LITERATURE REVIEW

At Boutique we aim to provide our customers with the most up to date materials, techniques and information based on current clinical evidence. S4S Technical Director, Matt Everatt, and Dr David Bretton, recently completed a literature review on the design of whitening trays which yielded some interesting results!

The current S4S Ultra-seal trays have been incredibly well received, with outstanding client feedback. However, with neither company wanting to rest on their laurels, the findings of the literature review prompted us to review and improve our current trays, to give even better results, with improved comfort and fit.

The specific design features of our 'Mark II Ultra-seal' trays are as follows:

- **Semi-rigid EVA bleaching tray specific material**
- **Hybrid pressure and vacuum formed process (technique unique to S4S)**
- **Dosing dots**
- **Non-scalloped margins**
- **Sealed gingival margins**

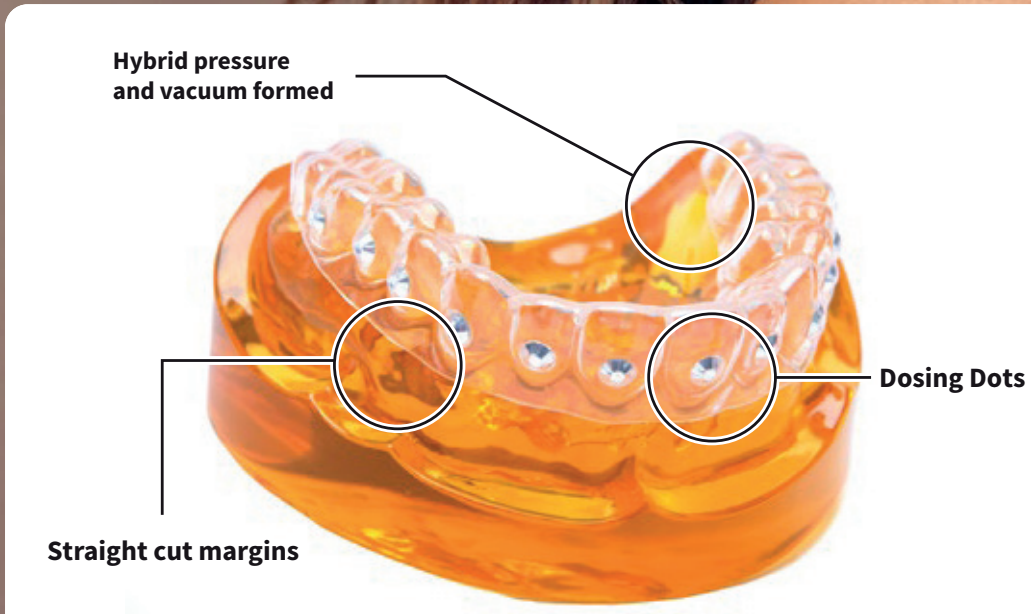
The combination of the semi-rigid material, and the unique pressure and vacuum forming process, not only ensures we have the best adapted trays, but a more uniform tray thickness, which translates to better stability. The technique used by S4S also produces a beautifully clear, glass-like finish on the trays.

Non-scalloped, straight cut margins are the biggest change in our Mark II trays, and the modification that we feel will have the biggest impact on clinical outcomes. The literature indicates that superior results are achieved with a straight cut margin on the tray, as opposed to scalloping. Further details will be released once the review has been published.

Sealed gingival margins are also an important design feature of our trays. The preparation of the margins is paramount to ensure a good marginal seal, which means less saliva ingress, and less gel wash-out, which in turn means more active gel is in contact with the tooth surface, leading to better results and less sensitivity.

The combination of all these factors will take our tray design, and whitening results, to new heights. The fantastic synergy between Boutique Whitening and S4S Dental Laboratory means continuing innovation and the pursuit of excellence, to the ultimate benefit of our valued customers. Watch this space!

The 'Dosing Dots' are a tool to aid the patient in administering the correct quantity of gel. By only filling the dot, the patient can be sure that they are not over filling the trays which can lead to sensitivity caused by excess gel in contact with soft tissues. It also means that the gel lasts longer to give better results.



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A LITERATURE REVIEW OF BLEACHING TRAY DESIGN AND EFFICACY

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Tooth whitening is very common practice in dentistry today, made famous by celebrities in the 1980's and initially thought to have been discovered by accident by a group of dentists using peroxide to treat gum disease (Kurthy, 2016). The UK tooth whitening industry is believed to be worth over £40m as more consumers seek the white healthy smiles endorsed by many celebrities. (National Smile Month, 2018) Further market research shows that 99.2% of us believe our smiles are an important social benefit. (Hexa Research, 2017) Furthermore, a study found 48% of adults believe that a person's smile is the most memorable thing they remember when first meeting them. (Salemi, 2013)

Haywood (2003) suggests that the efficacy of whitening is greatly improved when the peroxide level is around 6% Hydrogen Peroxide and custom made dental trays are made to hold the gel close to the teeth for a period of around 2 hours. Carey (2014) supports this positive approach and states "Home-based bleaching (following manufacturer's instructions) results in less tooth sensitivity than in-office bleaching. The optimal regime to obtain persistence of tooth whitening is to follow an in-office treatment with monthly home-based touch-up treatments using OTC products." It is therefore important to consider the design and use of custom made bleaching trays to achieve the optimal results in a timely and safe manner.

