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Review of Orthognathic Surgery Occlusal Wafers Application in 185 Patients

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Abstract **A comparative study of occlusal wafers for orthognathic surgery made for 185 orthognathic surgery patients with mean age of 24.4 ± 4.3 years, is presented . This study is intended to highlight any wafer associated surgical problems, which determine wafer design. Various types of occlusal wafers were used during the period of this review, but in most of the cases a simple quick-cure acrylic wafer was found to be the most satisfactory. However, some difficult patients with cleft palate or neuromuscular disorder may require wafers of a novel design and materials.**

The treatment of severe malocclusions and facial deformities of skeletal origin often involves a combined orthodontic and surgical approach. Most orthognathic surgical procedures involving single or double jaws require occlusal wafers to facilitate surgical efficiency, accuracy and stability.[1,2]

The orthognathic surgery wafers (Figure 1) are used in orthognathic surgery as: a) an intermediate guide for repositioning the mobilized maxilla relative to the intact mandible, b) an aid to achieve the planned final occlusion, and c) a post-operative proprioceptive guidance (see below). The wafer enables the dental arches to be put in any desired preplanned position.[2-4] This eliminates intra-operative decisions, which are often impaired by limitations of access especially in viewing the posterior segments.[5] The wafer is also valuable when the post-operative occlusion is not sufficiently stable for either temporary or permanent intermaxillary fixation.

Post-operative Proprioceptive Guidance

After rigid fixation of the mandible the wafer may be wired to the maxilla, or less frequently to the mandible, to provide post-operative proprioceptive guidance for up to two weeks. The wafer will help the patient to gain occlusion into the planned position

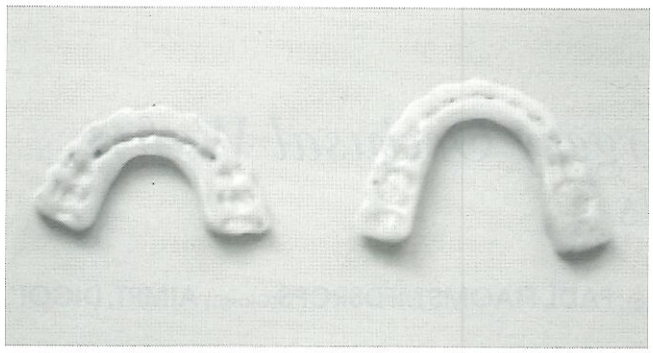

Fig. 1 High-impact acrylic intermediate (left) and the final (right) occlusal wafers.

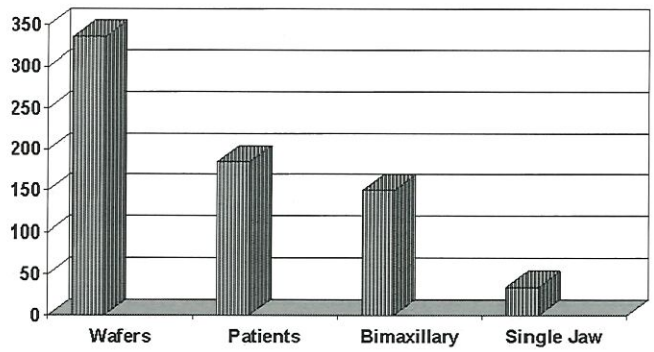

Fig. 2 Patients and wafers reviewed for this study.
Wefers = total number of wafers used during this study period.
Patients = total number of patients reviewed.
Bimaxillary = double jaw surgery.
Single jaw = single jaw mandibular or maxillary procedure.

with or without the help of elastics by over-riding the patient's pre-operative proprioceptive drive.[3] This also improves the arch relationship for any final orthodontic refinement of the occlusion.

Types of Occlusal Wafers

The wafers may be fabricated from self-cured or heat-cured methyl methacrylate or more rarely cast in silver or cobalt chromium alloy for difficult cleft palate cases. It is essential to use recent models for wafer construction, impressions must be taken at least 2 weeks after any final adjustment of the orthodontic stabilizing arch wire. Similarly it is futile to use models, which precede the removal of an appliance pre-operatively. A poorly designed and fabricated wafer can spoil the most skilful surgical technique.[2,4,6]

Proffit and White[4] advised that for patients whose arches had been levelled before surgery, the thinnest practical wafers with 1 to 2 mm of material between the teeth was the minimum necessary to keep the wafers from breaking easily during use. This problem may be resolved by the use of high impact acrylic. It has also been suggested that the wafer could be made slightly thicker posteriorly (<2mm) to allow some room for upward recoiling of the condyle post-operatively.[7] The literature review showed that there was a lack of consensus among the orthognathic surgeons and technologists on the type and design of occlusal wafers. This study is intended to highlight any wafer-associated problems, which determine wafer design.

