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Form Ever Follows Function: The Occlusal Compass and Direct Resin Composite Restorations

Abstract: Direct composite resins in the posterior dentition are a day-to-day treatment modality for most dental practitioners. It is challenging for many operators to produce a restoration that is both aesthetic and functional in a clinically realistic timeframe. This article helps to address this.

CPD/Clinical Relevance: To present a functionally-generated approach to occlusal anatomy based on the DeVreugd Occlusal Compass to simplify the placement of direct composite resin in the Class I and II situation.

Dent Update 2019; 46: 344–350

Statement of problem

It is the pervading law of all things organic and inorganic, of all things physical and metaphysical, of all things human and all things super-human, of all true manifestations of the head, of the heart, of the soul, that life is recognizable in its expression *That form ever follows function. That is the law*[1]

The posterior direct resin restoration is the most common restoration carried out in general dental practice[2] and therefore consumes a large amount of a dentist's energy and time. A significant portion of the appointment time for direct resin restorations in the posterior dentition is spent on layering and contouring resin masses and final finishing with rotary instrumentation.

The majority of operators choose to layer their composite resin in its pre-polymerized state as a fairly amorphous mass with basic cuspal inclines, followed by contouring and polishing with burs, discs and points after polymerization. In recent years, more anatomical layering techniques have been proposed[3,4] which offer a more elegant solution to layering, however, they are based on layering the enamel masses to a preconceived *aesthetic* ideal. This means that the operator has an idea in his or her mind of the ideal occlusal anatomy (usually from textbooks of anatomy or, in *Today's World*, online learning) and then imparts this 'one size fits all' solution to each tooth. Whilst these approaches are simple to teach and easy to learn, they confer the following disadvantages:

1. Significant occlusal adjustment is common, particularly in patients who are restored conformatively (the majority) who are in group-function or have pre-existing posterior interferences. This is due to two main factors: first, the contact point in *maximal intercuspation position* is commonly too 'high' (maximal intercuspal position; the complete intercuspation of the opposing teeth independent of condylar position, sometimes referred to as the best fit of the teeth regardless of the condylar position; comp, *centric* occlusion.[5] Secondly, the designed occlusal scheme often does not allow freedom of movement in dynamic occlusion; that is, during chewing.
2. Occlusal adjustment often results in loss of key anatomical detail: convex cusps become concave, fissure patterns and fossae are erased and enamel composite is removed, leaving exposed dentine composite. The net outcome being an aesthetic compromise; often a shapeless grey mass.
3. The process of occlusal adjustment in itself is time consuming and is often unpredictable in terms of the time scale involved.
4. The author proposes a more fluid dynamic approach to occlusal anatomy based on *function* using the DeVreugd Occlusal Compass as a guideline. This results in either no adjustment or, more commonly, very limited adjustment of restorations after final layering, with the advantages of a more aesthetic restoration which is faster to place and easier to polish.

The occlusal compass

The patient's pre-existing dentition: specifically, the position of cusps,

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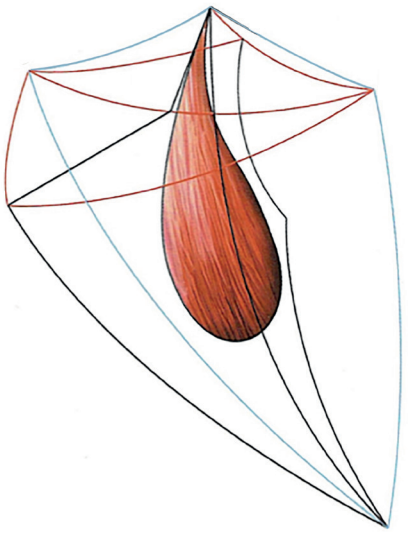

Figure 1. Posselt's Envelope of Motion of the Mandible.

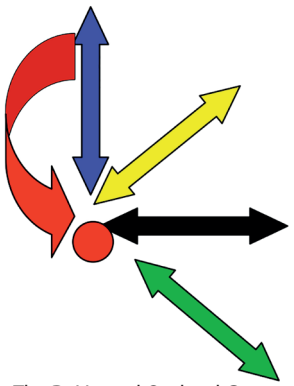

Figure 2. The DeVreugd Occlusal Compass.

Figure 3. Typodont occlusal cavity pretreatment.

fossae and fissures; the angulation of the cuspal inclines; and wear patterns, act like road maps showing us where patients have been during their chewing patterns and, in turn, suggesting to us a route which is ideal for the occlusal scheme of each particular case. In essence, the intended final occlusal scheme should be clear to the operator by simple observation prior to touching the tooth with a bur.

