

Perfect impressions made simple™

INTRODUCTION

It has been almost four decades since Dr. S. Rand Werrin invented the Triple Tray™.

In a July 2010 interview with Dr. Damon Adams, editor-in-chief of Dentistry Today, Dr. Werrin speaks of the elegant simplicity of the Triple Tray™ a successful design of a dual-arch tray. He also discusses the ridicule and criticism that met his invention.

Over 80% of all crown and bridge impressions are made for single units.¹ For these, years after Dr. Werrin's invention, the dual-arch tray is the most commonly used impression approach. However, the dual-arch tray is virtually ignored by many dental schools and lecturers. Often, dental labs do not recommend it. Frequently, dentists have problems using it. I was one of them! Where did the problem lie? No one had an answer for me.

Frustrated, 15 years ago I began a quest to try to solve the dual-arch tray conundrum.

I endeavored to collect all available information and take a long hard look at the state of the art of dental impression-taking. I hoped to make some discoveries and apply this information to develop and standardize a

simple, reliable system. I will take you with me on my journey of discovery, using the following roadmap.

I will attempt to convey to you what I found in well over 10,000 hours of research, testing, development, and trials.

I - GOAL

II - STATE OF THE ART

- A. Preparation Design**
- B. Tissue Preparation**
(Retraction and Hemostasis)
- C. Vinyl Polysiloxane impression material**
(hereafter referred to as VPS)
- D. Tray Design**
- E. How above components and current methods integrate**
- F. An assessment of digital scanning**

III - DISCOVERY

- What have we learned?
- Is there a better way?

IV - CONCLUSION

I GOAL

A simple, reliable system that produces highly accurate impressions or digital scans suitable for fabrication of crowns, bridges, veneers, and implants.

- *To clearly define this goal, many dentists, both recent graduates and those with decades of experience were asked for a wish-list of qualities that their ideal impression system would have.*

WISH LIST FOR AN IDEAL IMPRESSION SYSTEM

TOP 10

- 1 **1. Extreme accuracy**, especially for subgingival margins
- 2 **2. Reliable** – works well every time
- 3 **3. Fast** – from completion of prep to completed impression / scan
- 4 **4. Lowest possible cost**
- 5 **5. Gag-free**
- 6 **6. Minimizes retakes, remakes**
faulty impressions/scans can be easily diagnosed chairside
- 7 **7. Easy learning curve**
- 8 **8. No expensive devices** (i.e. disposable devices, equipment) or software fees
- 9 **9. Allows patients to recline** during impression
- 10 **10. Bio-compatible** – no harm to tissue



II STATE OF THE ART

(A) Tooth Preparation

It is very important, particularly when using dual-arch trays, CAD/CAM, digital scanning, and all-ceramics that all line angles should be rounded.

Long preps should be less retentive² (i.e. should have less parallel vertical walls) with more of a domed top to allow easier flow and less trapping of Light-body VPS on the occlusal part of the prep. Dual-arch trays should not be attempted by novice users on the last tooth in the arch or on preps with no adjacent or opposing teeth.

(B) Tissue Preparation, Retraction and Hemostasis What is it?

- This is a **separate step**, before the actual impression or scan. It is generally viewed as an integral, compulsory part of the impression process if there are any subgingival margins on the preparation.

Retraction - refers to the expansion of the “collar” around the base of the crown.
(see illustration next page)

- allows access to astringent chemicals
- allows access to Light-body VPS during impression-taking

Hemostasis – chemicals to dry sulcular fluids and initiate hemostasis (clotting). It stops bleeding from restorative or cord-packing trauma.

How Retraction and Hemostasis is done

1. Retraction cord/Astringents (*Common method*)

Retraction cord is packed into the sulcus (requiring a force of between 1-10 N/mm²).⁷ widening the sulcus. Bleeding resulting from restorative and/or cord-packing trauma is usually treated by impregnating the cord with a chemical agent to initiate hemostasis (leading to coagulation). The double-cord packing technique is often referred to as the “gold standard”. Here, a single cord is packed prior to tooth preparation to minimize restorative tissue trauma. Then a second cord is pushed on top of the first to drive it further into the sulcus. Only the top cord is removed prior to impression taking, or intraoral scanning.