Materials and Methods

In Department of Oral and Maxillofacial Surgery, Eastman Dental Institute and University College London Hospitals during the period from 1992-1998, 335 occlusal wafers made for 185 orthognathic surgery patients with the mean age of 24.4 ± 4.3 years: 35 single jaw and 150 bimaxillary surgery (Figure 2).

The following types of wafers were fabricated and used: (Figure 3)

1) 60 clear self-cured and 40 heat-cured acrylic wafers with (final) or without (intermediate) holes for wire loop suspension.

2) 102 high impact acrylic wafers with full occlusal coverage and provision for wire loops.

3) 13 wafers with ball end clasp and 14 with C clasps with full occlusal coverage in high impact acrylic.

4) 24 thick (before autorotation) and 24 thin (after the autorotation) wafers in high impact acrylic (Figure 4).

5) 16 wafers with posterior occlusal coverage only (with lingual connector): 10 in high impact and 6 in clear acrylic.

6) 24 short anterior wafers in high impact acrylic.

7) 8 wafers with transpalatal acrylic connectors and full occlusal coverage in self-curing polymethyl methacrylate.

8) 6 silver and 4 cobalt chromium alloy wafers, with buccal loops and palatal holes for wiring.

The orthognathic surgery workup was carried out using the Denar Slidematic facebow (Denar Corporation, USA) and facial midline jig recordings.[5] Impressions were cast in Kemrock, a synthetic dental stone, and the models anatomically mounted on the Denar Automark articulator using the facebow transfer

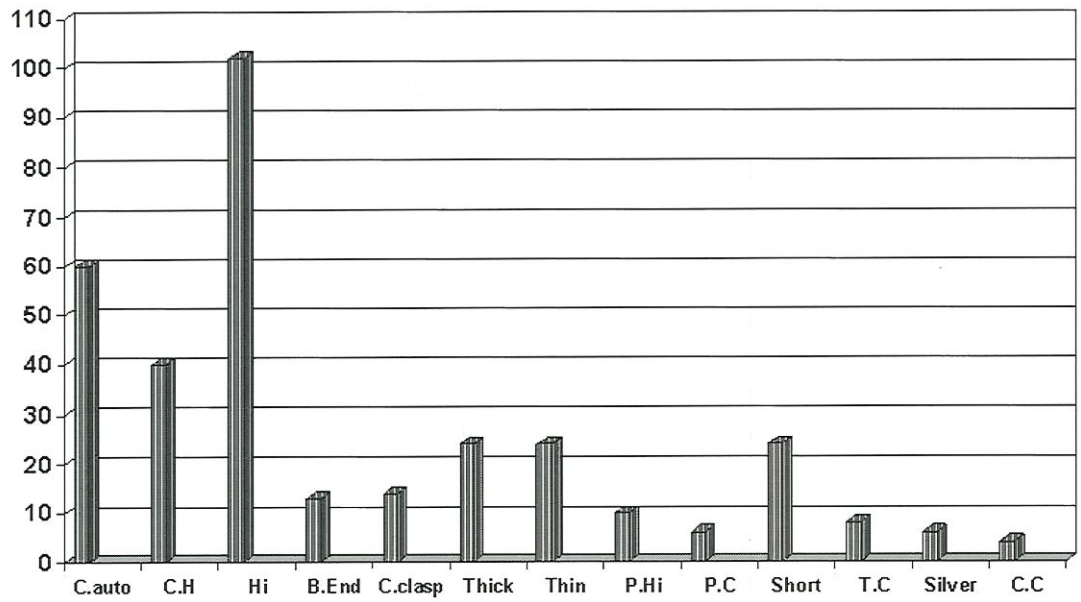

Fig. 3 Various types of wafers used during this study.

