Accuracy of Impressions Obtained with Dual-Arch Trays

Bernd Wöstmann, Dr Med Dent[a]/Peter Rehmann, Dr Med Dent[b]/Markus Balkenhol, Dr Med Dent[c]

This study aimed to analyze the accuracy resulting from dual-arch impressions when compared to conventional impressions in complex preparations (ie, inlay and partial crown). One hundred eighty impressions were made using two different dual-arch trays; conventional trays served as the control. The accuracy of the dies obtained (Fuji-Rock EP, GC Europe) was assessed indirectly from the change of 59 transversal dimensions. Statistical analysis (*t* test, analysis of variance) revealed that less rigid dual-arch trays performed better than rigid ones. Though the inlay preparation was more difficult to reproduce with dual-arch trays, it can be concluded that the accuracy obtainable with nonrigid dual-arch trays is comparable to impressions taken from full-arch trays. *Int J Prosthodont 2009;22:158–160*

Though dual-arch impressions in a closed mouth impression technique were introduced nearly 20 years ago and have become very popular since, scientific data regarding their accuracy are still rare. The studies available focus mainly on the transversal dimensions of full crown preparations.[1–4] More complex preparations (ie, inlay and partial crown) have yet to be investigated. Thus, it was the aim of this study to assess the accuracy of dual-arch impressions in comparison to conventional full-arch impressions in more complex preparations.

The following null hypotheses were tested: *(1)* dimensions of working dies from a conventional impression do not differ from those obtained with dual-arch trays, *(2)* die dimensions are not influenced by preparation design, and *(3)* die dimensions are not influenced by impression material.

[a]Professor, Department of Prosthodontics, Justus-Liebig University, Giessen, Germany.

[b]Department of Prosthdontics, Justus-Liebig University, Giessen, Germany

[c]Assistant Professor, Department of Prosthdontics, Justus-Liebig University, Giessen, Germany.

Correspondence to: Prof Dr Bernd Wöstmann, Department of Prosthodontics, Schlangenzahl 14, D - 35392 Giessen, Germany. Fax: +49-641-9946 139. Email: Bernd.Woestmann@dentist.med.uni-giessen.de

Materials and Methods

A stainless steel cast of a right mandibular arch with a partial crown, mod-inlay, and full crown preparation was completed using resin teeth (KaVo) in a full mandibular arch cast and mounted to an articulator with a corresponding antagonistic cast of the maxilla (Fig 1). Ten impressions were taken with each material/tray combination (Tables 1 and 2). For the dual-arch impressions, the complete closure of the articulator was verified with 8-μm-thick shim stock foil (Roecko). All impressions were visually inspected and repeated in case of inaccuracies (eg, voids, material separating from the tray). Vacuum-mixed type IV dental stone (Fuji-Rock EP, GC Europe) was used to pour the impressions, including the opposing parts, for all dual-arch impressions. All casts were stored at room temperature (23 ± 1°C) for a minimum of 7 days.

A microscope (M420, Leitz) was used to determine the x, y, and z coordinates of all reference marks depicted in Fig 2. The reproducibility of the measurement was 5 μm on the horizontal plane, 10 μm on the vertical plane, and 30 μm for the reference marks denoted with an "X" (Fig 2). These reference marks were excluded from further analysis.

From all coordinates obtained, every possible dimension (n = 59) in between two of the reference marks for a single tooth was calculated, and the relative linear dimensional deviation from the master cast was computed.

Fig 1 Study setup of mandibular master cast and opposing cast mounted in a SAM-II articulator.

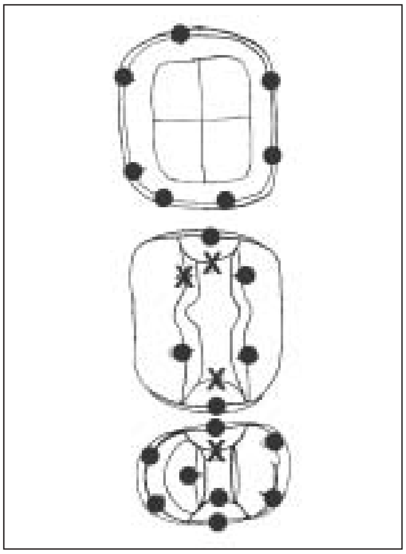

Fig 2 Drawing of relevant part of the master cast. Bullets denote location of reference marks. **X** = reference marks excluded from analysis due to reduced recognizability on the gypsum casts resulting in insufficient reproducibility of the measurement.

Table 1 Trays Under Investigation*

Tray	Manufacturer	Type
Bite Relator 2000 XI (BR)	Temrex	Metal framework
Triple Tray (TT)	Premier	Plastic framework
Schreinemakers stock tray (SM)	Clan BV	Conventional: Full metal tray
Custom tray (CT) (Palatray XL)	Heraeus Kulzer	Conventional: Full custom tray

*All trays were coated with the respective tray adhesive (see Table 2).

