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Precision impressions – A guideline in theory and practice

Impression compendium

In collaboration with Prof. Dr. med. dent. Bernd Wöstmann and
John M. Powers, Ph.D.

Precision impressions – A guideline in theory and practice

Preface

As one of the world leaders in impressioning, 3M Oral Care aspires to be the partner of choice for precision impressions in practice and teaching establishments. Our goal is to leverage our expertise in innovative materials, technology, and manufacturing to provide our customers with the highest performing impression systems and workflow on the market. We have received a resounding, positive response to the first and second editions of “Precision Impressions – A Guideline for Theory and Practice” from dentists around the world. This confirms the importance of our process-oriented approach and demonstrates our commitment to continually deliver customer-valued solutions.

Over the past years, thousands of dentists and their teams have been working with our handbook. In addition, many universities and training centres utilize the guidelines for precision impression taking as a benchmark. Many dentists especially value the clear and concise step-wise procedures, as well as the supportive function for vocational training and further education in practice. This third edition puts even stronger focus on the procedure of impression taking since this is the most important step for ultimately producing high-quality esthetic restorations. The improvements achieved through material science and dental procedures, as well as important changes in the workflow, prompted us to update almost all the chapters.

3M Oral Care feels very much indebted to Prof. Dr. med. dent. Wöstmann, one of the authors of the first and second editions, for his competent, clinical and process-oriented view. Chapters 1, 2, 4 and 6 – 11 very much benefit from his outstanding clinical expertise. 3M Oral Care wishes also to thank Dr. Powers who in chapter 3 links the chemistry of impression materials to their clinically relevant properties in an intelligible and user-friendly way.

3M Oral Care complements their work with a long standing expertise in impression material mixing technology in chapter 5.

We hope that you find the changes made to the latest edition will help you to further improve the quality of your impressions and the restorations you produce in practice or training.

Dr. Joachim Zech
Division Scientist
Seefeld, Germany
June 2017

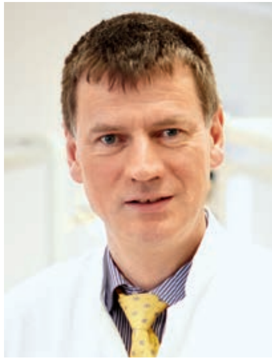
Joachim Zech

Contributor biographies

Bernd Wöstmann, Prof. Dr. med. dent.

Dr. Wöstmann graduated from the University of Münster, Germany in 1985. From 1986 to 1992 he was assistant doctor and from 1993 to 1995 assistant medical director of the Department of Prosthodontics of the Westphalian Wilhelms-University, Münster, Germany. In 1995 he was appointed assistant professor and in 1998 professor at the Justus-Liebig-University in Giessen, Germany, where he has held the chair in dental prosthetics since 2009. His main areas of interest are dental elastomers and related aspects of material science, especially impression taking in dentistry. He is also working in gerodontology and implantology. Dr. Wöstmann is a member of several scientific organisations including the IADR and also several DIN-ISO working groups. He is a member of DGPro´s (German Prosthodontic Association) advisory committee.

Dr. Wöstmann is the author of more than 200 scientific articles, abstracts, books, and chapters. He serves on the editorial boards of many dental journals and has given more than 400 scientific and professional presentations and lectures. Dr. Wöstmann has been awarded the Friedrich-Hartmut-Dost Award in 1999 for excellent education in dentistry and co-authored several presentations that have been awarded by the **Deutschen Gesellschaft für Prothetische Zahnmedizin und Biomaterialien** (DGPro), the German Geriatric Society (DGG) and the Austrian Geriatric Society.



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John M. Powers, Ph.D.

Dr. Powers graduated from the University of Michigan with a B.S. in chemistry in 1967 and a Ph.D. in dental materials and mechanical engineering in 1972. He was Professor at the University of Michigan School of Dentistry from 1972-1988. He was Professor at the University of Texas Dental Branch at Houston from 1988-2005, where he also served as department chair and associate dean for research. He founded the Houston Biomaterials Research Center and served as Director from 1994-2005. From 2005-2018, he was Clinical Professor of Oral Biomaterials at the University of Texas School of Dentistry at Houston, where he currently is Adjunct Professor.