2. Pastes (*More recent method*)

Primarily kaolin clay, it is injected into the sulcus to widen it and dry the blood and moisture. Often used in conjunction with cord/astringents due to issues injecting into a narrow sulcus with a wider needle tip, as well as in the presence of bleeding.

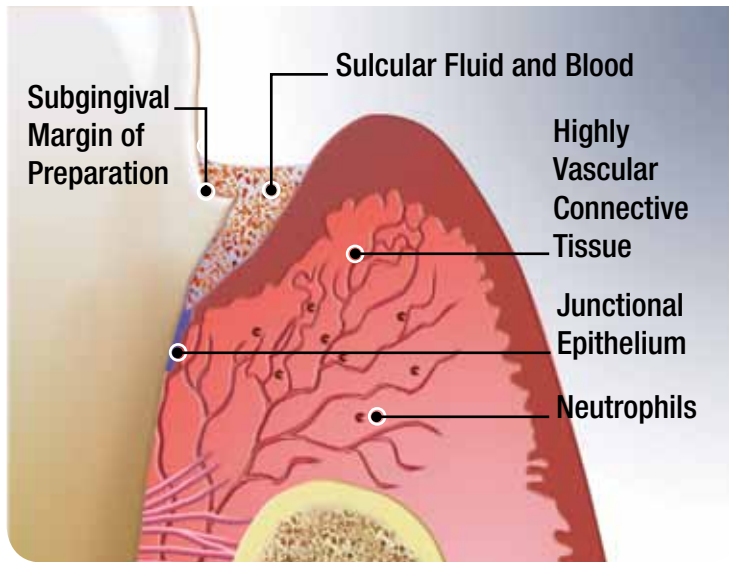
3. Compression systems (*In limited use*)

Many devices have been used to try to force astringents into the sulcus to produce retraction and hemostasis. Challenges include cost, required time, and skill to use such devices as well as the difficulty of forcing the astringent into the sulcus.

4. Lasers, Electrosurgery (*Not widely used*)

Energy is used to widen sulcus and cauterize bleeding. There are concerns with cell death, post-op discomfort, and gingival recession.³⁻⁴

PREPARATION MARGIN AND SULCUS



The tooth is the only place in the body where hard tissue from inside punctures the integument of the body. These puncture points are very vulnerable to bacterial invasion of the body. The sulcus has several lines of defense.

(see illustration left)

The **first line** is the junctional epithelium, a thin, delicate collar that seals the connective tissue of the sulcus to the tooth. If this line is breached, the **second line** of defense is the sulcular fluid, containing neutrophils (analogous to alligators and barracudas in a castle moat).⁵

The **third line** is the highly vascular tissue of the sulcus walls. While containing many neutrophils as well as lymphocytes and monocytes, when overwhelmed, this tissue provides easily accessible "highways" for systemic invasion.⁶

RETRACTION AND HEMOSTASIS ISSUES

1. Junctional epithelium can be traumatized at 2.5 N/mm². In 1978 VanderVeden & Devries reported that packing even a single cord can take 2.5 -10 N/mm² to place.⁷
2. It is not proven how long it takes for junctional epithelium to heal after cord packing or if it can completely heal.³
3. Astringents dry up defenses in the sulcus when they dry the sulcular fluid.
4. Invasion of biofilm has been found in heart, pancreas, and brain.⁶ Biofilm at the junctional epithelium is a highly organized and adhesive colony of aggressive bacteria⁸ that communicate with and defend each other.
5. At the time of writing, intraoral digital scanning requires retraction and hemostasis for subgingival preps and areas with bleeding, just as conventional impressions do. While manufacturers claim close to 100% excellent results with their scans, they are assuming successful hemostasis and retraction steps have taken place in advance. Scanners are presently not able to differentiate blood and other fluids from dentin and may have difficulty "seeing" the margin below a tight sulcus.^{9,4,1}

(C) Use of VPS

Most dentists love working with VPS, but many are unaware of the following considerations:

1. VPS Cartridges – heavy and light - must be bled, then have the mixing tip attached and be bled again IMMEDIATELY before use.