The reason for the existence of posterior occlusal morphology is to allow the mastication of food whilst maintaining freedom of occlusal contact from MIP out towards the border positions. (That is, the posterior cusps disclude during excursive movements, the guidance being from the anterior units).[6] Posselt described the functional movements of the mandible as an 'Envelope of Motion' separated into three planes of space (Figure 1): sagittal, frontal and horizontal. Therefore, it follows that the dynamic interrelationship of the teeth is also in three dimensions.[7] The summation of each cusp's movement in three dimensions throughout functional pathways is known as its 'Occlusal Compass' (Figure 2). The Occlusal Compass is individual to any given cusp (in terms of its depressions and elevations) and is governed by the position of the cusp in relation to the centre of rotation of the condyle of the mandible. The terminology used to describe the Occlusal Compass is taken from The Glossary of Occlusal Terms formulated by The Glossary Committee of The International Academy of Gnathology.[8] It should be remembered that mandibular movements leave from, and (importantly) return to, MIP during chewing strokes and during swallowing. The movements are:

- PROTRUSION (black) – the forward thrust of the mandible;
- LATEROTRUSION (blue) – side thrust laterally or outward;
- LATEROPROTRUSION (yellow) – outward and forward thrust;
- LATERORESURTRUSION (red) – an outward, backward and upward thrust. This is commonly known as the Bennett Movement, after Norman G Bennett (1870–1947);
- MEDIOTRUSION (green) – a side thrust medially or inward allowing for the downward/forward thrust of the non-working condyle.[9]

The Compass Point itself (the contact in MIP) has a small area of additional freedom surrounding it which allows for opposing cusp movement in 'Long Centric' (or 'Freedom in Centric').[10] This is the basis of The 'Polz' Biomechanical Wax Up[11] on which the DeVreugd Compass is based.

This article aims to illustrate a dynamically driven, common sense approach to the restoration of posterior teeth with direct resin, which results in minimal adjustment of the restoration on completion of layering. For brevity, the author will concentrate on the upper first molar; this tooth was selected since, during mastication, the first molar bears the most force and has the highest number of occlusal contacts.[9]

Stage-by-stage upper first molar on typodont model

Developing functional occlusal anatomy in the mesio-distal and bucco-lingual planes

Start Point: simple Class I occlusal cavity (Figure 3)

As a general rule, The Occlusal Compass is developed on a cusp-by-cusp basis, always starting opposite the largest cusp: since the largest cusp on the upper first molar is the mesio-palatal, the author begins at the mesio-buccal. The mesio-buccal triangular and marginal ridges are placed with a low opacity mass of composite resin of the appropriate VITA Shade. In doing so, the mid-buccal fissure (blue – laterotrusive) and secondary mesio-buccal anatomy (yellow – lateroprotrusive) are formed. The author favours manipulation of the resin using a simple Ash Number 6 explorer.[12] However, a spatula or POCS (Posterior Occlusal Carver Small – similar to a PK Thomas 3 wax carver) may be employed to the operator's preference. The resin-mass is then further modelled and the anatomy 'softened' and adapted to the cavo-surface margins with a Number 1 Brush (GC Corp) and a modelling-resin. Modelling resin is a liquid resin used in small quantities to allow brush adaptation of the resin: many companies manufacture this product, for example Kulzer (*Signum Liquid*), Bisco (*Modelling Resin*) and Cosmedent (*Brush and Sculpt*). This increment is polymerized to a gel state employing the 'Pulse-Activation' Protocol:[13] this has the dual advantage of saving time and reducing the impact of polymerization stress within the restoration (Figure 4a and b).

The disto-buccal triangular and marginal ridges are then formed in much the same way; this completes the mid-buccal fissure (blue – laterotrusive) and develops the secondary anatomy of the disto-buccal cusp (red – lateroresurtrusive). As an aside, the correct positioning of

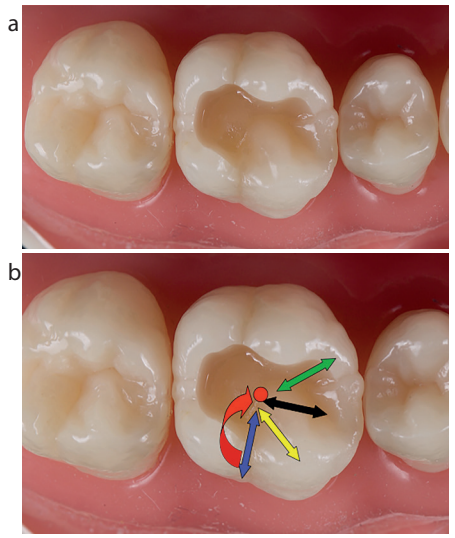

Figure 4. (a, b) Placement of mesio-buccal cusp.

