from a to b (distance between first and second implant)
   • Measurement 2, from b to c (distance between second and third implant)
   • Measurement 3, from a to c (distance between first and third implant)

The experiment measurements were done when a group of operators tightened the transfers manually. Five males (group B) and five females (group C) operators, with more than 3 years of clinical experience in implant dentistry, were asked to hand-torque the three transfers into the implants. The operators were seated in their normal operating position, wearing examination latex gloves and each operator was asked to tighten the transfers to the implant independently 5 separate times with the force normally used in clinical situations. The transfers were tightened ten separate times using a torque controlled ratchet at 30N/cm force to act as the control group (group A). Each time, the distance between the three transfers was measured from the lateral and top views.

1. Tapered Screw-Vent Implant System, Zimmer Dental Inc., USA.
2. Olympus Stereomicroscope with Olympus DP-10 Digital Camera, Olympus America, Inc., USA.
2. Effect of the impression method on the prosthesis fitness

The same acrylic model was used in this part of the study. Three crown and bridge abutments were fastened to the implants using the 1.25mm hex driver and the 30 N/Cm torque controlled ratchet. An impression was made for the abutments and poured directly into extra hard stone. On that model, an electroformed gold bridge restoration was made and tried on the abutments (Fig. 5); this bridge was considered as a master bridge.

Seven groups of transfer impressions were made, by different methods, for the implants using mechanically mixed polyether impression material in an indexed custom acrylic tray to control the impression variables every time the impression was taken. Impression was then removed and transfers were unscrewed from the implants. Implant analogue was attached to each impression coping, snapped into its place in the impression, boxed and poured in extra-hard stone.

The transfers were removed and replaced by the abutments on the stone model. Then the bridge was seated on the abutments by applying gentle finger pressure. The accuracy of seating of this bridge was measured in 16 marked locations: 6 marks buccally (2 for each abutment), 6 marks lingually (2 for each abutment), and 2 marks at the side of each peripheral abutment.

The accuracy of seating was represented by the vertical distance between the bridge margin and a groove on the abutment at definite marked points. This was measured using a travelling microscope\(^1\) with 1µ accuracy. Each measure was repeated five times for each model obtained from the following groups of impression methods:

- Group 1: using manually tightened transfer.

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\(^1\)Nikon SC-102
• Group 2: using transfer tightened with controlled torque.
• Group 3: using an abutment as a transfer that was manually tightened.
• Group 4: using an abutment as a transfer that was tightened with controlled torque.
• Group 5: using an abutment as a transfer manually tightened to a used implant analogue.
• Group 6: using an abutment as a transfer tightened with controlled torque to a used implant analogue.
• Group 7: (control group) bridge on the acrylic master model tightened with torque.

To properly function as impression transfer in groups 3, 4, 5 and 6, the abutment were modified by cementing custom made metal caps on them (Fig 6). These caps provided flat sides and undercuts to resemble transfers.

Statistical analysis was carried out using SAS program. Student t test (Procedure T-TEST of SAS) was run to compare the effect of new and old analogues. One way analysis of variance (Procedure ANOVA of SAS) followed by Duncan’s multiple Range Test were used to test the effect of techniques on bridge fitness and distance between analogues. Data were presented as mean and standard deviation values in tables 1 and 2.

**RESULTS**

1- The effect of tightening force on the accuracy of recording the relationship of the implants to the working cast

Table 1 shows the means and standard deviation values, ANOVA and Duncans test results for the effect of different operators’ forces on the distance between the transfers from the top and lateral views. Statistically significant difference was found between each group, with the males’ mean tightening forces value being closer to the mean control group value.

**TABLE (2) The means, standard deviation values of the effect of modified impression techniques on the fitness of the frameworks to the abutment/implant.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Analogue</th>
<th>Mean (µ)</th>
<th>S.D.</th>
<th>dt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer - manual (group 1)</td>
<td>new</td>
<td>189.250</td>
<td>57.2302</td>
<td>a</td>
</tr>
<tr>
<td>Transfer with controlled torque (group 2)</td>
<td>new</td>
<td>176.3250</td>
<td>42.23610</td>
<td>a</td>
</tr>
<tr>
<td>Abutment - manual (group 3)</td>
<td>new</td>
<td>166.0000</td>
<td>50.14343</td>
<td>a</td>
</tr>
<tr>
<td>Abutment with controlled torque (group 4)</td>
<td>new</td>
<td>165.0833</td>
<td>44.28104</td>
<td>a</td>
</tr>
<tr>
<td>Abutment controlled torque (group 5)</td>
<td>old</td>
<td>1445.700</td>
<td>89.90000</td>
<td>b</td>
</tr>
<tr>
<td>Abutment- manual (group 6)</td>
<td>old</td>
<td>234.8000</td>
<td>34.80000</td>
<td>c</td>
</tr>
<tr>
<td>Control (group 7)</td>
<td>new</td>
<td>148.5000</td>
<td>30.08488</td>
<td>a</td>
</tr>
</tbody>
</table>