He is also Adjunct Professor at the University of Michigan School of Dentistry, where he is a consultant to the Michigan Pittsburgh Wyss Regenerative Medicine Resource Center. Dr. Powers received an honorary Ph.D. from the Nippon Dental University in 2011. He was a founding member and Director of the Society for Color and Appearance in Dentistry (SCAD) and received the E.B. Clark Award from SCAD in 2012. He received the 2013 IADR Distinguished Scientist – Wilmer Souder Award. He was named AADR Fellow and SCAD Fellow in 2016. Dr. Powers has authored more than 1000 scientific articles, abstracts, books, and chapters. He is Publisher of Dental Advisor. He is co-author of Dental Materials – Foundations and Applications and co-editor of Craig's Restorative Dental Materials and Esthetic Color Training in Dentistry. He has served as Dental Materials Section Editor of the Journal of Esthetic and Restorative Dentistry since 2011. He is a reviewer for JERD, JPD and JoP. He has given numerous scientific and professional presentations.

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Precision impressions – A guideline in theory and practice

1. Clinical importance of the precision impression (B. Wöstmann)

1.1. Introduction

Restorations which fit exactly and can be inserted without any further corrections are high on the list of every dentist. Precise fitting restorations not only facilitate both time and efficiency, but are esthetically superior and enable healthier tissue and gums.

The impression is an important step in obtaining a perfect restoration. The aim of the impression is to produce a dimensionally stable “negative” which can serve as the cast mold for a model. Because indirect restorations are typically produced in the dental laboratory, precise-fitting restorations are only possible if the model matches the original situation. Despite rapid technical progress in the field of CAD/CAM systems, the impression remains immensely important to prosthetic dentistry. At least in the near future, the impression will continue its vital role conveying information from dentist to dental lab. Most dental lab CAD/CAM systems available today start from the model and also require an impression. Despite many efforts, the conventional impression process has not yet been replaced by more modern reproduction procedures such as 3D imaging. These innovations are promising and will increasingly be used, however, especially for deep subgingival areas and areas difficult to access, the conventional impression remains a necessary and indispensable procedure in dental treatment.

Digital impressioning

Over the last 100 years, elastomeric impression materials were continuously developed and optimized for improved precision, patient comfort and ease of use. Modern materials are robust, precise, fast, hydrophilic, and can be automatically mixed. However, the patient needs to keep a filled impression tray in the mouth for several minutes, and external factors, e. g. temperature, can impact the final result.

Digital impressioning seeks to circumvent these problems. The first optical impression system was marketed in the 1980s as part of the CEREC system (Dentsply Sirona). Other systems have followed.

While model fabrication still is a necessary work step, it might become less important in the future as model-less restorations increase in popularity.

Marginal accuracy: What is necessary and what is possible?

The margin of a restoration is a critical point, since inadequate restoration margins can hardly be corrected afterwards. Occlusal interferences as well as inaccurate fit around the proximal contacts can be corrected much easier – independent of whether these are classical metal restorations or CAD/CAM-produced zirconium oxide restorations. Thus, the reproduction of the preparation margin in an impression is a necessary requirement in order to achieve good marginal quality. In vitro, the marginal precision of a dental restoration is approximately 50 µm on average[1–3]. However, this level of precision can rarely be met clinically. This divergence applies mainly to restorations with subgingival or paragingival margin areas. If the crown margin is completely supragingival, it is possible to obtain accuracies which are quite comparable with the results from lab tests. This has been impressively proven in several studies[4–9].

What are the reasons for the considerable discrepancy between the technical possibilities of the respective materials and the clinical results? These mainly relate to the clinical factors encountered during the treatment of the patient. Otherwise, similar results as in lab tests would be achieved. Thus, factors related to the clinical procedure have a significant influence on the fitting accuracy and will be described in the next chapter.

1.2. Reasons for a discrepancy between laboratory results and precision in clinical situations

The preparation of a fixed dental restoration with the help of precision impression materials requires several treatment and laboratory steps independent of whether a conventional or CAD/CAM technique is chosen.

The same potential error sources apply to all fixed restorations. We will use the example of a crown for explanation.

The interior of a crown has to be a little bit larger than the original preparation so that the restoration can be cemented, so it is desirable to achieve a slight enlargement of the crown interior in the course of the workflow from impression to crown. However, due to material-related reasons (like shrinkage of cast gypsum or impression material) this is not possible.

Usually, any known dimensional errors of the impression are compensated by experienced dental lab personnel by applying spacers or changing the setting expansion of the material to achieve well-fitting restorations.

1.3. Improved results through standardization

To achieve accurately fitting restorations, it is important to standardize the process from tooth preparation to final seating of the restoration[10]. Fig. 2 shows – in a simplified manner – that the dimension of the preparation, as it is reproduced in the impression, approximately corresponds to a normal distribution (Gaussian distribution). Its width depends on the consistency or rather the inconsistency of the initial conditions like impression technique, choice of tray, temperature, etc. In daily practice it is scarcely possible to evaluate the actual dimension of the reproduced preparation in the impression, since such discrepancies are rarely obvious to the naked eye.