If you bleed a VPS cartridge, attach a mixing tip and remove the tip 30 minutes later, you will often see that the two components of the cartridge have moved to different levels. Sometimes an oily separation of components is visible. This can change the mix ratio dramatically in the first VPS to exit the mixing tube. Many dentists place the Light-body VPS on the tooth prep first. An inappropriate mix ratio can lead to un-set Light-body VPS on an impression.

Our interviews showed us that the vast majority of dental assistants set up the tips at the beginning of the appointment. They almost unanimously responded that they were taught this in school. Furthermore, they stated that if they did not, their dentist would be upset because they were “not ready”.

2. There is a difference in VPS brands – not only in quality, but also in composition. Different brands of VPS should never be mixed in the same impression to avoid VPS separation and distortion.

3. Expiry date may not correspond to what is printed on the cartridge. Warehouse, transport, and office storage conditions may have a major effect. VPS that does not seem to possess its usual characteristics should be returned to supplier. Expiry date should be checked at every use.

4. Astringents may impede set¹⁰ of VPS, resulting in grainy margins that tear. Even more concerning, if bleeding after cord-packing persists, dentists often place additional astringent. It does not wash off with water!

5. There are two very different methods for using Heavy and Light-body VPS.

- **One-Step** – Heavy-body and Light-body VPS are used and set at the same time. Light VPS can be applied on top of Heavy VPS in the tray or directly on the teeth. The problem lies in placing Light VPS on the prep and/or teeth then placing the tray with Heavy VPS on top and seating. The warmer intraoral temperature causes a very fast set of the Light VPS. ¹ The slower-setting Heavy VPS can warp partially-set Light VPS when the tray is seated. It is almost impossible to gauge the exact set time of VPS and this becomes an essentially uncontrollable variable in one-step impressions.
 - **Two-Step** – Heavy-body VPS is used to fill the tray and used to take a preliminary impression. Light-body VPS is then applied to the teeth and/or preparation, or over the set Heavy VPS. The Heavy-VPS/tray unit is then re-seated and the Light VPS sets to complete the impression. Two-step methods may have issues with excess Light-body VPS being trapped under the Heavy VPS, preventing tray seating and distorting impressions.
- 6.** The following can be expected from overfilled trays:
- **Gagging** – sometimes patients panic (or worse!)
 - **Inability to see** where tray is placed relative to the teeth can result in poor tray alignment and incomplete seating.
 - **Inability to recline patient** – prevents patient from biting in a natural centric relation. Often a separate bite is needed with a dual-arch technique.
 - **In full-arch impressions** – long tray extensions on the buccal/labial surfaces combined with excess VPS will set over bony undercuts. This can overwhelm the tray adhesive and cause VPS/tray separation on removal. This is especially true if a palate or handle is used.
 - **VPS is expensive** – calculate the cost of VPS in your next impression. Is that amount of VPS really necessary?

(D) Design and Use of Trays

Dual-Arch Trays

- There is a huge choice of design of dual-arch trays. Like VPS, “more is better”, is the prevailing view when deciding on tray size. However, too long a tray can induce distortion. Beyond capturing the cuspid rise, a longer tray is often counter-productive. Trays with no side walls lack directive action on the VPS, resulting in the need for excessive VPS.
- Different tray designs, composition and mesh material have a major effect on adhesion and stability of VPS.
- The connector bar on posterior trays must not impinge on tooth or gingiva at distal. If it does, a custom full-arch tray should be used.
- While “rigid” vs. a “semi-rigid” is a matter of controversy in tray selection, we found rigid is best for one-step techniques since un-set Heavy-body or putty provides almost no rigidity. However, problems can happen because of wide variations of tooth alignment and arch shape. Rigid trays can result in tray walls protruding into impressions. For two-step techniques, we found semi-rigid works best since it allows the Heavy-VPS to deflect the tray wall away from the prep and the rebound of the tray wall pushes the Heavy-body toward the prep. The set Heavy-body/tray unit gives good rigidity, in effect customizing the dual-arch tray.

