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A comparison of the cost effectiveness of pressure-indicating materials and their ability to detect pressure areas in complete dentures

Keywords: pressure indicating materials, efficacy, cost effectiveness

SUMMARY

Pressure areas on the fitting surfaces of dentures can cause great discomfort and pain to denture wearers if not detected and removed. Pressure-indicating materials are commonly used to detect these areas, and several commercial varieties are available, but these tend to be expensive. The cost effectiveness of these materials has not been investigated, nor has this been linked to their efficacy and ease of use. The aim of this study therefore, was to compare the different pressure-indicating materials available commercially with that of a home-made paste. An assumption of efficacy was made by the number and size of pressure areas revealed, by taking standardised photographs and analysing the images. User friendliness was determined by the time taken to mix, apply and remove the material. Cost was determined by a cost per unit calculation based on the average or minimum quantity required for each material. The results indicated that a home-made paste made of equal quantities of hand lanolin (BP) and zinc oxide powder was not only the most effective, but was also the cheapest, being only 3% of the cost of the most expensive of the materials.

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OPSOMMING

Drukplekke op die passende oppervlaktes van kunsgebitte kan heelwat ongemak vir die draers meebring indien dié plekke nie aangedui en verlig word nie. Materiale om drukplekke te identifiseer is in algemene gebruik en verskeie tipes is in die handel verkrygbaar, maar is redelik duur. Die kostedoeltreffendheid van hierdie materiale is nog nie ondersoek nie, en daar is ook nie 'n verband bepaal tussen hierdie faktor en hulle effektiwiteit en gemak van gebruik nie. Die doel van hierdie ondersoek was derhalwe om die verskillende materiale wat beskikbaar is, te vergelyk met 'n tuisgemaakte pasta. 'n Maatstaf van doeltreffendheid was die aantal en grootte van drukplekke soos getoon in 'n analise van die beelde verkry van gestandaardiseerde foto's. Gebruiksvriendelikheid is bepaal deur die tyd wat gebruik is om die materiaal te meng, te plaas en te verwyder. Koste is vasgestel volgens 'n eenheidskosteberekening gebaseer op die gemiddelde of minimum hoeveelheid van elke materiaal gebruik. Die resultate dui daarop dat 'n tuisgemaakte pasta van gelyke hoeveelhede handlanolien (BP) en sinkoksiedpoeier nie alleen die mees effektiewe materiaal is nie maar ook die goedkoopste, synde slegs 3% van die koste van die duurste van die materiale.

Introduction

The role of ill-fitting dentures in causing mucosal changes and rapid bone resorption in the elderly patient is generally accepted by the profession (McLaughlin, 1989). A variety of factors can cause pain and make the wearing of dentures difficult (Scott, Packer, and Watson, 1997), among which are pressure areas on the fitting surface of removable prostheses, which can contribute to a variety of pathological conditions of the oral mucosa (Rodegerts, 1964; Nater *et al.*, 1978; Bennie, 1980; Schaefer, Hine and Levy, 1983; Dorey *et al.*, 1985; Smith and Hughes 1988; Agerberg and Viklund, 1989; Regezi and Scuibba, 1993). These pressure areas should therefore be detected by clinicians when fitting removable prostheses, as failure to do so may lead to unnecessary pain and suffering.

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Pressure-indicating materials are commonly used to detect defects on the fitting surfaces of dentures, and several commercial varieties are available. As early as 1947, Anthony advocated the use of a paste that was applied to the fitting surface of the denture base. The prepared base was then seated firmly to force out all surplus paste past the margins. The denture was then chilled *in situ*, removed, and 'high spots' were disclosed by showing through the white coating on the denture base. Most textbooks since that time have also advocated the use of pressure-disclosing materials, both for detecting undercut areas on the fitting surface of the denture (Rahn and Heartwell, 1992) as well as for detecting pressure areas (Zarb, Bolender and Carlsson, 1997). Several commercial materials are available, but tend to be expensive; and when used in the academic environment costs escalate, as students often use excessive amounts. Many of the materials available on the market are also not user friendly, and leave a sticky residue on the fitting surface of the denture base, although recent advances have seen the development of setting silicone-based materials for pressure detection. The manufacturers claim these to be easier and more convenient to use, and more easily removed from the denture base. In addition, some clinicians have advocated the use of a slurry of alginate impression material, as an alternative to the more expensive silicone-based materials.

Several studies have tested various pressure-indicating materials for their ability to detect pressure spots (Rodegerts, 1964; Woelfel and Paffenbarger, 1965; Cutright *et al.*, 1976; Gronas, 1977; Firtell, Arnett and Holmes, 1985), and their behavioural characteristics using creep tests have also been studied (Stevenson-Moore, Daley and Smith, 1979). However, the cost effectiveness of the materials has not been investigated, nor has this been linked to their ease of use.