The subsequent work steps in the lab (fabrication of the model, carving, embedding, casting) in principle follow the same scheme. The difference is that the position of the curve maximum no longer corresponds to the original tooth but to the position delivered in the impression (e.g. positions a, b or c, Fig. 2).

At this point the problem is clear: With each further work step the spreading of the results becomes larger. It can never become smaller (Fig. 2 blue curve).

Thus, it is a widespread fallacy that the deviations resulting from insufficient standardization “level out” on their own[19].

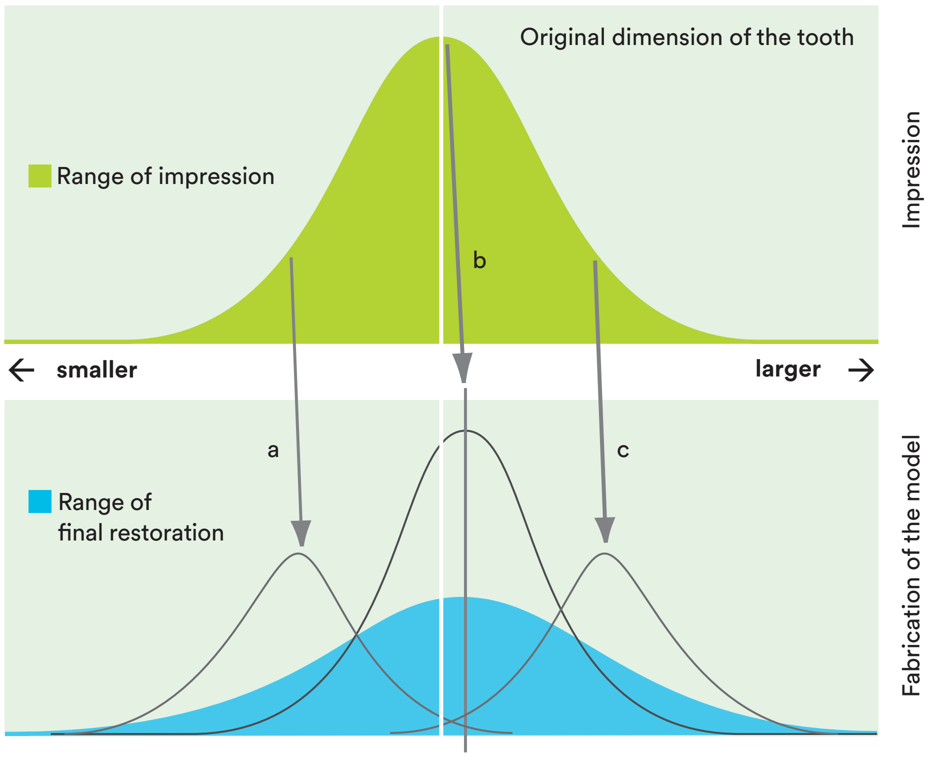


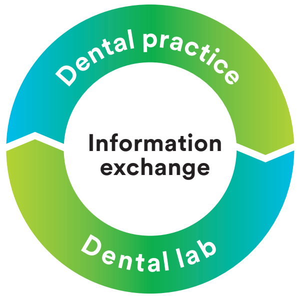
Fig. 2: Schematic of the spreading of results along a multi-step workflow.

The statistical spread of results can be reduced by standardized procedures, good communication between dental technician and dentist, the use of modern, high-quality impression materials (with constant and reproducible properties in all production batches) as well as correct and reproducible handling of these materials, especially through automatic mixing[11].

1.4. Standardizing the communication between the dentist and lab

In daily clinical practice, the statistical spread can be reduced especially through the standardization of processes. This starts with the planning of the treatment and ends with the shipment conditions when sending the impression to the lab.

Clear communication is essential between the dentist and lab. If the lab technician knows which impression technique and materials were used, then the dental lab can effectively coordinate the lab process to produce an accurately fitting restoration.



2. Clinical parameters influencing impression taking

(B. Wöstmann)

Systematic standardization can reduce the number of retakes and corrections. Additionally, the final success of an impression is strongly influenced by the clinical situation and is individual for each patient.

2.1. Periodontal status and oral hygiene

The periodontal and **oral hygiene** status of the patient significantly influence the result of an impression, since an inflamed periodontium around a diseased tooth shows increased bleeding tendency. As periodontal disease and **sulcus bleeding** are closely connected to the oral hygiene behavior of the patient, it is very important to achieve good oral hygiene circumstances before the prosthetic therapy, especially with regard to the impression. The worse the individual hygiene circumstances, the more failures can be expected. Thus, the vicious circle as shown in Fig. 3 is inevitable[64;65].

