BUTTERWORTH HEINEMANN

Journal of Dentistry Vol. 23, No. 1, pp. 21–26, 1995

0300-5712/95 $10.00 + 0.00

Treatment times for three different types of veneer restorations

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ABSTRACT

In a longitudinal clinical trial the treatment times needed for the fabrication of veneer restorations (VRs) were recorded and analysed. Treatment times were determined for: (1) direct resin composite (DC), (2) indirect resin composite (IC) and (3) porcelain (P) veneer restorations and for two preparation designs, with and without incisal coverage. Significant effects on the treatment times were found for the factors: (1) type of VR, (2) operator, (3) number of VRs and (4) 'problems' in try-in phase for indirect VRs (IC- and P-VRs). The mean total time needed to perform one DC-VR was 46 min with a 95% confidence interval (c.i.) of 40–54 min, for one IC-VR 70 min (c.i. 60–82 min) and for one P-VR 62 min (c.i. 53–71 min). In the cases where more than one VRs were placed in one patient the times per VR were respectively: DC, 38 min (c.i. 34–44 min); IC, 59 min (c.i. 52–67 min); P, 49 min (c.i. 44–55 min). The results of this study are considered to be useful in further cost-benefit analyses.

KEY WORDS: Veneers, Cost analysis

J. Dent. 1995; **23**: 21–26 (Received 22 October 1993; reviewed 17 January 1994; accepted 6 March 1994)

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INTRODUCTION

A popular option for aesthetic correction of anterior teeth is the veneer restoration (VR). Since the first publication on the bonding of VRs using the etching acid, many studies have followed on this subject aiming to improve the technique and increase its use[1, 2]. At present the most common techniques for veneering are direct or indirect resin composite or ceramic VRs. After a number of publications including clinical procedures several articles were published including clinical results[3–8]. Until now no research has been published on the costs and benefits of these restorations. Cost-benefit factors are important in decisions making on dental treatment alternatives. The benefits for the patient in terms of function, comfort and survival time are still unknown. The costs depend on the dentist's fee and the expenses for dental materials and dental laboratory work.

This study aimed to determine the treatment times for VRs and to identify factors influencing these times.

MATERIALS AND METHODS

This analysis was part of a clinical trial that was originally designed to test the influence of a number of clinical variables on the survival of VRs.

In this trial 180 veneer restorations of three different materials and two preparation designs were placed by seven dentists working in the Dental School of Nijmegen. The restorations were placed on central and lateral incisors in the maxilla for aesthetic reasons (62% discoloration, 24% deviation of position and 14% deviation of shape).

The three types of veneer restorations were:

1. Direct resin composite, referred to as type DC (Silux Plus, 3M Co., St Paul, MN, USA).
2. Indirect resin composite, referred to as type IC (Denta color, Hereaus Kulzer GmbH, Wehrheim, Germany).
3. Porcelain, referred to as type P (Flexo-ceram, Elephant Ceramics, Hoorn, The Netherlands).

Table I. Factorial design and sample sizes of the different treatment combinations

	Type DC	*Type IC*	*Type P*
prep. 1	60	30	30
prep. 2	—	30	30

DC, direct resin composite; IC, indirect resin composite; P, porcelain; prep. 1, no reduction of the incisal edge; prep. 2, reduction of the incisal edge.

The materials and the operators were assigned using a number of balancing criteria, including: age, sex, reason for making a VR, number of restorations present in the tooth to be restored as well as in the whole dentition, and number of teeth to be treated.

In the case of the indirect techniques (IC and P) a minimal preparation depth of 0.6 mm was required.

The preparation designs were mainly determined by differences in the incisal region and in the cervical region. In the cases where two contralateral incisors (i.e. two central incisors or two lateral incisors) were to be treated with one of the indirect techniques (i.e. type IC or type P), one of the two possible preparation designs of the incisal edge was assigned to one of the teeth. Then the other preparation design was chosen for the other tooth. The preparation design was assigned by balanced drawing using the criteria occlusion on the teeth. The preparation of the incisal edge consisted either of no incisal reduction (preparation 1) or an incisal reduction of the tooth of 1.5 mm with a short bevel at the palatinal side of the edge (preparation 2) (*Table I*). No incisal reduction was performed in DC-VRs.