The aim of this study was to compare five different pressure-indicating materials available commercially with a home-made pressure-indicating paste. It was predicted, based on the clinical experience of the authors, that the home-made paste would have similar properties to those of pressure-indicating materials available commercially. The ease of use of each of the materials as well as their cost effectiveness would also be compared.

Materials and method

Two commercial pastes were used, Cadco High Spot Indicating Cream (Cadco, Los Angeles, USA), and Pressure Indicating Paste (Mizzy Inc., Clifton Forge, USA). The setting materials used were a slurry of the alginate material Colourgel (Wright Health Group, Dundee, Scotland), produced by mixing a standard measure of powder with one-third extra water, and the silicone-based material Fit Checker (GC Corporation, Tokyo, Japan), a light-bodied silicone material. In addition, a home-made paste of a mixture of lanolin BP (Torch Brand, Poulenc SA, Johannesburg, South Africa) and zinc oxide powder was created, using equal weights of each component. This mixture had been found to be effective clinically, after several trials of different consistencies. It was stored in a calibrated syringe and the same batch of each of the materials was used for all dentures in the study. All materials were kept at room temperature.

Thirty patients with complete upper and lower dentures were used in this study, randomly selected from the undergraduate clinic at Medunsa. The quantity of each material used was measured: 1ml of the pastes was dispensed from a calibrated syringe, and applied to the denture bases with a brush; the alginate was measured as the standard minimum quantity that could be used; and the silicone-based materials were measured by length of material extruded, converted to volume subsequently.

One operator carried out all procedures. Placement of each denture was made by using finger pressure over the premolars on each side, the operator having been calibrated by using finger pressure on a digital scale.

The term *efficacy* was used as an expression of the ability of the materials to record pressure areas, as determined by the number and size of the pressure areas detected on the fitting surface of the denture, at first placement. On removal from the mouth, the fitting surface of the denture, with the indicating material still in place, was photographed. A 35 mm camera with a 90 mm auto-focus lens and ring flash at the same focal length and standard distance produced the same magnification for each photograph. From the photograph, the number of pressure areas was recorded, and the size of each area was determined by using an Image Analyser (Leco Image Analyser, Montreal, Canada). Pressure areas that were analysed were those showing as having a well-circumscribed, continuous unbroken outline, with the fitting surface of the denture clearly showing through the pressure-indicating material. The pressure areas that were not well circumscribed and did not show clearly through the denture base were not analysed. This was because at first placement, some areas could not be definitely identified as pressure areas (Fig. 1.)

The ease of use or user friendliness of each of the materials was determined by the time taken to mix, apply and remove each of the materials from the fitting surface of the denture after first placement. The removal of each of the materials from the denture base was done using a paper tissue and Hibiscrub solution (Zeneca, Woodmead, South Africa). The cost of each of the materials was

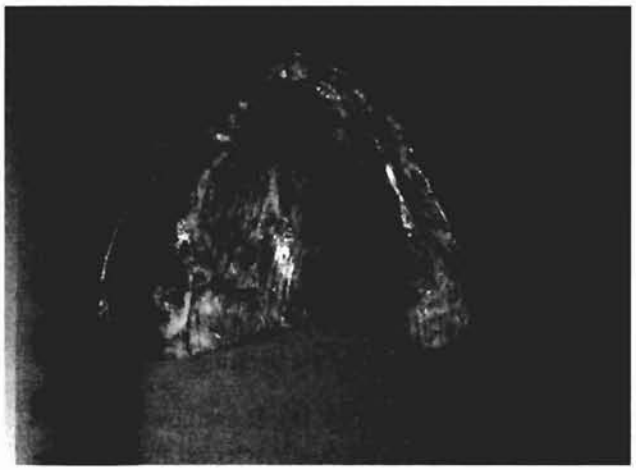

Fig. 1. An upper denture with pressure-indicating paste showing the different types of pressure area. Those marked A were analysed, as they were well circumscribed, with the fitting surface of the denture clearly showing through the pressure-indicating material. The pressure areas that were not well circumscribed and did not show clearly through the denture base were not analysed, and these are marked N.

determined by the minimum amount of material used per denture, averaged over all the dentures used in the study.

Analysis of results was carried out using a one-way analysis of variance for each of the variables. Statistically similar variables were grouped by applying the Bonferroni (Dunn) multiple comparison test.

Results

Table I shows the summary data, and Table II shows the results of the multiple comparison tests for the efficacy and ease of use. There were significant differences between the materials tested for each of the variables at $P < 0.01$. Similar letters indicate those materials not significantly different from each other, with the letter A representing the greatest quantity of each variable, and C the least.

Efficacy

All materials showed an ability to detect pressure areas, but varied in the number and average size of the areas detected. There was no difference in the number of areas detected between the home-made paste and the Mizzy paste, but the Mizzy paste detected a lesser average size of area. The only material that behaved consistently better in all tests was the home-made paste.

