International Poster Journal IPJ of Dentistry and Oral Medicine

Int Poster J Dent Oral Med 2002, Vol 4 No 3, Poster 140

Comparison of the Transfer Precision of Impression Materials for the FRIALIT®-2 System

Language: English

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Date/Event/Venue:
April 15-17, 1999
8th International Congress on Reconstructive and Preprosthetic Surgery
San Diego, USA

Transfer of the precise position of implants to a master cast is a prerequisite for an accurate and passive fit of the superstructure. Implants lack the mobility of natural teeth and therefore inaccurate frameworks result in stress within the mechanical parts and the implant-bone interface. Various impression methods have been described to achieve accurate reproduction of the intra-oral relation of the implants.
The aim of this experimental study was to compare three different impression materials (polyether, polyvinylsiloxane, hydrocolloid) with the FRIALIT®-2 system and the indirect technique. In addition, the use of TransferCaps to improve the transfer precision was tested with all three materials. All measurements were performed using a 3D co-ordinate measuring machine that is capable of locating points in space and calculating the relative distortions as angles of tilt (rot-xy, rot-xz, rot-yz) and 3D displacement.
The results suggested that addition silicone and polyether are the materials of choice for implant transfer procedures. The use of transfer caps resulted in a significantly reduced rotation in the xy-plane, but did not improve the absolute 3D displacement. Addition silicone with the use of TransferCaps proved to be most precise. The comparison between polyether and polyvinyl siloxane showed significant differences in the xy-rotation and the 3D displacement in favour of the silicone.
Since the mean distortion between the original model and the master casts were about 100 µm, absolutely precise fit may be unattainable due to the physical properties of the materials. Further studies will have to evaluate the amount of tolerable stress at the implant-bone interface.

Introduction

The main objective of contemporary implant prosthodontic techniques for working cast fabrication is to relate implant analogs in the same manner as the implants, or abutments, are related intra-orally. The technique of component transfer demands accurate inter-implant dimension transfer to achieve the requirement of a passively fitting prosthesis (Humphries et al. 1990, Carr 1991). The indirect transfer requires fastening a transfer coping to the implant and making the impression. Upon completion of set, the impression is removed from the mouth, leaving the transfer coping fastened in place. It is removed and attached to an appropriate analog, then positioned into its respective impression space. Due to their favorable physical characteristics, their stability concerning dimension as well as their simple clinical applicability, polyether and polyvinylsiloxane proved to be particularly suited for conventional and implant-borne restorations (Eames et al. 1979, Wichmann et al. 1990, Chee & Donovan 1992, Hung et al. 1992, Liou et al. 1993, Idris et al. 1995).

Materials and Methods

The original model used was an edentulous Frasaco model representing 8 FRIALIT®-2 implant analogs (FRIADENT GmbH, formerly FRIATEC AG, Mannheim, D). Three 5.5 mm implant analogs were polymerized in the positions 16, 26 and median. They were connected to telescopic abutments and served as reference points for the measurements. Abutments on the right side were provided with TransferCaps (TC), which should reduce distortion due to imprecise reposition of the transfer copings into the impression. The four abutments on the left side were left without transfer caps.

Fig. 1

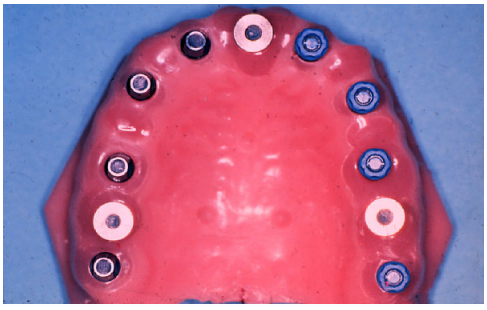

Fig. 2

Impressions: Under clinical conditions 6 impressions of this original model were taken with each of the following three materials:

1. Polyether (elastomer, Impregum® F polyether-impression material, Espe, Seefeld, D; DIN EN 24823/ISO 4823 Type 2 - mean consistency, ADA type 1, Spec. No. 19) with a custom acrylic tray (Palatray LC, Heraeus Kulzer GmbH, 61269 Wehrheim, D).
2. Polyvinyl siloxane (elastomer, a[ddition reaction]-silikon, BLEND-A-GUM®, Procter & Gamble Vienna, A; DIN 13913/ISO 4823 type 1 group A high consistency, ADA type 1, Spec. No. 19 and DIN 13913/ISO 4823 type 1 group C low consistency, ADA type 1, Spec. No. 19) with a Rimlock tray.
3. Hydrocolloid (AKKULOID Reversible Hydrocolloid Tray Material; RUBBERLOID Reversible Hydrocolloid Prefabricated small sticks, Van R Dental Products, Inc., Oxnard, CA 93033, USA).