The preparation of the cervical region was determined by the severity of discoloration of the teeth: in cases of non-discoloured teeth chamfer preparation was undertaken, while in cases of discoloured teeth a shoulder preparation was chosen to mask the discoloration.

At the phase of checking the fit and shade of the veneers 13 porcelain VRs (22%) had to be remade because the shade was judged to be unsatisfactory by the patient and the operator. These VRs were excluded from the analysis. At the second try-in phase three VRs were still unacceptable. Ultimately three VRs were made with the direct resin composite technique which were acceptable for the dentist and patient. For the IC type 13 VRs (21%) were unacceptable because of a mismatch in shade, and these had to be remade. Four restorations were made with the direct resin composite technique. Furthermore one tooth fractured on removal of the temporary provision and was restored with a crown.

Operators

Seven dentists were involved in inserting the VRs. All the operators were part-time University staff-members and part-time general practitioners (1–24 years since graduation). The experience of the operators in using the various type of VRs varied wildly. None of the operators had experience with indirect resin composite veneer restorations. Three operators had some experience (less than five VRs) with porcelain VRs. All operators had some experience with direct resin composite VRs, while two dentists had placed more than 50 direct resin composite VRs before participating in this study.

Selection of patients

Subjects for this study were selected from a group of 112 patients taking part in the clinical trial on VRs. These patients were treated with one or more restorations with a maximum of six. However, a maximum of two VRs per patient was included in this part of the study. The other VRs were excluded.

For the analysis of most of the factors considered to influence the treatment time, only one VR per person was selected (always preparation 1). Only for analysis of the factor 'preparation design' were two contralateral teeth with different preparation designs (with and without incisal reduction) included.

Clinical procedures

The direct VRs were made in one session. For the indirect VRs two sessions were required. The dentists were assisted by a dental nurse. All operators followed the same written protocol as described in *Table II*.

For each step the time required for the clinical procedures was recorded in minutes. If significant deviations in the protocol occurred for a certain part of the procedure, these data were excluded from the analysis.

Factors influencing treatment time

Within the context of the given study design a number of factors were considered to influence the treatment time (*Table III*).

The factors 'operator' and 'type of VR' were experimentally assigned. The factors 'number of VRs' and the 'shade of the teeth' were patient-dependent variables. The factor 'shade determination' was an operator-dependent variable. Colour and shade could be selected with either a mock-up (in which resin composite is placed on the unetched enamel and cured) or a custom Vita-shade guide for porcelain. The factor 'try-in phase' was considered to be independent from the other studied variables. Other factors that might have been a minor influence were not considered.

Statistical methods

An analysis of variance (ANOVA) was applied to analyse the treatment times in relation to the factors that may have been of influence. To deal with the skewed distributions of the treatment times, a log-transformation was necessary for the proper application of ANOVA. Consequences of this transformation were:

Table II. Clinical procedures for the fabrication of veneer restorations as used in this study

Direct veneer restorations (one session):
Shade determination
Cleansing of all maxillary anterior teeth
Selection of shade of the veneer using a mock-up
Preparation
Preparation of the tooth according to the instructions
Restoration
Isolation with a contourstrip and/or cotton wool rolls
Etching of the tooth by Scotchgel (3M, St Paul, USA)
Covering of etched enamel with Scotchbond dual-cure (3M, St Paul, USA) and curing
Fabrication of the veneer with Silux plus and Valux TI resin composite (3M, St Paul, USA)
Occlusion adjustment
Finishing
Finishing and polishing using Sof-Lex discs (3M, St Paul, USA)
Instructions using oral hygiene procedures
Indirect veneer restorations (two sessions):
SESSION 1
Preparation (see d-VR)
Shade determination
Selection of the shade of the veneer using a mock-up as for type IC or with a shade guide for type P (Vita Zahnfab. KG. Bad Säckingen, Germany)
Impression
Recording of the impressions using standardised techniques (maxilla: vinyl polysiloxane (Express Regular Body 3M, St Paul, USA), mandibula: alginate impression (CA 37, Cavex, Haarlem, The Netherlands))
Temporary restorations
Temporary resin of composite restorations with spot etching
SESSION 2
Removal of the temporary restorations
Cleansing of all anterior teeth
Teeth
Assessment of the fit of the VR and adjust where indicated clinically
Cementation
Keeping the veneer dry with a contourstrip or/and cotton wool rolls
Bonding of the VR (following the manufacturer's instructions) type IC: Adhesive cement (Hereaus Kulzer GmdH, Wehrheim, Germany) or Type P: Flexo-ceram inlay light cure adhesive composite (Elephant Ceramics, Hoorn, The Netherlands)
Removing of excess of luting material
Occlusion adjustment
Finishing (see d-VR)