Table 2 Materials Used*

Material	Manufacturer	Chemical nature	Tray type used	Adhesive used
Impregum Penta	3M ESPE	Polyether	BR, TT, CT	Polyether adhesive (3M ESPE)
Honigum-MixStar Mono	DMG	Polyvinyl siloxane with wax matrix	BR, TT, CT	Honigum tray adhesive (DMG)
Panasil putty soft / Panasil contact plus†	Kettenbach	Polyvinyl siloxane	BR, TT, SM	Panasil tray adhesive (Kettenbach)

*All materials were used according to manufacturer recommendations.
†Applied in a one-step double mixing technique.

All data sets were subjected to a Kolmogorov-Smirnov test ($P = .05$) to check for normal distribution and the Levene test ($P = .05$) to check for homogeneity of variances. As the values were normally distributed and the Levene test revealed a satisfactory level of homogeneity of the variances, a *t* test was used to analyze the differences between the conventional impressions (CI) and the Triple Tray (TT) and Bite Relator (BR) impressions. A one-way analysis of variance (ANOVA) was carried out to identify possible influences on the different tray types, the preparation, and the impression material.

Results

Differences between the master cast and working dies ranged from 0.12% ± 0.26% (CI) to 0.26% ± 0.26% (BR). Dimensional aberrations in the BR impressions were significantly larger than in the CI. The accuracy achieved by TT was comparable to the CI in the partial and full crown preparation (Table 3). The ANOVA (Table 4) revealed tray and preparation type as the decisive factors regarding accuracy, whereas the influence of the impression material was negligible. Consequently, parts *(1)* and *(2)* of the null hypothesis were rejected.

Table 3 Results: Overall Discrepancies (n = 90)

Tray type/		Inlay		Partial crown		Full crown		Overall error	
Impression material	n	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD
Bite Relator (BR)**								0.264	0.262
Impregum Penta	10	0.624	0.181**	0.373	0.286**	0.151	0.116**		
Honigum Mono	10	0.388	0.235*	0.189	0.248	0.217	0.175		
Panasil	10	0.037	0.270	0.156	0.178	0.238	0.174		
Overall	30	0.350	0.332**	0.240	0.252*	0.202	0.156		
Triple Tray (TT)								0.162	0.214
Impregum Penta	10	0.235	0.330	0.234	0.227*	0.134	0.215*		
Honigum Mono	10	0.350	0.163*	−0.052	0.150	0.115	0.090**		
Panasil	10	0.172	0.221	0.127	0.252	0.150	0.262		
Overall	30	0.252	0.251*	0.103	0.238	0.133	0.196		
Conventional Impression (CI)								0.120	0.260
CT Impregum Penta	10	0.126	0.234	0.036	0.161	−0.050	0.114		
CT Honigum Mono	10	0.106	0.319	−0.034	0.230	0.354	0.195		
SM Panasil	10	−0.003	0.318	0.250	0.155	0.296	0.250		
Overall	30	0.076	0.288	0.083	0.217	0.199	0.261		
Total	90	0.226	0.310	0.142	0.244	0.178	0.209		

*$P < .05$.
**$P < .01$.

Discussion

All trays produced dies within a clinically relevant standard.[5] Though in some groups the dual-arch trays performed better than the conventional, it must be noted that, especially in the inlay preparation, the CI tended to be superior. Thus, the geometry of the preparation seems to have a notable impact on accuracy. However, the severe dimensional errors reported by Larson et al[3] are not reflected in our data. This may be due to the experimental setup. Larson et al[3] deflected the tray during impression taking by pressing it onto a simulated torus mandibulae, which is not the standard clinical situation. In our study, without this deflection the flexible TT performed better than the rigid BR, which is in good agreement with Ceyhan et al.[6]

It is hypothesized that it is not the primary stiffness of a tray but its tendency to reset after deformation that is the crucial factor for impression accuracy and the problem lies not with the actual deformation but the elastic recovery of the tray. The analysis of a potential influence of soft tissue pressure (ie, tongue, vestibule) on the deformation of a dual-arch tray is hardly possible in an in vitro setup and consequently has to be assessed in a clinical trial.

Conclusion

In this study, all impression trays produced dies within a clinically relevant range. Within the limitations of this study it can be concluded that dual-arch trays—especially when flexible—are an acceptable alternative to conventional impression-taking techniques.

Table 4 Results of the ANOVA

Factor	*P* value
Tray type (TT)	< .001
Impression material (IM)	.337
Preparation type (PT)	< .05
TT * IM	< .001
TT * PT	.08
IM * PT	< .001
TT * IM * PT	.033

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