Impressioning: back to the future

Brenda Baker and **David Reaney** provide an overview of physical impression materials and dip into the world of digital impressioning

One of the most important areas of dentistry is accurate detail reproduction of the tooth surfaces for diagnostic and evaluation purposes as well as definitive restorative care.

This article is a review of the more commonly used physical impression materials and their handling, as well as an overview of the realm of digital impressioning, which is becoming more widely accepted on a global level.

ALGINATE

Alginate is an elastic irreversible hydrocolloid impression material used to take impressions of both dentulous and edentulous arches.

Its composition is made up of calcium sulphate, trisodium phosphate, diatomaceous earth, zinc oxide, potassium titanium fluoride.

Uses:

- Primary impression of edentulous patients with undercut ridges
- Impressions for dentulous patients – study models and temporary removable prostheses
- Provisional crown and bridge impressions
- Bleaching trays, mouthguards – less dimensionally critical appliances.

Advantages:

- Easy to mix and manipulate
- No elaborate equipment needed
- Material is elastic and comes out easily from undercuts
- Economical.

Disadvantages:

- Poor tear strength, especially in thin sections
- Poor dimensional stability (imbibition or dessication is a problem)
- Distortion if tray shifts in setting
- Not dimensionally stable on storing due to evaporation
- Alginate powder is unstable on storage in the presence of moisture or in warm temperatures
- Good for only one pour per impression
- Messy to work with.

Note: high points on indirect restorations are often a result of inaccurate opposing arch restorations from alginate materials.

Predictable alginate impressions can be made by adhering to the following protocol:

Selection of impression tray

- Select correct tray for dental arch
- Should be perforated
- Use alginate adhesive – paint-on or spray-on. Allow to dry for five minutes
- Can be modified with wax or tracing stick impression compound or heavy-bodied silicone. (If patient has a high palatal vault, tracing stick compound can be used in the centre of the maxillary tray to reduce the bulk of alginate impression material.)

Figure 1: Full-arch polyvinyl siloxanes (PVS) with occlusal perforations confirms correct interocclusal registration

Mixing and loading alginate

- Setting time should be controlled by varying water temperature, not the consistency of the mix
- Mixing should be rapid with a wide-blade spatula
- Mix should be creamy in consistency but not drip off spatula when lifted from the bowl
- Mixing time is 60 seconds for hand spatulation and 15 seconds for mechanical.

Preparing the mouth for impressions

- Occlusal surfaces of teeth should be blown off with an air syringe to remove debris and saliva in order to minimise air blows
- Teeth should not be left to dry completely as alginate sticks to dried teeth as the thin film overlying the teeth is removed. When the surfaces are dry, the alginate radicals in the impression material form chemical bonds with the crystals of hydroxyapatite in enamel; the alginate then tears upon

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removal
- Get the patient to rinse with water to eliminate mucin and lower the surface tension, thus eliminating air bubbles
- For removable prosthesis, impressions of the sulci are essential. The alginate should be spread generously over lower lingual, upper labial and hamular notch/distobuccal areas
- Mixed alginate should be rubbed onto the occlusal surfaces with a gloved finger to fill the occlusal grooves, allowing accurate reproduction of the occlusal tooth anatomy.

Note: alginate materials start setting from the tooth surface to the impression tray.

Removal and inspection of impression
- Once set, the impression has to be removed with a firm, quick snap
- During removal of the upper impression, the operator's index fingers (of both the hands) should be in the buccal sulci to break the seal while thumb holds the tray handle and the other fingers support the impression tray
- Inspect the impression for defects under good light
- Rinse impression with cold water
- Cover impression in a damp gauze/napkin (do not immerse in water) and place in zip-lock plastic bag until cast is poured. Wait 10 minutes as the elastic recovery of alginate impression material is slow
- Remove excess unsupported alginate with a sharp knife immediately. Unsupported alginate will result in distortion.

Storage and disinfection
- Spray full strength (5.25%) sodium hypochlorite (Westerholm et al, 1992).

Cast fabrication
- Initially, stone is allowed to set in the tray with the teeth down
- If tray is turned upside down onto base of stone immediately, water tends to rise to the highest point (cusp tips). This can cause faulty very soft cusps on the model
- Wait until set of stone before inverting to pour a base. Ensure adequate base thickness
- Remove cast immediately after adequate set to avoid 'moth-eaten' appearance
- Never leave alginate in contact with stone overnight.

POLYVINYL SILOXANES

Polyvinyl siloxanes (PVS) are addition reaction silicones elastomers.

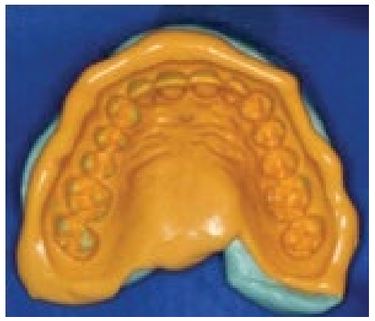

Figure 2: This impression will be suitable for commencement of sequential aligner therapy

Vinyl polysiloxane impression materials are routinely used in procedures in almost every general dental practice. As Endo and colleagues (2006) said: 'Manufacturers have developed and refined these materials to the level at which it is nearly impossible to blame the impression material for restoration misfits. These materials are accurate and stable.'

