IN BRIEF

- In a busy clinical environment laminated appliances required less chair-side adjustment than acrylic appliances.
- With both appliances we still advise an inter-premolar separation of about 4 mm but this may be increased if the patient also has marked tooth wear anteriority.
- The principle of the mechanism of action of both appliances is to reduce nocturnal parafunctional activity.

Fitting acrylic occlusal splints and an experimental laminated appliance used in migraine prevention therapy

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Objective To evaluate clinical procedures and chair time required to seat and adjust hard, heat-cured acrylic occlusal splints and an alternative laminated appliance developed to simplify construction of migraine prevention appliances.
Design and setting Single-centre study in the Oral Medicine Clinic, The Royal Hospitals, Belfast, Northern Ireland.
Method Questionnaires were distributed, January-May 2003, to operators fitting occlusal splints for 100 consecutive patients selected for migraine prevention therapy. Half the appliances were made in heat-polymerised acrylic with the remainder using a novel combination of ethylene vinyl acetate and light-curing urethane dimethacrylate. Information on operator experience, the nature of any fitting surface and occlusal adjustments together with an estimate of the time taken to make alterations was recorded.
Key findings The need for adjustment to seat appliances intraorally was significantly less for migraine prevention appliances made using an experimental laminating technique. Where modifications were necessary, there was no significant difference in the chair time required to fit either the heat-cured hard or experimental laminated migraine prevention appliance.
Conclusion Provision of migraine prevention appliances may be more time efficient if the dental practitioner considers a laminated approach to construction.

Migraine is a debilitating condition characterised by a throbbing headache and often accompanied by phonophobia, photophobia and nausea or vomiting.[1] Prevention and treatment of migraine attacks include conventional drug, complementary and alternative therapies.[2-5] The use of occlusal splints has been demonstrated to reduce the incidence of migraine attacks for selected patients[6] and in this context the design of the appliance is important.[7] Descriptions of rigid thermoformed, self-cured, and photopolymerised together with resilient and combination hard/resilient occlusal splints have been reported in the literature.[8,9] Hard heat-cured acrylic persists as a material of choice for occlusal splints not least because the materials and processes used are common in most general dental laboratories.[10-12] Appropriate eradication of undercuts when overlaying hard oral structures such as teeth with rigid materials during the construction process is difficult however and may cause problems when seating an appliance at the fitting stage.

The aim of this investigation is to identify the extent and nature of problems encountered when fitting heat-cured occlusal splints of proven design for migraine prevention therapy. An experimental splint of similar design, using alternative materials and a novel construction process, is described and the intra-oral fitting experience of the two appliances compared.

MATERIALS AND METHODS

One hundred consecutive patients selected for migraine prevention therapy were prescribed alternately either a heat-cured or experimental laminated migraine prevention appliance. A sample size of 50 in each group ensured power of 80% with an alpha of 0.05. Upper and lower alginate impressions together with a record of the centric occlusal relationship of the teeth were recorded. The type of migraine prevention appliance, heat-cured or laminated, the arch on which the appliance was to be made and a key design feature, the interocclusal height required was identified on the laboratory prescription.

Models of adequate strength to resist the rigours of the construction process for laminated appliances are produced if the teeth and mucosal structures are formed in Hydrocal with the bases cast in Plaster of Paris to facilitate trimming. The model on which the appliance is constructed, commonly the maxillary model, was coated with separating medium such as sodium alginate and placed on the mounting platform of a thermoforming unit (Drufomat; Dreve-Dentamid GMBH, Max-Planck-Str. 31, 59423 Unna/Germany). A 4 mm thick layer of Ethylene Vinyl Acetate [EVA] (Drufosoft; Dreve-Dentamid) was thermoformed on the model. The periphery was trimmed to leave a 2 mm incisal overlap labially and to the level of the gingival margins of the posterior teeth buccally. Palatally the periphery extended beyond

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Fig. 1 The resilient lining is roughened on the non-fitting surface using a course emery cloth band and a layer of the chemical bonding agent shown applied and polymerised as directed by the manufacturer.