1. Direct interpretation of the mean values calculated after log-transformation is not possible. Retransformation (anti-log) results in the geometrical mean, which in this situation is an estimate of the median treatment time.
2. Differences in treatment time after log-transformation are to be interpreted as relative differences between treatment times. The residual standard deviation in ANOVA may be interpreted as the residual coefficient of variation, i.e. the percentage of the median treatment time that is due to random fluctuations.
3. In order to evaluate the factors that influence the treatment time, the median treatment time is presented as a reference. To get a 95% prediction or confidence interval for the untransformed treatment times, the symmetrical intervals are retransformed. This will result in asymmetrical intervals.

The arithmetic means of the treatment time are also presented because of their relevance in the dental practice. The percentage of explained variance will be presented to give an indication of the combined influence of the factors.

RESULTS

The factors considered to influence the treatment time of certain phases and the actual influence on these phases are presented in *Table III.*

Table III. Overview of the factors with significant influence on the treatment time

Treatment phase	*Factor* *Type of VR*	*Shade†*	*Operator*	*Number of VRs*
Session 1				
Shade determination	***	NS	NS	—
Preparation	**	—	*	NS
Modelling/finishing (Type DC)	—	NS	***	***
Impression (Type IC-P)	—	—	**	—
Temporary provision (Type IC-P)	—	NS	***	**
Session 2				
Checking fit	NS	NS	NS	*
Cementation	NS	—	NS	***

†Shade of the teeth before treatment (discolored or not discolored).
NS, No significant influence; *, significant influence $P < 0.05$; **, significant influence $P < 0.01$; ***, significant influence $P < 0.001$; —, not related to treatment time of particular phase.

Table IV. Mean treatment time, median treatment time, 95% confidence intervals and 95% prediction intervals for each single session and total procedure subdivided for each type (in min per VR)

	Single VR					*Multiple VRs*				
	n	*Mean time*	*Median*	*95% confid.*	*95% predic.*	n	*Mean time*	*Median*	*95% confid.*	*95% predic.*
Direct resin composite	16	46	48	40–54	25–85	21	39	40	34–44	22–68
Indirect resin composite										
Session I	13	39	39	33–45	22–66	20	36	38	31–42	19–68
Session II	10	31	28	25–38	15–62	19	23	23	20–26	12–42
Total (I+II)	10	70	72	60–82	43–115	19	59	62	52–67	34–102
Porcelain										
Session I	11	35	32	28–43	17–69	22	27	25	24–30	15–48
Session II	8	29	29	24–35	17–49	22	22	22	19–25	12–40
Total (I+II)	8	62	57	53–71	41–92	22	49	52	44–55	30–82

Differences in *n* are caused by exclusions.

The mean treatment time, median treatment time, 95% confidence intervals and 95% prediction intervals for the three types of VRs for the different sessions and for the total procedure are presented in *Table IV*. A subdivision is made for single VR and multiple VRs. The 95% prediction intervals are presented to give insight to the variability of treatment times. ANOVA showed a significant difference ($P < 0.001$) for the total time needed to make a veneer restoration for the three techniques. The total procedure of an IC-VR took 22% more time than the overall median time, the total procedure of a P-VR took 3% more time while the application of a DC-VR took 20% less time than the overall median time. The number of VRs placed in one dentition demonstrated a significant effect as well ($P < 0.01$). It was not possible to demonstrate a relation between treatment time and experience of the operator.