Ease of use

The results show the clear differences between the use of

Table I. **Summary data**

Variable	Material	Mean	Standard deviation	Minimum	Maximum
Area	H	4.44	1.62	1.70	8.21
Area	M	3.73	1.76	0.00	8.50
Area	C	4.22	1.92	0.00	7.42
Area	F	4.04	3.20	0.00	10.93
Area	CG	2.11	3.63	0.00	14.05
Number	H	5.63	2.27	1.00	11.00
Number	M	4.67	1.65	0.00	8.00
Number	C	3.43	1.57	0.00	6.00
Number	F	2.33	1.63	0.00	5.00
Number	CG	1.00	1.49	0.00	5.00
Mxng time	H	0.00	0.00	0.00	0.00
Mxng time	M	0.00	0.00	0.00	0.00
Mxng time	C	0.00	0.00	0.00	0.00
Mxng time	F	17.70	2.84	10.00	20.00
Mxng time	CG	19.23	1.85	14.00	21.00
Appl. time	H	18.13	2.97	10.00	21.00
Appl. time	M	19.47	2.61	11.00	22.00
Appl. time	C	20.07	3.55	10.00	25.00
Appl. time	F	12.53	9.47	5.00	60.00
Appl. time	CG	11.97	3.20	5.00	16.00
Rem. time	H	58.60	8.47	15.00	65.00
Rem. time	M	60.13	8.08	20.00	65.00
Rem. time	C	61.23	8.12	20.00	66.00
Rem. time	F	5.77	1.43	5.00	10.00
Rem. time	CG	5.50	0.78	4.00	7.00

H = home-made paste; M = Mizzy paste; C = CadCo paste; F = Fit-Checker; CG = Colourgel.

Table II. **Bonferroni test results: similar letters group materials not significantly different from each other. For each quantified variable, A > B > C**

	Variable				
	Efficacy			Ease of use	
Material	**Area**	**Number**	**Mixing**	**Application**	**Removal**
Home-made paste	A	A		A	A
Mizzy	B	A B C		A	A
CadCo	A	B C		A	A
Fit-Checker	A	C	B	B	B
Colourgel	B	C	A	B	B

pastes, and those materials that require to be mixed prior to use. Of these latter materials, not surprisingly, the alginate took longer to mix than the silicone-based material. Also not surprising was the fact that the pastes took longer to remove from the denture surface than the set materials, which could just be peeled off; however, all pastes took as long to apply.

Cost effectiveness

Table III shows the results of the cost calculations for the materials used, as the cost of the quantity of each material used, averaged across all dentures.

Discussion

An injury to the denture-bearing tissues should not be used as an indicator of those parts of a denture that require adjustment. If pressure-indicating materials are used at the delivery of a denture to the patient, a suitable material will reveal areas of the denture that might potentially cause harm to that patient.

It is generally sound advice to first test for these areas prior to doing any occlusal adjustments, by placing one denture at a time so as not to allow any occlusal interferences to cause a false reading. After first adjustment, it is then necessary to re-test the denture's fitting surface to ensure not only that sufficient material has been removed, but also that other areas of the fitting surface are not now implicated as being potentially harmful.

Hence, ideally, a pressure-indicating material needs to be able to show all pressure areas, and at the same time be easily applied and removed. Unfortunately, from the evidence of this study at least, the most efficacious material was not the quickest to apply or remove. However, the actual figures involved are not great: the average time taken to apply the pastes was 19 seconds. The average time taken to remove the pastes was 60 seconds as against an average of 6 seconds for the setting materials.

There was a difference between the size of the areas detected by one of the pastes (Mizzy) compared with all other pastes and even with one of the setting materials (Fit-Checker). This may be due to the consistency of this paste, which has a lower viscosity than the other pastes, and is unlikely to be due to any temperature variation as all tests were carried out at the same room temperature.

It is as important to have a material that performs its required function as it is to have one that is cost effective. The calculations from this study are for just one application, but as stated above, at least two applications are generally required. It is therefore fortunate that the most effective material used in this study was also the cheapest.

Table III. **Cost of materials used, per denture**

Material	Cost per denture (R)
Home-made paste	0.56
Cadco	1.66
Mizzy	2.00
Colourgel	12.00
Fit-Checker	16.67

Conclusion

The home-made paste was better able to detect the size and number of pressure areas, and was also the cheapest of the materials tested. All the pastes were more difficult to remove than the elastomeric setting materials (although removal only took 1 minute), but the latter were unable to consistently reveal the pressure areas beneath complete dentures.

If this paste is used in the private as well as in the public sector services, considerable savings can be made in the long term. The paste can be easily made up by mixing equal quantities by weight of hand lanolin, obtainable from any pharmacy or store, and zinc oxide powder (as used for temporary restorative materials). The resultant paste can be placed in 10 ml syringes (without the needle) for ease of application and hygienic storage.

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