Fig. 2 Models are orientated using an occlusal index, articulated and adjusted to provide the prescribed inter-occlusal separation. The resilient lining is returned to the upper cast as indicated in the illustration, in preparation for the application of the hard, light command-cured material.

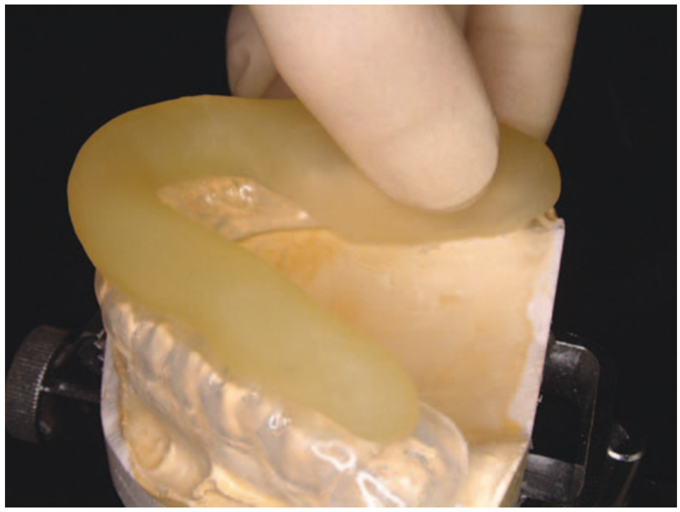

Fig. 3 A cylinder of light command-cured material is shown being moulded over the resilient liner and on to the palatal structures on the model. Subsequently, the articulator is closed gently to express excess resin and develop contact of opposing teeth on the surface of the appliance.

Fig. 4 Intraoral image depicting a fully constructed and occlusally accommodated experimental laminated appliance. Note the magnitude of the inter-occlusal separation that normally exceeds by 2 mm at least the interocclusal space.

the gingival margins by 2 mm. This resilient lining was removed from the model and roughened on the non-fitting side using a coarse emery cloth band (Arbor Band; Buffalo Dental Manufacturing Company Inc, 575 Underhill Blvd., Syosset, New York USA), to increase the surface area and provide a mechanical key for bonding. The palatal surface of the model was smeared with separating medium (Triad®Model Release Agent; Dentsply International Inc., York PA17405-0872). The thermoformed layer was returned to the model and coated with a chemical bonding agent (Triad® Bonding Agent; Dentsply International Inc.), left to dry for two minutes and photopolymerised for two minutes in a light command curing unit (Triad®; Dentsply International Inc.) (Fig. 1). The resilient lining was removed from the model. Upper and lower models were articulated using the occlusal index provided. The articulator was adjusted to produce the prescribed inter-occlusal separation, typically 4 mm between upper and lower first premolar teeth (Fig. 2). The EVA resilient lining was returned to the model. A sheet of, urethane dimethacrylate (TranSheet™ Colorless, Visible Light Cure Material; Dentsply International Inc.) was rolled to form a cylinder shape approximately one centimetre diameter and pressed on to the occlusal aspect of the resilient lining. The articulator was gently closed to express surplus resin and to mould appropriate occlusal form against the lower teeth (Fig. 3). Excess resin was manipulated around the buccal and labial surfaces to the level of the resilient layer. Overlapping the resilient layer by approximately 3 mm providing a rigid palatal periphery. The non-fitting surface of the appliance was painted with Triad® Air Barrier Coating (Dentsply International Inc.) and the appliance photopolymerised for 10 minutes on the model and a further six minutes on the underside. The models and appliance were re-articulated and the occlusal surface accommodated to provide an uninterrupted physiological slide of the mandible in lateral and protrusive excursions. The palatal border was trimmed with a tungsten carbide trimmer and the EVA material on the buccal and labial border smoothed with finishing discs (Acorn Polymers (UK) Limited, Acorn House, No 1 Kershaw Street, Bolton, England.) The non-fitting surface of the appliance was polished using normal finishing techniques for denture base resins. Finishing liquid (Dreve-Dentamid GMBH) was used to restore the surface vibrancy of exposed EVA on the buccal and labial border (Fig. 4). Standard lost wax denture construction processes produced the heat-cured acrylic migraine prevention appliances incorporating Adams Clasps, identical to that published previously.[7] As with the laminated appliance, the therapeutic vertical dimension of the occlusal component was set at approximately 4 mm inter-premolar separation.