Bleaching Tray Design

Bleaching Tray designs have been debated amongst dental professionals over the years and many opinions formed on the basis of very little scientific evidence to support any particular design. Many assumptions are made and logic used in the absence of science when discussing the specifics of tray design. There are several technical specifications used such as; scalloped margins, straight cut margins, extension beyond the gingiva, with or without reservoirs. The process of thermoforming is also debated; Mizuhashi and Koide (2017) found that vacuum formed appliances maintained material thickness, whilst pressure formed appliances obtained a better fit. Model thickness can also affect the fit and thickness of the finished tray. Due to the morphology of the oral tissues and dentition, it is difficult to provide a standardised model size in which to form the tray therefore material thickness can vary from model to model. Mizuhashi and Koide (2017) also noted the marginal fit of the pressure formed appliances was significantly improved by pressure forming appliances.

Reservoirs or No Reservoirs?

Matis et al (2002) showed that there was little difference in results in terms of shade difference when comparing trays with and without reservoirs, despite there being minor shade differences when using a colorimeter, the shade difference was below the threshold of visual differentiation. It would appear that the importance of using reservoirs is linked to how well the margins are sealed, trays that are scalloped are inevitably more flexible and will allow more bleach to escape the tray therefore requiring a larger amount of bleach present in a reservoir.

There are clinicians such as Kurthy (2016) who advocate the use of a reservoirs and finishing the tray exactly at the gingival margin. The margin for error from the impression stage to the dental laboratory finishing the trays is high. With this heightened risk versus the data to say there is no benefit in using reservoirs, it would appear counter effective to have gingivally trimmed trays and trays with a straight cut margin approximately 2mm beyond the margin will give better stability to the tray. (Cowley, 2012)

Dosing Dots

A relatively new method introduced in the tray design are 'Dosing Dots' (S4S, 2018) or 'dimples' (Chan, 2018). These are not to be confused as reservoirs, these small areas in the trays are designed to help the patient add the correct amount of gel to each tooth and not overload the tray. Overloading the tray can lead to sensitivity and non-compliance (Zase, 2009).

Gingival Contouring or Straight Extension?

Theory may suggest that gingival contouring or scalloping could reduce the amount bleach having mucosal contact, however there appears to be no cited references to the benefits to scalloping trays. In principal, one could argue that by closely following the gingival margin with a scalloped designed tray, the surface area covered is less and therefore leads to less mucosal irritation although this theory is not supported by any literature. To the contrary, Curtis et al (1996) demonstrated in a group of fifty two patients, there was no soft tissue damage in any of the sample group as a result of the bleaching regime. To further support that the extension of the bleaching tray has no effect on efficacy or sensitivity, Morgan et al (2015) demonstrated in their group of twenty subjects, there was no statistical difference in how effective the bleaching was, nor did the extended or non-extended trays cause anymore or any less sensitivity.

There appears to be a lack of clinical evidence to support gingival contouring. Research by Cowley (2012) compares the fit and retention of thermoplastic retainers in the different design of finishing, these being scalloped, straight cut at the gingival zenith and a straight cut 2mm beyond gingival zenith. The best retention was found in the appliances finished 2mm beyond gingival margins and the poorest retention was with those finished at the gingival margin. Although the materials cannot be compared like for like, finishing with a straight line cut will increase the stability of any thermoformed appliance, thus resulting in the likelihood that the bleach will remain in contact with the tooth surface longer possibly increasing the efficacy of the bleaching material. Further to support the benefits of cutting the trays straight in a line 2mm above the gingival margin, Cowley (2012) also suggests that the appliances should "[...]be more comfortable than before, because there will be less risk of them impinging on the unattached marginal gingiva".

Two points raised in this section are in regards to sensitivity and comfort. Cosmetic Dentist, Dr Zase (2009) lists sensitivity and compliance as the two main problems associated with tooth whitening. The whitening procedure could help reduce sensitivity whereas tray design can directly help improve compliance.

Tray Material

There are several materials that are commonly used for bleaching trays, most commonly used is 1 or 1.5mm soft EVA. In recent years there has been an introduction of material designed for the use in bleaching. A foamed lined tray for instance was introduced, the theory that the foam would have an advantage in holding the bleach over standard trays, however Haywood et al (1993) proved there was no difference in the clinical results. Manufacturers have introduced a material that has a firmer feel to standard EVA material and make this commercially available as a 'Bleach Tray Material' with the majority of the manufacturers offering 1.5mm semi-rigid as the most popular type for bleaching.

Conclusion

In conclusion, this review has highlighted that there is only a limited number of clinical studies that discuss tooth bleaching. Furthermore there are even less studies to support bleaching tray designs in relation to their effect on treatment. Further studies should consider trays designs in relation to compliance alongside the efficacy of the whitening gels.

With the limited clinical evidence, a conclusion can be drawn that a bleaching tray should have some specific design features whilst other features appear to be operator led without having any proven clinical benefit other than it being accepted by the clinician and patient as acceptable.

From the evidence reviewed in this report, optimal design of trays should have a good peripheral seal around the gingival margin, be trimmed straight just beyond the gingival margin to help the seal, improve the stability of the tray and improve comfort to the patient. There is no evidence to show reservoirs improve shade reductions and there is little evidence to support their use other than in trays that are trimmed gingivally to aid the seal. Although there is no published data to support 'Dosing Dots' or 'dimples' on the labial surfaces, it appears to be a useful tool in demonstrating to patients how much bleach to administer per tooth.

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