Uses
- Fixed prosthodontics for impressions of dentulous and edentulous arches, duplication of casts and bite registrations (Figure 1)
- Implant dentistry
- Sequential aligner therapy (Figure 2).

Presentation
Two pastes (base and accelerator) can be hand spatulated or autodispensed from dual cartridge and mixed in equal quantities for use.

Fewer voids are reported in impression material that is mechanically mixed than that which is hand-mixed (Di Felice et al, 2002).

Advantages
- Clean, odourless and tasteless
- Good working and setting time
- Superior dimensional accuracy and stability
- No reports of patient sensitivity to the addition silicones.

Disadvantages
- Inhibition of setting by sulphur-containing materials
- Expensive.

Viscosity
- These vary, ranging from very low (for pouring, syringing or wash use) to medium, high and very high
- The viscosity of the material increases with the proportion of the filler present.

Working and setting times
Modern PVS has a working time of two minutes and a setting time of six minutes (Chee and Donovan, 1992).

Reproduction of detail
- These reproduce the greatest detail of all impression materials. International standard for dental elastomeric impression materials states that type III (light body) impression material must reproduce a line 0.02 mm wide. All PVS (light, medium and heavy body) achieves this except very high viscosity putty materials
- Heavy body and wash impressions were reported to be more accurate than putty and wash impressions (Wassell and Ibbetson, 1991).

Dimensional stability
- PVS shows the smallest dimensional changes on setting of all the elastomeric impression materials is, approximately, 0.15% (Rubel, 2007)
- Most of the shrinkage is due to continued polymerisation occurring within the first three minutes of removal of the impression from the mouth
- Not susceptible to changes in humidity and do not undergo any further chemical reactions or release any by-products
- PVS can be repoured to produce stone dies, which are as accurate as the original as many as seven days later (Torassian et al, 2010)
- Least outgassing that produces cast surface porosity occurs if poured 60 minutes after mixing (Baxter et al, 2012).

Tear energy, elastic recovery and deformation
PVS deforms more slowly and tears at points of less permanent deformation than other elastomeric materials and exhibit better elastic recovery.

Hydrophilic properties
- PVS is inherently hydrophobic due to its chemical structure (Rubel, 2007). Recently, new 'hydrophilic' PVS has been introduced with claims that it better wets moist dental surfaces.
- Use of a modified polydimethyl siloxane wetting agent applied to the tooth surfaces before the impression was made showed a significant reduction in the number of voids and overall increased quality of PVS impression
- Applying an external surfactant to the impression surface has been suggested to reduce both the contact angle and the number of voids trapped in the resulting cast.

Impression trays and adhesives
- Use of adhesives in trays have been shown to achieve higher material bond strengths for PVS than mechanical retention. Adhesives used are usually polydimethyl siloxane and ethylsilicate. The adhesive reacts with the surface of the tray material and forms a chemical bond to the tray
- Wait 10-15 minutes after applying the adhesive before doing the impression (Cho et al, 1995). This allows time for the solvent to react with the tray material
- If the stock tray and the impression material inside it are not adequately rigid, the impression's accuracy will be compromised because of the flexibility of the tray and the material (Christensen, 2008)
- Roughening the surface of the impression tray significantly improves the effectiveness of PVS adhesives (Sulong and Setchell, 1991)
- Try-in impression tray in the mouth before impression making. If the tray has already been painted with adhesive then a new application is advised to maintain bond strength
- Contaminated adhesives have shown a drop in bond strength of 1/5 of the original amount.

Disinfection
Immerse in 1% sodium hypochlorite.

Compatibility with die materials
- Compatible with gypsum, epoxy resin and polyurethane resin
- Gypsum stones cannot reproduce detail

Figure 3: Clear, clean accurate margins are the cornerstone of successful restorative dentistry

much smaller than 20 microns
- Epoxy and polyurethane resins can reproduce detail down to one or two microns
- PVS can be silver electroplated and it is best to soak the impression in water for 24 hours before applying the silver powder. Silver dies made with PVS impressions are the most accurate dies
- Possible to pour duplicate dies from one impression.

Gloves
Avoid rubber gloves – a sulphur compound retards polymerisation. Zinc diethyldithiocarbamate is an accelerator used to make latex gloves that reacts with the platinum catalyst in the PVS to cause delay or total inhibition of polymerisation. Use synthetic latex gloves.

DIGITAL IMPRESSIONING

Computer-aided design (CAD) and computer-aided manufacturing (CAM) has become increasingly popular with the dental profession over the last 25 years.