All clinicians including Consultants, Staff Grades, Registrars and Senior House Officers fitting laminated and heat-cured anti-migraine appliances for patients attending the Oral Medicine Clinic, The Royal Hospitals, were asked to complete closed ended questionnaires to assess the need for and nature of alterations required to adjust the appliances at the fitting stage, together with the time required to make adjustments. The questions were developed and piloted with a small number of providers. Information on operator experience levels was recorded. An estimation of the adequacy of retention after fitting each appliance was sought; appliances could be described as too retentive, satisfactory or too loose. Operators were asked to record if saddle areas were involved in splint design. Time required to seat splints was recorded in four bands ranging from no adjustment to 10 or more minutes. The time required to refine occlusal contacts and correct discrepancies in the uninterrupted physiological slide of the mandible established at the laboratory stage was recorded similarly.

RESULTS

Operators fitting occlusal splints in this study had either less than 10 years or 20 years postgraduate experience. Equivalent proportions of operators, grouped according to experience fitted heat-cured acrylic (68% 20+ years) and laminated (63% 20+ years) occlusal splints. Comparable proportions of heat-cured acrylic (8%) and laminated (10%) occlusal splints involved saddle areas. Equivalent proportions of heat-cured acrylic (92%) and laminated (90%) splints were made on the upper arch. The retention of comparable proportions of heat-cured acrylic (92%) and laminated (90%) splints was described as satisfactory with equivalent proportions of each type described as too retentive or loose. Almost all heat-cured acrylic splints in this study were found to require chair side adjustment of some sort at the fitting stage; a comparison with levels of adjustment for laminated occlusal splints is presented in Table 1. The most significant difference between the two appliances was found for seating adjustments and is presented in Table 2. A greater proportion of heat-cured appliances (44%) required occlusal accommodation compared with laminated splints (26%) however this was not found to be statistically significant. Where modifications were necessary, an equivalent amount of time was taken to make adjustments overall and for seating the appliances and is presented in Tables 3 and 4.

Table 1 Proportion of 50 heat-cured acrylic and 50 experimental laminated appliances requiring chair side adjustment at the fitting stage

Adjustment	Number of hard acrylic appliances (%)	Number of laminated appliances (%)
Yes	48 (96)	16 (32)
No	2 (4)	34 (68)

χ^2 [1] = 44.44 $p < 0.01$

Table 2 Proportion of 50 heat-cured acrylic and 50 experimental laminated appliances requiring chair side adjustment to seat appliance at the fitting stage

Adjustment	Number of hard acrylic appliances (%)	Number of laminated appliances (%)
Yes	41 (82)	7 (14)
No	9 (18)	43 (86)

χ^2 [1] = 46.31 $p < 0.01$

Table 3 Overall chair time necessary to fit heat-cured acrylic and experimental laminated splints where modification is required

Time in minutes	Number of hard acrylic appliances (%)	Number of laminated appliances (%)
<5	17 (35)	7 (44)
5 to <10	13 (27)	5 (31)
≥10	18 (38)	4 (25)
Total	48	16

χ^2 [2] = 0.84 $p > 0.05$

Table 4 Chair time adjustment of heat-cured acrylic and experimental laminated splints where modification is required to seat appliance