Full-Arch Trays

- Excessive buccal tray extension can be a problem as the bony undercut-engaged VPS can easily overwhelm the tray adhesive on removal.
- It takes 2-3 days for custom trays to set.¹⁰ If enough time is not allowed, post-impression distortion can occur. Tray adhesives may take a long time to reach full adhesion. Check manufacturer instructions.
- Trays should not have a palate.
- Handles are a problem as the distal downward tilt can overwhelm the tray adhesive / VPS bond. Full-arch trays should always be removed by simultaneously placing index fingers on the distals at the edge of the VPS /tray interface to break the seal.
- Dual-arch full arch trays must fit the arch well.
- Stock trays use huge amounts of VPS and can be very uncomfortable to the patient.

(E) Integration

There appears to be no evidence of any proprietary integrated **Tray/VPS /Method** in current use.

(F) Intraoral Digital Scanning

It should be noted that this method has **none** of the obstacles discussed with trays or VPS, but **all** of the Retraction and Hemostasis obstacles apply.

III DISCOVERY

After the review of the Goals, the Wish-List, State of the Art, and dentist and lab interviews, the following observations were made:

1. There are intractable problems with Retraction and Hemostasis:

- not easy to perform
- time-consuming
(on average at least 6 minutes)
- not predictable
- costly
- requires extra injections
(palatal or buccal)
- not bio-compatible

2. VPS has several useful properties that have not yet been exploited:

- Hydrophilic Light-body VPS is denser than blood or sulcular fluid and can easily enter any sulcus and flush it, displacing the fluids it contains, when constant controlled pressure is applied.
- Light-body VPS can be engineered to place enough pressure on leaky blood vessels and on cells producing sulcular fluid to keep fluid and blood from entering the sulcus during the time between flushing of sulcus and setting of VPS.

This constant pressure on the blood vessels is not chemical hemostasis (i.e. clotting of blood) but rather a physical finger in the dike that prevents blood and sulcular fluid from entering the sulcus.

3. Years of extensive experimentation showed:

- VPS is an excellent, user friendly material when simple precautions are taken.
- The use of a **VPS fluid displacement system** can **eliminate** the need for Retraction and Hemostasis in all impressions and scans.

4. Two-step VPS Impressions (first Heavy-VPS then separate Light-VPS) can be designed to generate constant pressure on the Light-VPS to direct flow of Light-body VPS into the sulcus and maintain pressure to stop blood and fluid flow.

A wash system or one-step system is not capable of generating sufficient pressure to do this.

5. The advantages of digital scanning (immediate viewing, instantly in lab, no model fees) can be made ACCESSIBLE to all dentists by using scannable VPS with a fluid displacement impression system and an inexpensive desktop scanner (with no intraoral scan).

Replacing the Retraction and Hemostasis step plus intraoral scanning with a fluid-displacement impression system and a desktop scan by an assistant saves valuable chair time.

IV CONCLUSION

After extensive trials and testing, it was found that excellent impressions are possible for **dual-arch, full-arch, and desktop scanning** while completely **eliminating retraction and hemostasis**.

1. A fluid-displacement system can only be successful using a Two-Step system (i.e. Tray/Heavy body VPS, then Light-body).

Using correct materials and methods, excellent impressions/ scans can be made faster and at lower cost than current methods.

It is critical to use specific tray design, dimensions, and composition as well as VPS engineered for this purpose. Operators MUST FOLLOW INSTRUCTIONS for excellent results with a fluid-displacement system.

2. Gag-free impressions are possible even with patients in reclining positions.

3. Digital scanning can be made accessible to all dentists.

A patent for a system to produce impressions implementing the fluid - displacement system has been issued.

Patent No: US 9,603,682 B2.

The MiTi™ System is now being manufactured and distributed in the U.S.A. and Canada

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Dr. Mahn has been a dentist in general practice since 1978. He founded The Paris Dental Centre in 1979. He invented the MiTi™ System and is founder & president of MiTi Incorporated.

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