CAD/CAM technology was developed to address several challenges:
- Ensure adequate strength of the final restoration, especially posterior teeth
- Create natural aesthetic restorations
- Facilitate faster, more accurate manufacturing processes
- Allow more rapid turnaround time.

Digital impression units function as a digital replacement for physical impression materials – ie, PVS (Schoenbaum, 2012). The dentist prepares the teeth and has to manage the soft tissues as for a physical impression. The digital impression unit is situated chairside in the surgery and the screen is clearly visible to the clinician.

The scan always begins with a clean sleeve on the scanner for infection control. Some systems require the application of a contrasting powder before scanning. The prepared arch, the opposing arch and the interocclusal registration are scanned using an intraoral wand to take a series of digital images. Most systems offer the special benefit of being able to determine the precise occlusal clearance through the use of a digital 'colour map'.

Some systems allow the clinician to mark the preparation scan to indicate the desired margin. After the digital scanning process, provisional restorations are fabricated and placed. In the background, the digital impression unit compiles the scan data and prepares it for export. The data are then sent through a wireless router to the model facility or laboratory.

When laboratories receive a digital impression, they can create a three-dimensional resin print or mill a model from the data. With the use of a software program, the digital technician can digitally mark the margin, digitally ditch and trim the dies. Some systems allow the dental laboratory to mill the restoration directly from digital data.

Uses
- General diagnostic
- Fixed prosthodontics – inlays, onlays, veneers, crowns and bridges
- Restorative dentistry
- Implant treatment and prosthodontic rehabilitation
- Sequential aligner therapy.

Advantages
- Patient acceptance, eg patients who gag
- Marketing tool – enhanced patient recruitment and retention
- Secure data storage and eliminates need to store physical impressions for medicolegal records
- Rapid data transmission for digital and technical processing
- Allows all types of larger and more complex restorations – any deficiencies on a scan can be corrected immediately and it is patched by the software
- Potentially less time-consuming and can increase clinical efficiency and productivity
- Enables immediate checking of marginal integrity, preparation form and occlusal registration and clearance
- Allows immediate preparation adjustments and isolated scans can be done to check any concerns and thus eliminates the need for extra appointments to retake impressions
- No material restrictions
- No likelihood of distortion of either impression materials or bite registration materials
- Accuracy of scanning the occlusion and occlusal surfaces helps to reduce the time needed for minor occlusal adjustments at the issue appointment.

Disadvantages
- Initial cost acquisition
- Learning curve.

Accurate capture of marginal integrity
Proper isolation of subgingival margins is

Figure 4: Digital impressioning will only capture data. The dentist is compelled to provide the necessary retraction. Arrows indicate lack of clarity

Figure 5: The mesiobuccal and mesiolingual areas were prepared with sharp line angles, which were distorted by scanning. The dentist had to smooth the red-marked areas in the photo and re-scan before the onlay was fabricated

one of the most challenging procedures in clinical practice (Figure 3). For both conventional and digital impression techniques, an accurate final representation of the intraoral situation is crucial.

Clinicians who are experienced in the digital impression technique realise that digital impressions require even more definitive preimpression isolation of tooth preparation margins than conventional impressions.

Several principles are common to all the scanners, which significantly affects the outcome of the data:

- A dual-cord retraction technique is advisable (Schillingburg, 2012). After the preparation, a thin cord is placed and an initial scan is performed. Any areas on the preparation that need to be modified are noted and the preparation is refined. A hemostatic agent is used as needed and a thicker cord is placed for five minutes. The final scan is then completed
- Digital impressions are sensitive to moisture contamination as are traditional impression materials. Blood and saliva obscure the surface to the tooth or margin from the camera and prevent an accurate recording. One of two things occurs: either the camera records the moisture as an inaccurate surface contour or no data is recorded where the moisture has collected. Both undesirable situations mean that an accurate restoration cannot be fabricated
- Inadequate soft tissue management and retraction may prevent visualisation of the marginal areas, which can translate into an inaccurate recording with the camera (Figure 4). To provide an adequate digital image of tooth preparations, the dentist must isolate the margins of all of the tooth preparations and ensure that they are visible to the eye before making a digital impression.
- The final restoration is only as accurate as the recorded data file
- Technology cannot compensate for preparation inadequacies (Figure 5)
- Current digital systems do not scan through soft tissues
- Digital scanners can only record data that is directly visible to the camera lens. A digital scan should capture the entire restorative margin as well as about 0.5 mm of the tooth/root surface apical to the margin. This is critical for either the ceramist or milling machine for fabrication of the correct emergence profile. Diode lasers are popular adjuncts for digital impressions as they create lateral retraction while preventing bleeding and ensuring a dry field of view.

FUTURE SCOPE

The needs of the dental practitioner are complex. Technological change has witnessed constantly improving physical materials.

More significantly, digital developments facilitate a level of accuracy previously not envisaged. There is scope for employment of all modalities in single or group practices based on patient preferences, treatment needs and speed of restorative requirements. **ID**

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