C.auto = self cured clear acrylic wafers.
C.H = heat cured clear acrylic wafers.
Hi = high impact acrylic wafers.
B.End = wafers with ball end clasps.
C.clasp = wafers with C type clasps.
Thick = wafers made without mandibular autorotation after maxillary impaction.
Thin = wafers made after maxillary autorotation in cases of maxillary impaction.
P.Hi = wafers with posterior coverage made from high impact acrylic.
P.C = wafers with posterior coverage in clear acrylic.
Short = short wafer with anterior coverage in high impact wafer.
T.C = wafers transpalatal connectors.
Silver = wafers cast in silver alloy mainly for cleft palate patients.
C.C = wafers cast in cobalt chromium alloy, rarely used in patients with neuromuscular disorder.

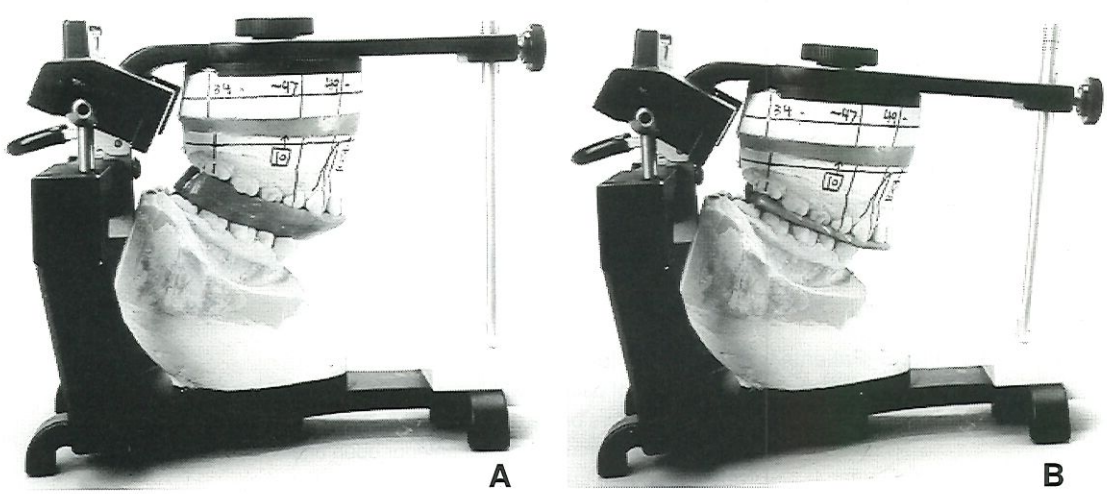

Fig. 4 A. Thick occlusal wafer in high impact acrylic
B. Thin occlusal wafer in high impact acrylic

record. The facial midline was marked on the patient and the models as indicated by the midline jig recording and the model surgery was carried out following the Eastman technique.[2]

Osteotomy wafers were fabricated following standard laboratory procedures for processing polymethyl methacrylate and metals. Beading wax strips were used to mask the orthodontic brackets on the dental casts and to control the flow of the acrylic deep into the sulci and the palate.

Using a pro forma provided with the orthognathic surgery workup, participating surgeons were asked to indicate whether the wafers were satisfactory or unsatisfactory and comment freely on the wafer material, design, accuracy, fit or any other problem and suggest modifications. All the intermediate and the final occlusal wafers with the filled pro formas were collected after surgery, examined and the results analyzed.

Results

In 170 patients (92%) the wafers were found to be satisfactory with good surgical results. Whereas, 15 patients (8%) wafers were recorded as unsatisfactory (Figure 5). Of these, two broke during the operation, two short high impact wafers produced an anterior open bite, one gave inaccurate maxillary movements, two were not used as the surgeons changed the treatment plan and in 2 patients the wafers did not fit well enough at the operation. The remaining 6 did not fit at the try in stage so had to be modified or remade. The thick occlusal wafers were conceptually regarded as inaccurate and cumbersome, the majority of surgeons were reluctant to use them. Wafers retained with ball end or C type clasps were found useful during the operation, but unstable for training elastics. Metal wafers used in three cases were found to be very reliable. Wafers with transpalatal and lingual connectors were disliked. All participating surgeons preferred thin wafers trimmed close to the teeth with holes to accommodate wire loop suspension to the maxilla. Most participating operators felt better to be able to check the fit of clear acrylic wafers.