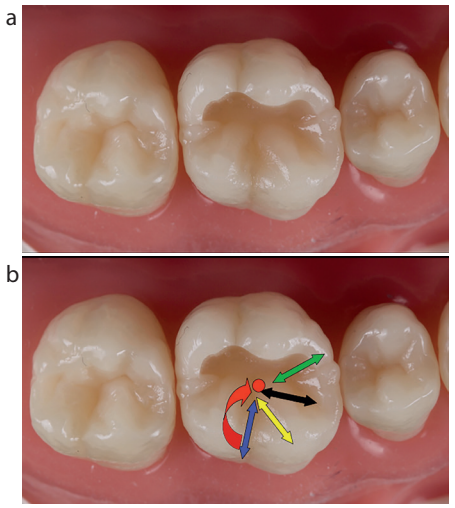

Figure 5. (a, b) Placement of disto-buccal cusp.

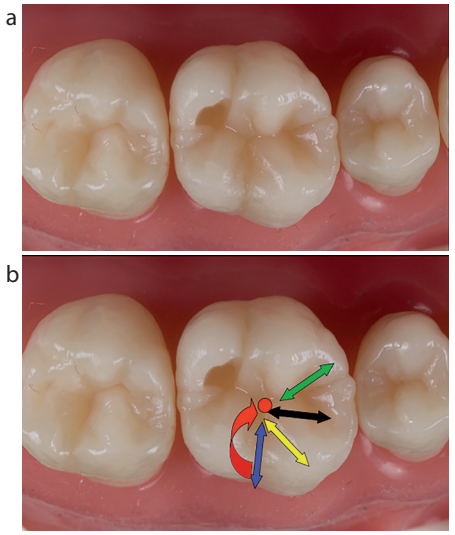

Figure 6. (a, b) Placement of mesio-palatal cusp.

Figure 7. (a, b) Placement of disto-palatal cusp.

Figure 8. Completed Class 1 restoration with fissure tints.

Figure 9. Occluso-apical position of Compass Point formed by converging cuspal inclines.

the mid-buccal fissure is critical to the laterotrusive movement and also to the final position of the Occlusal Compass Point: anecdotally the author finds that mentally drawing a line from MB cusp tip to DB cusp tip and bisecting this at right angles correlates well to the mid-buccal fissure in most cases (Figure 5a and 5b).

The mesio-palatal triangular and marginal ridges are then formed with a small depression to allow mediotrusion (green): in addition to the so-called 'Stuart's Groove'. A small finger-like projection of resin extending from the mesial marginal ridge to the Occlusal Compass Point is added to allow the black protrusive movement (Figure 6a and b).

The build-up is completed with the triangular and marginal ridges of the disto-palatal cusp. It should be noted that the palatal groove runs distally, making the MP cusp larger than the DP: this is one of the most common errors when building up the first molar. In addition, a further Compass projects mesially from the mesial marginal ridge of the second molar; care should be taken that the DP cusp inclines do not obstruct the mediotrusive pathway of this movement (Figure 7a and b).

Some operators chose to characterize the fissure pattern with tints in selected cases: this optically defines the cuspal anatomy and improves aesthetics. In addition, any minor defects within the fissure anatomy are sealed since the tint is in fact a flowable composite: this simplifies polishing procedures and improves the patient's long-term comfort (Figure 8).

Developing functional occlusal anatomy in the occluso-apical plane

The DeVreugd Occlusal Compass is extremely effective in creating the occlusal contact point and excursive pathways in two dimensions; however, what about the third dimension: that is the corono-apical or the height of the contact point?

The corono-apical dimension of the occlusal contact point is defined by the steepness of the intersecting cuspal inclines: cuspal inclines which are steeper result in a Compass Point which is more apical and vice versa (Figure 9).

If the cuspal incline created in resin is too steep, the restoration will be in infra-occlusion, whereas if the incline is too shallow, the restoration will be 'high' and significant occlusal adjustment will be required with all of the disadvantages listed above. A simple approach is employed to avoid these problems: prior to operative intervention, the cuspal inclines of the tooth to be restored are assessed and compared with the adjacent teeth both mesially and distally. The operator assesses if the cuspal inclines of the tooth to be restored are steeper than its neighbours, shallower or somewhat similar (this is the norm). This

Figure 10. Upper first molar failing amalgam restoration with Class II carious lesion.

Figure 11. Quadrant isolation with rubber dam.

Figure 12. Existing restoration removed and caries exposed.

Figure 13. Completed Class II preparation.

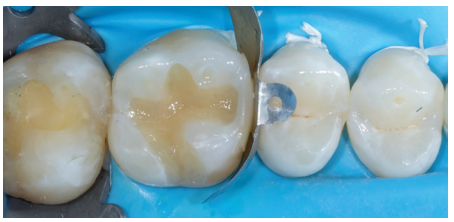

Figure 14. Class II box closed with direct resin.