Impression material	number of casts	number of implants	implants without TransferCaps	implants with TransferCaps
polyether	6	48	24	24
polyvinyl siloxane	6	48	24	24
hydrocolloid	6	48	24	24

Measurements: The measurements of the implant positions at the original model and the master casts were performed using a 3D co-ordinate measuring machine (ECLIPSE-Portalmeßmaschine, ZEISS Industrielle Meßtechnik Austria GmbH, Graz, A). This device has a processor-controlled measuring arm with a measuring precision of 0.003 mm. Since the change in position from the original model to the master model represents a complex spatial move consisting of a translation, tilting in two planes and, additionally, a rotation around the longitudinal axis, four parameters were used to describe and evaluate the precision of the transfer methods; i.e.: x-, y- and z-co-ordinates of the 3D displacement (LDV) and the angle of tilt about xz -, yz- and xy -plane (rot-xz, rot-yz, rot-xy).

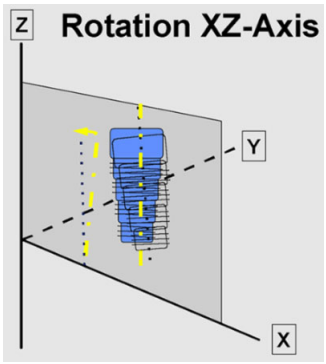

Fig. 3

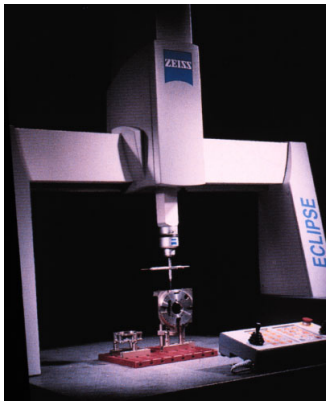

Fig. 4

Results

TransferCaps (TC)
There was only a differentiation between application and non-application of the TCs (n = 72). The following statistically significant differences could be evaluated: ROT-XY (p > 0.001) is significantly higher without the application of TC (3.4 + 0.7) as compared to application of TC (0.2 + 0.04). ROT-XZ (p = 0.002) is also significantly higher without TC (0.28 + 0.03) than with TC (0.17 + 0.02). With the remaining variables ROT-YZ (0.38 + 0.04 without TC to 0.43 + 0.04 with TC), and LDV (0.136 + 0.014 without TC to 0.133 + 0.01 with TC) there were no statistically significant differences.

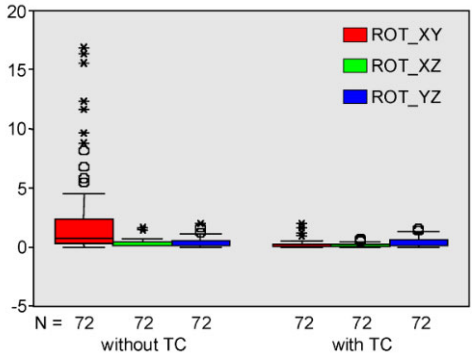

Fig. 5

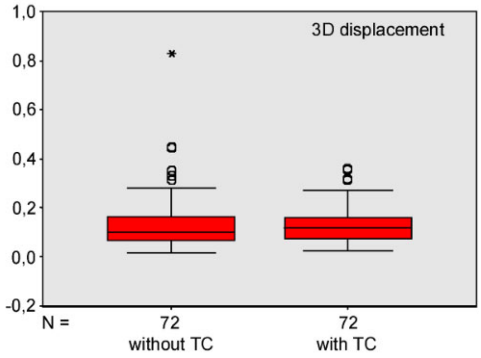

Fig. 6

Impression Materials
Figures show a comparison of impression materials irrespective of an application of TCs (n = 48). polyether, addition-silicone and hydrocolloid. There are significant differences concerning the variables LDV ($p < 0.001$) and ROT-XY ($p < 0.001$). A direct comparison between Impregum (polyether) and Blend-a-Gum (a-silicone) carried out on the basis of the Mann-Whitney U test has also revealed significant differences with these very variables, however, with a different significance level from the three materials, namely LDV ($p = 0.046$) and ROT-XY ($p = 0.012$). In both cases better results were achieved with Blend-a-Gum.
Figures represent box plots which result from the measuring values under consideration of both the impression material and the TransferCaps. With a statistical comparison of the six groups (n = 24) the analysis of variance according to Kruskal-Wallis reveals significant differences concerning the variables LDV ($p = 0.0039$) and rot-xy ($p < 0.0001$).