*S.D.* = Standard deviation.  
*dt* = Duncans Multiple Range Test.  
Means with the same letter within each column are not significantly different at p≤0.05.
The effect of using abutments as an impression transfers on the fitness of the bridge framework when using used and unused analogues:

Table 2 shows the means and standard deviation values of ANOVA and Duncans test of the effect of using modified abutments as impression transfers on the framework seating on the abutments. It also compares the framework seating in case of manual and torque controlled tightening of both transfers and abutments while making the impression. Both impression techniques gave insignificant results between the four groups.

Table 2 also compares the means, standard deviation values of ANOVA and Duncans test of the effect of using new and old analogs on the fitness of the framework to the abutments. A remarkable misfit of the framework to abutments was found when old analogs were used.

**DISCUSSION**

Passive seating of the suprastructure whatever fixed or removable is of paramount importance for the long serviceability of the implants. Clinically the suprastructure in many cases with natural teeth can be seated while applying some pressure. Sometimes the patient may tolerate this situation and adapt to it. But this is not applied to implant supported prosthesis where undue forces will be applied continuously especially in fixed restoration cases. On the long run this may not be tolerated by the supporting bone and may affect the implant prognosis. However, with removable restorations, the problem is less but still present as the restoration is not continuously seated in the patient mouth.

Errors in transfer during the impression procedure reduce the possibility of the prosthesis passive fit. Tightening the screw attaching the transfer to the implant is an important point to be considered. The mean habitual closing torque of different operators is not constant. It was found that individual finger forces differ by gender, and not by hand dimension and age. It is also reported that some male operators do not normally apply maximum possible tightening force clinically for fear of endangering the osseointegration. Thus, to obtain optimal preload in the screw with least transmission of force to the bone, it is recommended to use an appropriate torque driver.

In this study, tightening the screw manually by different individuals was different than that done with the controlled torque ratchet. This difference was clearly reflected in the measurements done under the microscope which indicates that different screw torquing does affect the position of the transfer in relation to the implant. However it seems that the effect of this microscopic difference does not clinically exceed the acceptance level of accuracy as manifested by the insignificant difference in bridge seating in manual and definite torque groups.

The results of this study showed no difference between manual torquing and controlled torquing during
impression making, this may be attributed to using the same method of torquing during impression making, model pouring and abutment tightening for testing the bridge seating on that cast. However it looks that the force used during screw tightening is important as its variation during different steps of construction from one subject to another, for example the dentist and the laboratory technicians, may be reflected on the passive seating of the final prosthesis. This may be avoided by using a fixed torque during clinical and laboratory steps through the use of controlled torque ratchets. This point needs further investigation using definite variable torques during different steps.

It was clear from this study that using old implant analogue does not allow the transfer or the abutment to be precisely positioned in place, so the resulting model will not accurately represent the real situation and the restoration may apply undue forces to the implants. Thus the implant analogue should be used for only one time or be fabricated from a rigid material that does not deform easily under tightening force.

Many implant systems in the market now use a single component to act as an implant insertion mount, to do the function of an impression transfer, and used as final abutment. Although the results of this study showed no clinically significant difference between using the traditional transfer and the use of abutment as a transfer during impression making, a potential disadvantage of this technique may occur in the multiple screwing and unscrewing of the abutment many times that may deteriorate the hex angles of the implant-abutment joint, leading to less accurate fitting between them.\(^{29-31}\) However, repeated torquing does not affect the ultimate strength of the screw itself.\(^{22,33}\)

**CONCLUSIONS**

Within the limitation of this study the following may be concluded:

1. On a microscopic scale, the tightening force of the transfer screw does affect its relation to the implant.

2. There is no practical difference between using the transfers or the actual abutments while making impressions for implants, whether they were manually tightened or tightened with a controlled torque ratchet.

3. The repeated use of implant analogues for several times may affect the clinical accuracy of the transfer impression.

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**REFERENCES**