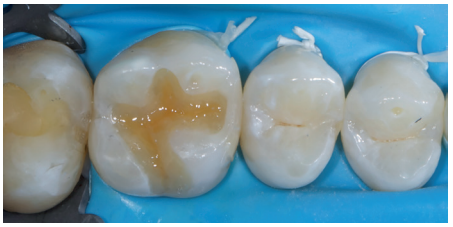

Figure 15. Hyperchromic dentine placed and enhanced with tints.

Figure 16. Enamel resin mass placed and tints applied.

Figure 17. Outcome immediately post operative.

is then documented either mentally or via intra-oral photography and then reproduced in the final restoration.

Case studies

Case 1

A 31-year-old male patient presented with symptoms of reversible pulpitis related to his upper right first molar. On clinical examination, an existing OP silver amalgam restoration was noted, alongside secondary caries mesially, with associated cavitation of the marginal ridge (Figure 10). A wear facet was noted on the MB cusp tip: the tooth was otherwise unremarkable clinically and radiographically. After informed consent, the tooth was treatment planned for a Class II three-surface direct resin restoration.

After local anaesthesia, the tooth was isolated with latex-free rubber dam; the dam was inverted and simultaneously retracted interproximally with floss-ties (Figure 11).

Under magnification (Operating Microscope) the old restoration was removed with a pear-shaped diamond bur in a 1.5 speed increasing electric handpiece at around 45000 RPM with water spray exposing the caries mesially. The author prefers the precision of the electric handpiece, which offers high torque and has lower tendency to stall at lower speeds. The adjacent premolar was protected from iatrogenic damage by a 'wedgeguard' (Triodent) (Figure 12). Iatrogenic damage of the adjacent tooth is a well-documented complication of Class II box preparation.[14]

Caries was excavated step-wise, utilizing caries detector dye and the Peripheral-Seal Concept[15] to create a peripheral zone of highly bondable caries-free enamel and dentine whilst retaining caries-affected dentine deeper within the cavity for remineralization[16] The margins were particle-abraded with alumina to remove biofilm and aprismatic enamel, thus improving bond strengths,[17] and planed with carbide burs to remove enamel prisms, which are fractured at histological level[18] and reduce the risk of white lines from 'Enamel Peel' (Figure 13).

The tooth was etched with 37% phosphoric acid and a 4th Generation dentine-bonding agent applied (*Optibond FL*, Kerr). The Class II box was first closed centripetally[19] with both flowable and heated composite resin aided by a sectional matrix band. The dentine was modelled with a hyperchromic paste composite resin of moderate opacity to mimic the optical properties of natural dentine (Figure 14). An ochre tint was applied to the fissure system in order to increase the chromaticity of the restoration (Figure 15). Enamel shade composite of moderate translucency is applied to the cavity using the 'Occlusal Compass' approach. Chocolate brown tints are applied externally to mimic fissure staining (Figure 16).

The restoration was polished with a combination of discs and silicone points, the occlusion checked and the patient dismissed. Note minimal disruption of the initial occlusal anatomy after finishing (Figure 17).

Case 2

A 26-year-old patient presented with a temporary Class I restoration in an upper right first molar after an endodontic therapy. Since a significant amount of dentine and enamel remained and the marginal ridges were intact, the tooth was treatment planned for a direct resin restoration after informed consent (Figure 18).

The tooth was prepared as per the description in Case 1 (Figure 19).

Finally, the cavity was restored with a 'Modified Super-Closed Sandwich Approach',[20] a modification of the classic

Figure 18. Upper first molar with existing provisional restoration.

Figure 19. Class I cavity preparation completed.

Figure 20. Final restoration.

Resin-Modified Glass Ionomer Closed Sandwich approach utilizing the Occlusal Compass to close the occlusal surface (Figure 20).

Conclusion

This article aims to share a simple, easy, yet predictable technique which will allow the average dental practitioner to produce beautiful, life-like aesthetic restorations that are functional and require very little, if any, occlusal adjustment after layering. All of this can be achieved in a clinically realistic timeframe in the average dental practice using minimal shades of composite resin, very few instruments and a knowledge of the Occlusal Compass.

Dedication and thanks

This article is dedicated to the late Russell T DeVreugd RDT: a fellow lover of dentistry, steaks and fine red wines, mentor, teacher and, most of all, friend: a firm unwavering guiding hand, which is constantly missed. The author with Russell DeVreugd and Miss Erica Heier outside David Burke's Primehouse, Chicago IL USA (Figure 21).

Figure 21. The author with Mr Russell DeVreugd and Miss Erica Heier outside David Burke's Primehouse, Chicago, USA.

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