Discussion

This review showed that a quick-cure polymethyl methacrylate occlusal wafer was reliable and most popular for routine orthognathic surgery, although in

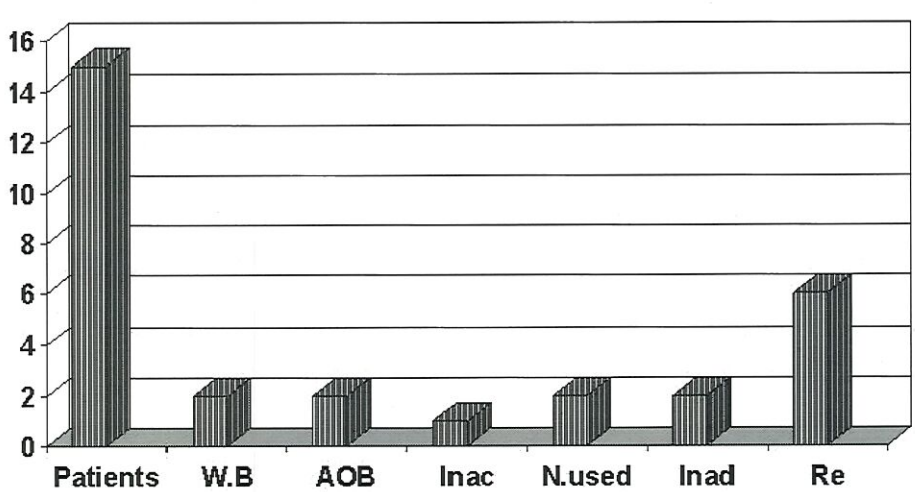

Fig. 5 Patients with unsatisfactory wafers.

Patients = total number of patients with unsatisfactory wafers.
W.B = number of wafers broke during the operation.
AOB = short anterior wafers produced anterior open bite.
Inac = wafers produced inaccurate movements.
N.used = wafers not used as treatment plan was changed.
Inad = fit was inadequate.
Re = at try in stage wafers did not fit and were remade or modified

some cases other types of occlusal wafer may be required. Patients requiring maxillary segmental surgery, cleft palate or uncooperative patients with neuromuscular disorder, who may exert exceptional occlusal forces in immediate post-operative phase may require metal occlusal wafers with or without palatal extensions.

It is part of our orthognathic surgery protocol to check the model surgery in the presence of the patients and try the wafers, with the exception of segmental procedures. Six wafers (3%) were regarded unsatisfactory or the treatment plan was changed at the try in stage and the wafers had to be remade or modified.

In cases where wafers fitted the models but were not accurate intraorally, it was felt that the most likely cause was the inability of the passive orthodontic archwire to retain teeth in position after the active orthodontic phase. In one case, it was felt that the wafer repositioned the maxilla incorrectly; the wafer was abandoned and the maxilla was fixed in the required position. In two cases, the fit and osteotomy movements with the wafer were inadequate, which may be a reflection of weakness in model surgery technique or errors in occlusal registration.[7] In two cases where wafers broke at the fixation stage, both cases involved segmental procedures and the thin wafers were made using self-curing clear acrylic, which possibly compromised the wafer strength. Additionally, in segmental surgical procedures there may be a tendency to force the wafer into position without adequate amounts of bone being removed thus putting extra stress on the wafer. This problem was resolved with the use of high impact acrylic in these difficult cases.

Block and Hoffman[8] suggested the use of ball-end clasps incorporated into the wafer to make it removable and claimed that patients could maintain an improved level of oral hygiene, and at the same time having the use of a wafer and training elastics to maintain occlusal stability. In practice, the authors found this method provided poor stability for training elastic traction and was without improved oral hygiene. The back of sufficient advantage over simple wire loop suspension did not justify the additional time for design and construction.

Ripley[9] suggested the use of a composite wafer, which was relatively thick and cumbersome. This study showed that surgeons generally disliked thick wafers. Conversely, Telfer and Page[10] suggested the use of carbon fiber to strengthen the occlusal wafer so that it could be made very thin. Harris and Reynolds,[2] Proffit and White[4] also emphasized the use of the thin-nest possible wafer. This review, supported by the authors' experience, showed that a quick-cure high impact acrylic was substantially more reliable for thin wafers than self-cured clear acrylic, which was more liable to fracture. For patients with neuromuscular disorders or with cleft maxillary surgery requiring extra-oral suspension, a silver or cobalt chromium alloy wafer may be required. In two cases, the surgeon reported that short anterior wafers produced anterior open bite. Thick wafers were cumbersome and difficult to manipulate intraorally. Silver and cobalt chromium wafers were time consuming to produce but essential in a small number of patients.

For bimaxillary procedures it is common practice to construct both intermediate and the final wafers as thin as possible to minimize occlusal discrepancies. Paradoxically the use of a thin intermediate wafer also assumes that the "autorotation" of the articulated models used to fabricate this wafer is an accurate simulation of an operative anatomical change.[7] To test this, Bamber and Harris[3] constructed a thick wafer without autorotation of the articulated models relating the repositioned maxilla to the unchanged mandibular model and compared with a thin wafer constructed between the repositioned maxilla and "autorotated" mandible. They reported that contrary to expectations, centric relation in the anaesthetized recumbent patient appeared to function in the same way as the articulator hinge axis. Not only did 74 per cent of cases show no difference between the thick and the thin wafers, but also in the remaining 26 per cent the mean difference was only 1.6 mm ± 0.6 mm. This error in the antero-posterior direction in 26 per cent of cases would appear to be determined by a discrepancy between the anatomical hinge axis in relation to the articulator axis,[11] which would be anticipated more frequently with an arbitrary facebow system and marked individual anatomical variation.[12,13]

The differences between the anaesthetized centric relation and active centric occlusion can usually be eliminated by overcorrection of the anteroposterior position of the mandible and immediate post-operative proprioceptive training with elastics and the final wafer for two weeks, followed when necessary by orthodontic refinement of the buccal occlusion. This controlled

review of wafers showed that an occlusal wafer design may vary much depending upon the patient and the treatment plan in a small number of patients, but in most cases simple autopolymerizing acrylic wafers with holes for maxillary suspension would prove to be most valuable.

References

1. McCance AM, Moss JP, James DR. Le Fort I maxillary osteotomy: Is it possible to accurately product planned pre-operative movements. Br J Oral Maxillofac Surg 1992; 30: 369-76.
2. Harris M, Reynolds IR. Fundamentals of orthognathic surgery. 1st ed. London: W B Saunders Company; 1991.
3. Bamber MA, Harris M. The role of the occlusal wafers in orthognathic surgery: a comparison of thick and thin intermediate osteotomy wafers. J Cranio Max Fac Surg 1995; 23: 369-400.
4. Proffit WR, White PR. Surgical orthodontic treatment. London, Toronto, Chicago: Mosby; 1991.
5. Bamber MA. Recording the facial midline for orthognathic surgery planning. Br J Oral Maxillofac Surg 1995; 32: 112-4.
6. Cottrell DA, Wolford LM. Altered orthognathic surgical sequencing and modified approach to model surgery. J Oral Maxillofac Surg 1994; 52: 1010-20.
7. Bamber MA, Abang Z, Harris, M, Linney A. The effect of posture and anaesthesia on occlusal relationship in orthognathic surgery. J Oral Maxillofac Surg 1999; 57: 1164-72.
8. Block MS, Hoffman D. A removable orthognathic surgery splint. J Oral Maxillofac Surg 1987; 45: 195.
9. Ripley JF. Composite surgical splint for dual arch orthognathic surgery. J Oral Maxillofac Surg 1982; 40: 687-9.
10. Telfer MR, Page KB. Carbon fibre reinforced osteotomy wafers. Br J Oral Maxillofac Surg 1990; 28: 210-1.
11. Nattestad A, Vedtofte P, Mosekilde E. The significant of an erroneous recording of the centre of mandibular rotation in orthognathic surgery. J Cranio Max Fac Surg 1991; 19: 254-9.
12. Bamber MA, Firouzai R, Harris M, Linney A. A comparative study of two arbitary face-bow transfer systems for orthognathic surgery planning. Int J Oral Maxillofac Surg 1996; 25: 339-43.
13. Marko JV. Simple hinge and semi-adjustable articulators in orthognathic surgery. Am J Orthod Dentofac Ortho 1986; 90: 37-44.