The overall median of shade determination was 7 min. In the case of a mock-up being used, the shade determination took 22% more time while for the use of a shade guide 46% less time was required. The time for preparation of an indirect veneer restoration (ind-VR) took 9% more and the time for preparation of a direct veneer restoration (d-VR) took 18% less than the overall median time for preparation (5 min). Preparations with incisal reduction took 20% more time than the preparations without incisal reduction.

The factor 'problems in the try-in phase' had a significant effect ($P < 0.01$) on the median treatment time.

A significant operator effect was seen at different levels as is shown in *Table V*. This table also demonstrates the influence of the number of VRs on the different steps in

Table V. Percentage differences of the median treatment time for the factors 'operators' and 'number of VR' according to the clinical phases which are significantly influenced

Factor	n	*Median*	*Range (%)*	P
Operator				
Preparation	100	5 min	− 24 to + 26	*
Modelling/finishing (type DC)	38	28 min	− 31 to + 43	**
Impression (type IC-P)	74	10 min	− 34 to + 23	**
Temporary provision (type IC-P)	61	7 min	− 46 to + 39	***
Number of VR				
Modelling/finishing (type DC)	38	28 min	− 17 to + 20	**
Temporary provision (type IC-P)	61	7 min	− 15 to + 24	***
Checking fit (type IC-P)	64	4 min	− 12 to + 27	*
Cementation (type IC-P)	62	19 min	− 10 to + 21	***

P values as given in *Table III.*

the clinical procedure. This effect was significant for all the steps mentioned. The residual coefficient of variation varied from 29% to 78% and the explained variance from 20% to 59%.

DISCUSSION

The treatment times for indirect VRs were respectively 75 min for one IC-type VR and 62 min for a P-type VR. The difference in treatment times for the IC- and P-type VR is in part a result of the different procedures in shade determination. The fact that all operators had no experience with the IC technique may also have influenced the treatment time of the IC/VRs. Generally there was a reduction of treatment time with 11–13 min per VR in the cases where two or more VRs were provided at the same time. This means a reduction in treatment time of approximately 15–20%. For the direct technique the reduction in treatment time was about 8 min, which is 17%. As could be expected, this factor (more VRs in the same patient) was found to be significant for all treatment phases except for 'shade determination', 'preparation' and 'impression' (*Table III*).

As seen in *Table III*, the operator had a significant influence on several clinical phases. This effect was also found in other studies on treatment time[9–11]. However, other typical operator-dependent factors such as 'shade determination' and 'checking of the fit' showed no influence on the treatment times. In the cases of DC-VRs the operator effect on the total treatment times was mainly restricted to the phases modelling and finishing. The slowest operator needed on average about 40 min for the modelling and finishing of a direct veneer restoration while the fastest used on average about 19 min for this phase of the restoration. Also the factors 'preparation', 'impression' and 'temporary restoration' were dependent of operator. However, the variation in times needed for these factors was only a few minutes.

The time needed to make a temporary restoration, in cases of ind-VRs, was 7 min on average. This was found to be at least 10% of the total treatment time needed for these restorations. The need to make a temporary restoration depended on several factors, such as sensitivity of the prepared tooth and the aesthetic demand of the patient. In cases in which a temporary restoration is not needed, this will decrease the total treatment time substantially.

The use of either a mock-up or a shade guide resulted in a difference of 4–9 min in treatment time. For the indirect composite technique a mock-up was used and for the porcelain technique a shade guide. There was no difference in terms of shade acceptance/dissatisfaction.

In the cases where the VR was unsatisfactory for immediate insertion (problems in the try-in phase), this had a highly significant influence on the treatment time. In these cases, the patient required a new temporary restoration and a further appointment for the try-in and bonding the VR. This factor was not taken into account in the treatment time analysis.

The residual coefficient of variation is most interesting for time planning in the dental practice. Unfortunately this variation was substantial. A possible explanation for this variation might be found in other factors that were not taken into account.

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