Time in minutes	Number of hard acrylic appliances (%)	Number of laminated appliances (%)
<5	18 (44)	4 (57)
5 to <10	15 (37)	3 (43)
≥10	8 (19)	0 (0)
Total	41	7

χ^2 [2] = 1.66 $p > 0.05$

DISCUSSION

The laminating process described in the current investigation streamlines provision of occlusal splints by reducing significantly the need for seating adjustments. Conversely the magnitude of the problem of seating heat-cured acrylic laboratory-made occlusal splints without chair side adjustment is highlighted. Chair time may be required to remove undercuts inadvertently left around teeth during the construction phase or as a result of dimensional changes occurring in the material at the time of, or subsequent to, polymerisation of the acrylic resin.[13] Care is required when deciding where to relieve and how much material to remove as grinding can so easily result in loss of retention and/or stability of the splint. It is for this reason that clasps were included in the laboratory design for heat-cured occlusal splints fitted in this study. When making laminated appliances the construction process is simplified in that model relief, for the most part, is unnecessary as the resilient inner surface distorts and slips easily over the teeth to engage all suitable undercuts without clasping. Direct thermoforming and light command curing processes obviate the need to wax-up, flask, pack and de-vest these splints.

Nocturnal clenching is experienced by some migraineurs,[14] a phenomenon which the occlusal splint is designed to reduce as it leads to an inappropriate release of a neuropeptide that triggers a migraine attack.[15] Teeth could also move as a result of clenching and the muscles of mastication are increased in volume in migraineurs.[16] Even slight tooth movement subsequent to impression making may cause seating difficulties and a need for adjustment for rigid appliances unlike resilient inner surfaces of laminated splints that can distort locally thereby accommodating small discrepancies.

Due to the almost inevitable destruction of models during devestment procedures, heat-cured appliances are generally fitted to secondary models for articulation and post fabrication occlusal refinement. It is possible that the additional steps and use of multiple models required to make the heat-cured splints are a cause for the larger number requiring occlusal adjustment.

A liner of resilient acrylic has been advocated as a retainer for hard, heat polymerised and self-cured occlusal splints.[17,18] One technique involves the construction of the heat-cured element on an adjusted model prior to lining the appliance with resilient self-curing resin. While the authors expect 'no adjustment, optimal seating and retention, requiring minimal chair time', the technique assigns additional complexity to the laboratory procedure. This is in contrast to the laminating process described in the current investigation, which simplifies construction of the appliance. Indeed the viscoelastic nature of self-curing soft acrylic resins may be desirable when used as a resilient denture liner.[19] Elastic characteristics associated with silicone-based liners and exhibited by the ethylene vinyl acetate, used as a liner in the current study may however be appropriate when retention exceeds cushioning as the primary requirement.[20]

Halachmi *et al.*[21] in considering the forces teeth opposing an occlusal splint are exposed to, found wholly resilient splints (soft splints) more protective than hard splints. Okeson[22] found that wearing soft occlusal splints increased bruxism, whereas, hard occlusal splints worn by the same subjects reduced nocturnal clenching and grinding behaviour. More recently, Hiyama *et al.*[23] confirmed the observation of a reduction in nocturnal masticatory muscle activity for hard splints. Certainly, hypertrophy of the muscles of mastication principally masseter muscles is a feature of migraineurs with parafunctional[16] activity as are mandibular tori.[24] Since the primary role of occlusal splints in migraine prevention therapy is to reduce nocturnal clenching, this work suggests splints with hard occluding surfaces may have advantages other than durability to withstand the effects of excessive parafunctional activity. Soft splints have also been claimed to be effective in migraine treatment.[25]

CONCLUSIONS

Overall our conclusions are:

- The need for chair time alterations to hard and hard/resilient migraine prevention splints is established and compared.
- A laminated approach is likely to make provision of migraine prevention appliances more time and cost efficient.
- The construction process for laminated appliances, involving a novel use of hard/resilient materials is presented.

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