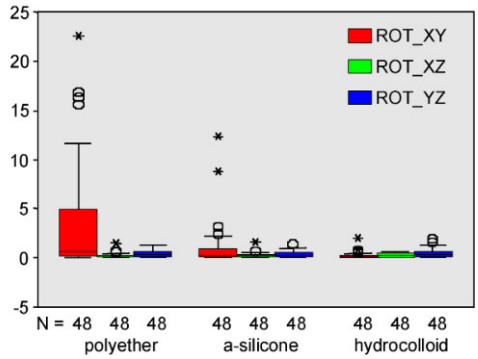

Fig. 7

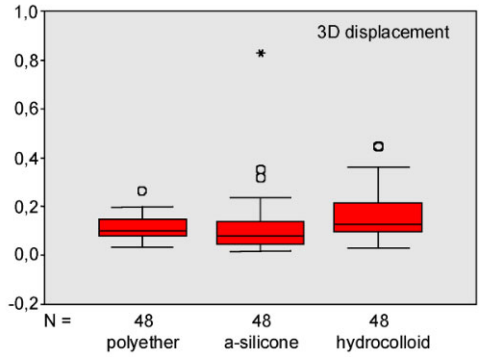

Fig. 8

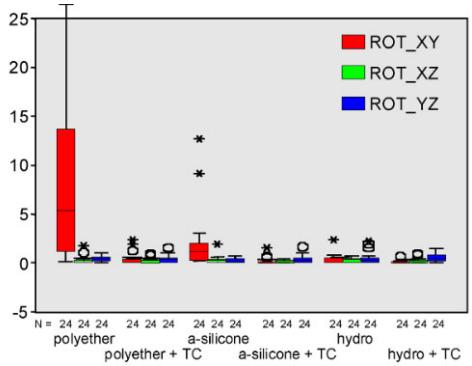

Fig. 9

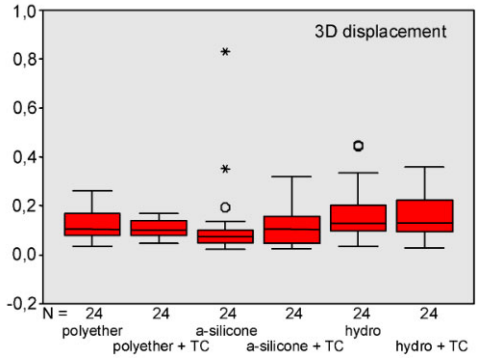

Fig. 10

The rank sum comparison reveals that the impression with a-silicone and TransferCaps occupies the first rank, followed by the method with a-silicone but without TC and Impregum with TC. Impregum without TC and hydrocolloid with/without TC show poorer results.

	3D displace	rot-xy	rot-xz	rot-yz	SCORE	RANK
Polyether	12	18	11	16	57	6
Polyether + TC	11	10	7	12	40	3
A-silicone	4	15	14	4	37	2
A-silicone + TC	9	4	9	8	30	1
Hydro	12	11	16	6	45	5
Hydro + TC	15	5	6	17	43	4

Discussion

The results of our investigation showed a significant reduction of the distortion in relation to the xy-plane with the use of transfer caps. Through their two flattened sides the transfer copings guarantee an appropriate reseat in the transfer caps in the impression. This mechanism reduces mainly the rotation in the xy plane. The deviation on the xz plane equally revealed a significant improvement following the application of transfer caps.
With the 3D displacement, on the other hand, the comparison with/without TCs showed no significant change in the measuring values. If, apart from the TCs, we also take into account the individual impression materials, no significant changes were shown concerning the 3D displacement between Impregum, Blend-a-gum and hydrocolloid. With Impregum the deviations on the xy plane while using TCs were significantly lower while there were no significant changes to be seen on the other two planes. The measuring values with Blend-a-gum revealed the same tendencies: here, too, the differences were only significant on the xy plane in favour of TC application.
The double-mix technique was introduced with the intention of replacing the custom tray with the putty material of high consistency (heavy body) (Idris et al. 1995). In the context of preliminary investigation - which did not render any improvements as to precision by using a custom tray in connection with a-silicones, this assumption was confirmed (Lechner 1995) and, for this reason, an acrylic resin custom tray was not used with a-silicones in this experiment. These results were backed up by a publication by Valderhaug and Foystrand (1984) who did not find any difference between stock trays and custom trays with Impregum.
The ranking of materials in our investigation revealed no significant difference between Impregum with TransferCaps and Blend-a-Gum with TransferCaps although the a-silicone showed a significantly better performance concerning deviations on the xy plane and the 3D displacement. The impressions with hydrocolloid rendered significantly poorer results than the elastomers, a fact which is first and foremost due to the less favorable elastic characteristics of the reversible hydrocolloid.

Conclusion

The results of our experimental study indicate, that polyether and addition reaction silicone in combination with the use of acrylic resin TransferCaps are the materials of choice for transfer procedures with the FRIALIT®-2 system. Since the mean distortion between the original model and the master casts were about 100 µm, absolutely precise fit may be unattainable due to the physical properties of the materials. Further studies will have to evaluate the amount of tolerable stress at the implant-bone interface.

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Poster Faksimile: