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Surgical Wafers: A Comparative Study

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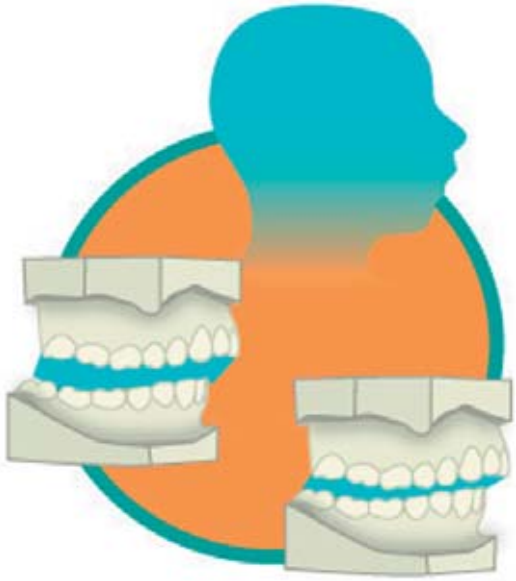

Abstract

A comparative study of occlusal wafers for orthognathic surgery made for 185 orthognathic surgery patients with the 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 most satisfactory. However, some difficult patients with cleft palates or neuromuscular disorders may require wafers of a novel design and material.

Keywords: Orthognathic surgery, occlusal wafers, osteotomy, Lefort I osteotomy, BSSO

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Introduction

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 of the jaws.[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) post-operative proprioceptive guidance.

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

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 temporary or permanent intermaxillary fixation.

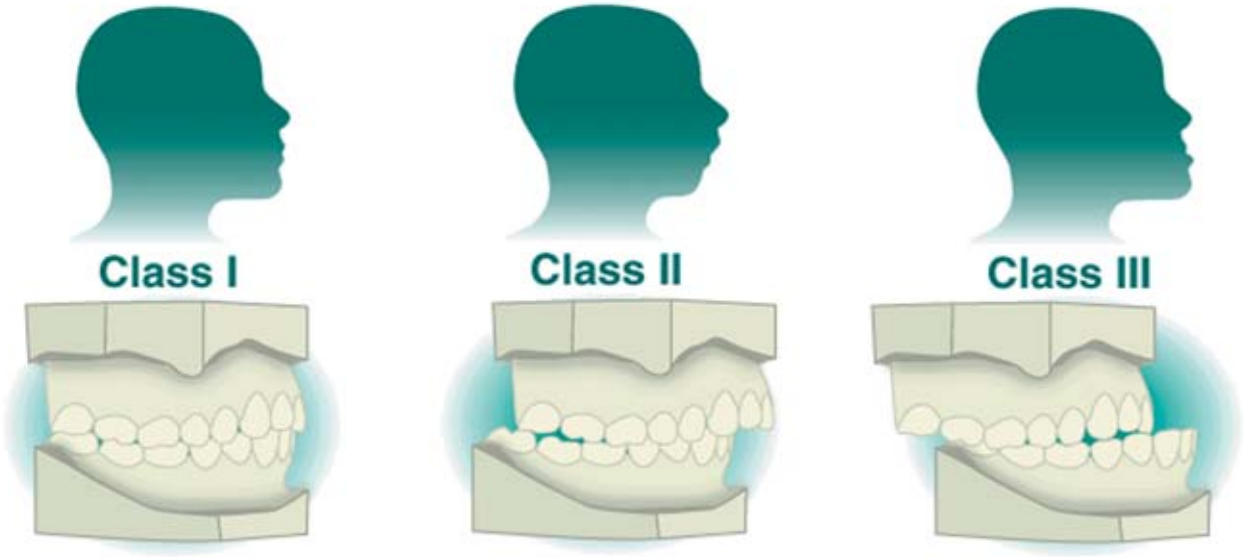
Post-Operative Proprioceptive Guidance

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 occlude into the planned position 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.

Materials and Types of Occlusal Wafers for Orthognathic Surgery

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 fabrication; impressions must be taken at least two 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 be detrimental to the outcome even when using the most skillful surgical technique.[2, 4, 6]

Proffit and White[4] advised that for patients whose arches had been leveled before surgery, the thinnest practical wafers had 1 to 2 mm



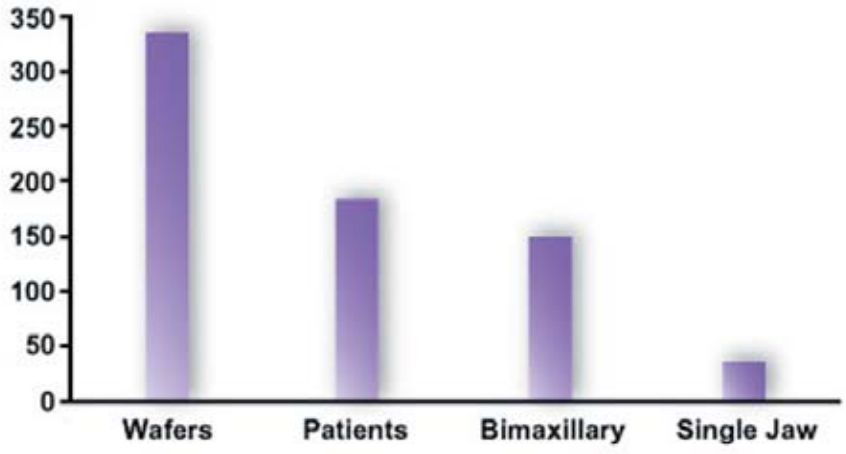


Figure 2: Patients and wafers reviewed for this study.

- Wafers = 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.

of material between the teeth, 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 making the wafer slightly thicker posteriorly (<2 mm) will allow some room for upward recoiling of the condyle post-operatively.[7] The literature review showed there was a lack of consensus among 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.

Methods and Materials

In the Department of Oral and Maxillofacial Surgery, Eastman Dental Hospital and University College London Hospital during the period from 1992–1995, 335 occlusal wafers were made for 185 orthognathic surgery patients (35 single jaw and 150 bimaxillary) with the mean age of 24.4±4.3 years (Figure 2).

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

1. Sixty clear self-cured and 40 heat-cured acrylic wafers with (final) or without (intermediate) holes for wire loop suspension.
2. One hundred two high impact acrylic wafers with full occlusal coverage and provision for wire.
3. Loops.
4. Thirteen wafers with ball end clasp and 14 with C clasps with full occlusal coverage in high impact acrylic.
5. Twenty-four thick (before autorotation) and 24 thin (after the autorotation) wafers in high impact acrylic. (Figures 4a, 4b)
6. Sixteen wafers with posterior occlusal coverage only (with lingual connector); ten in high impact and six in clear acrylic.
7. Twenty-four short anterior wafers in high impact acrylic.
8. Eight wafers with transpalatal acrylic connectors and full occlusal coverage in self-curing polymethyl methacrylate.
9. Six silver and four 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 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 the metal. Beading

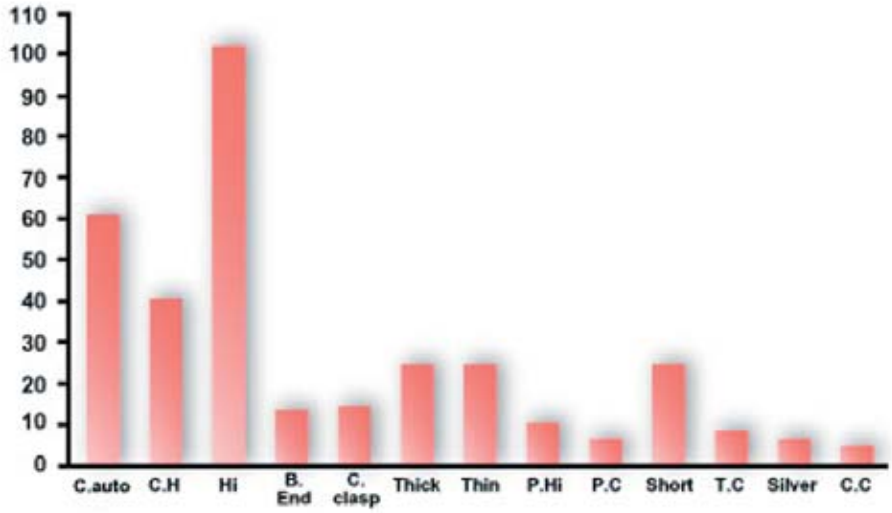


Figure 3: Various types of wafers used during this study.

- 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 = wafer made without mandibular autorotation after maxillary impaction.
- Thin = wafer made after maxillary autorotation in cases of maxillary impaction.
- P.Hi = wafer with posterior coverage made from high impact acrylic.
- P.C = wafer with posterior coverage in clear acrylic.
- Short = short wafer with anterior coverage in high impact wafer.
- T.C = wafer transpalatal connectors.
- Silver = wafer cast in silver alloy mainly for cleft palate patients.
- C.C = wafers cast in cobalt chromium alloy, rarely used in patients with neuromuscular disorder.

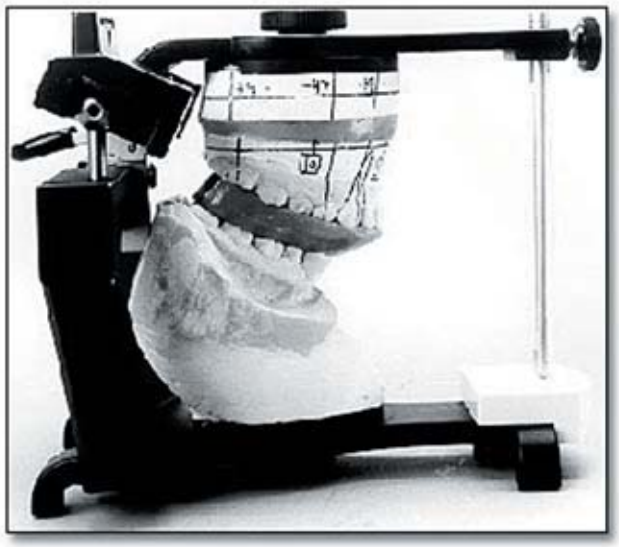


Figure 4a: Thick occlusal wafer in high impact acrylic.

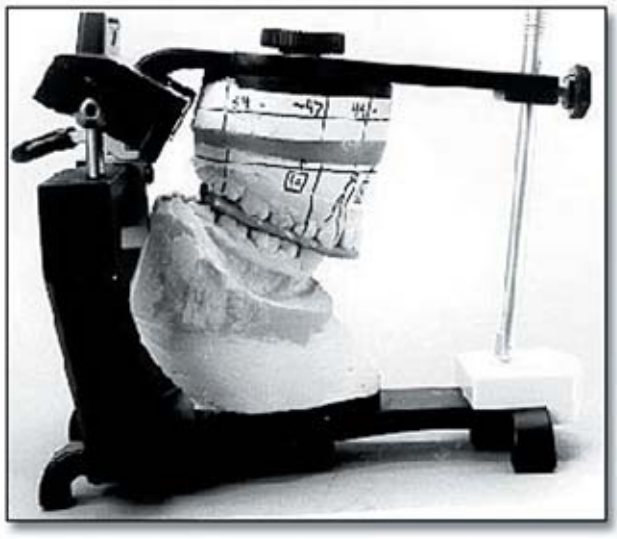


Figure 4b: Thin occlusal wafer in high impact acrylic.

Patient Name:	**Consultant:**
Hospital No: (EDH/UCH/GOS)	**Operations:**
Questions	**Responses**
Was model surgery satisfactory?	Yes / No
If no, how can it be improved?	
Was the intermediate wafer used? If no, why not?	Yes / No
Were both (thick and thin) intermediate wafers tried? If no why not? If yes were they different?	Yes / No mm:
Were bur reference holes drilled to work out the difference? If no, other reference marks used?	Yes / No
Was a final wafer used? If no, why not?	Yes / No
Can it be improved? If yes, how?	Yes /No
Were internal or external reference marks used for maxillary movement? If yes, which one?	Yes/No
At the end of the operation: Anterior/posterior relationship? Maxillary midline to facial midline? Mandibular midline to maxillary midline? Overbite?	 Pre-normal / Normal / Edge to edge / Post-normal Rt mm_____ / Coincident / Lt. mm_____ Rt mm_____ / Coincident / Lt. mm_____ Complete / Edge to edge / Open
Comments / Suggestions:	

Figure 5: Orthognathic surgery technology proforma to be completed by surgeons to record their operative notes.

wax strips were used to mask the orthodontic brackets on the dental casts and to control the flow of the acrylic deep into sulci and the palate.

Using a pro forma provided with the orthognathic surgery workup, 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. (Figure 5)

Results

Of the 185 patients in the study, 170 patients (92%) the wafers were found to be satisfactory with good surgical results, whereas in 15 patients (8%) the wafers were recorded as unsatisfactory (Figure 6).

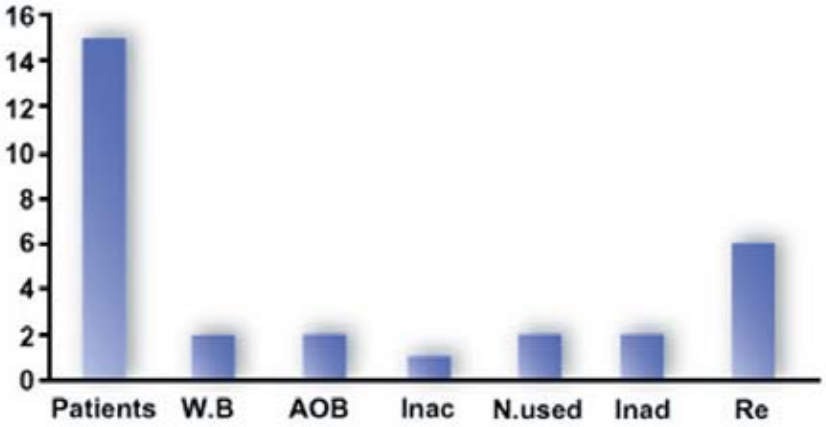


Figure 6: Patients with unsatisfactory wafers.

- 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.

Of these wafers 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 two patients the wafers did not fit well enough at the operation. The remaining six did not fit at the try in stage so they 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 surgeons preferred thin wafers trimmed close to the teeth with holes to accommodate wire loop suspension to the maxilla. Most operators felt better able to check the fit of clear acrylic wafers.

Discussion

This review has shown that a quick-cure polymethyl methacrylate occlusal wafer was most suitable for routine orthognathic surgery, although in some cases other types of occlusal wafers may be required. Patients requiring maxillary segmental surgery, patients with a cleft palate, or uncooperative patients with neuromuscular disorders, 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, one week before the operation. 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 the most likely cause was the inability of the passive orthodontic archwire to retain teeth after the active orthodontic phase. In one case it was felt 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 Hoffman8 suggested the use of ball-end clasps incorporated into the wafer to make it removable and claimed patients could maintain an improved level of oral hygiene, at the same time having the use of a wafer and training elastics to maintain occlusal stability. In practice we have found this method provides poor stability for training elastic traction without improved oral hygiene. This does not offer sufficient advantage over simple wire loop suspension to justify the additional time for design and construction.

Ripley[9] suggested the use of a composite wafer, which is relatively thick and cumbersome. This study showed surgeons generally disliked thick wafers. Conversely, Telfer and Page[10] suggested the use of carbon fiber to strengthen the occlusal wafer so it could be made very thin. Harris and Reynolds[2] and Proffit and White[4] have also emphasized the use of the thinnest possible wafer. This review supported by our experience has shown that a quick-cure high impact acrylic is substantially more reliable for thin wafers than self-cured clear acrylic, which is 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 short anterior wafers produced an 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 final wafers as thin as possible to minimize occlusal discrepancies. Paradoxically the use of a thin intermediate wafer also assumes 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 it 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% of cases show no difference between the thick and the thin wafers, but also in the remaining 26% the mean difference was only 1.6 mm ±0.6 mm. This error in the anteroposterior direction in 26% 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 anesthetized 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.

Conclusion

This controlled review of wafers showed an occlusal wafer design may vary 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.

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