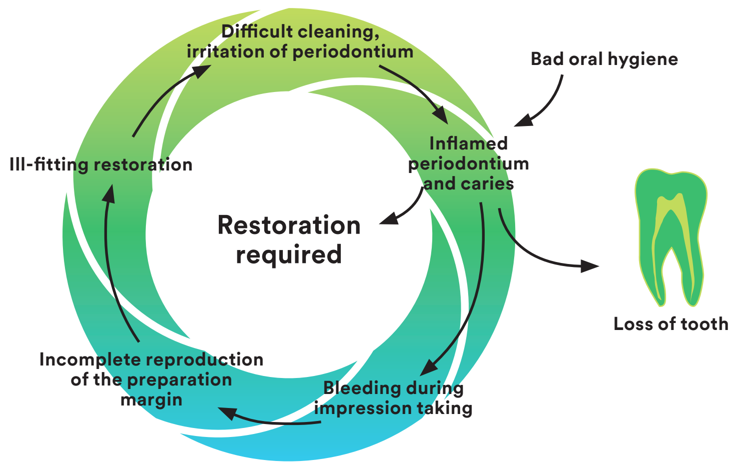


Fig. 3: Insufficient periodontal circumstances and possible after-effects.

2.2. Preparation of the operative field

Retraction

An essential requirement for a successful impression is the accurate reproduction of the prepared teeth. Only then can the preparation margin be defined unequivocally on the stone model.

You can only reproduce what is accessible. With supragingivally located preparations, keeping the area to be impressioned dry and accessible is usually quite easy[5;14]. However, if a tooth is crowned, it is often deeply destroyed and the preparation margin is fully or at least partly subgingival. If the tooth should serve as a bridge preparation, an epigingival or subgingival preparation is determined by the retention needs of the bridge.

If the preparation margin is not accessible, it can either become supragingival by surgical treatment and/or – preferably – the sulcus can temporarily be extended with a retraction material.

You can only reproduce what is accessible.

Retraction with cords

Haemostatic properties of the retraction material are not required when healthy periodontal conditions have been achieved with good oral hygiene and subsequent tissue management. However, sometimes it is necessary to work with pre-impregnated retraction cords despite the use of a local anesthetic containing a **vasoconstrictor** (warning: cardio-vascular risk patients). Pre-impregnated retraction cords or added retraction liquids – especially based on metal salts – can interact with impression materials and prevent their setting process[15;16].

The aim of retraction is to clearly display the preparation while causing the least trauma possible to the tissue. Mainly, **single and double cord retraction techniques (Figs. 4, 5)** are used depending on the impression site. In the double cord technique, at first a thin cord is placed in the bottom of the sulcus, and a thicker cord on top of it takes care of the actual tissue displacement. In both retraction techniques, the cord placed last is removed shortly before the impression is taken.

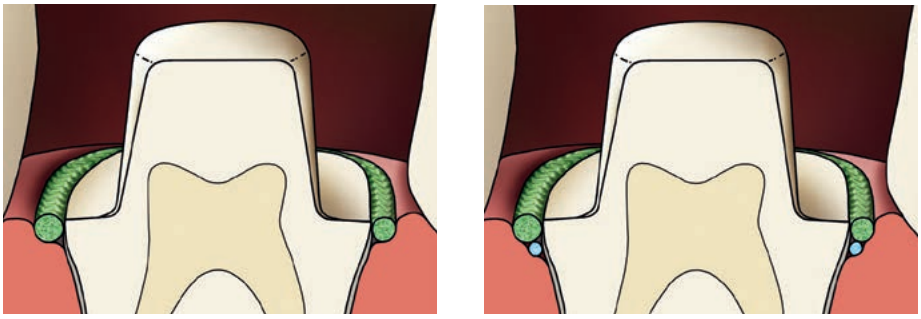


Fig. 4: Single (one) cord technique (left), double (two) cord technique (right) for retraction.

Testing the compatibility of impression materials and retraction agents is easy: A retraction cord is soaked with the astringent to be tested, slightly dabbed and coated with the light-bodied impression material which is selected to be used later. As a control, use another cord soaked with saliva or salt solution. After setting of the impression material the cords must stick tightly and it should not be possible to remove them from the impression material. If they can be removed easily and if there is even some unset impression material on the cords, the materials are NOT compatible.

Fig. 5: Retraction cord in situ.

Retraction with paste

Retraction with cords is technique sensitive. Retraction pastes have proven to be a less traumatic retraction method than cords: a histological examination revealed that they do not damage the periodontium.[65]

When using the 3M™ Astringent Retraction Paste, the tip of the capsule is inserted slowly and smoothly into the sulcus and around the tooth. After a two-minute exposure period, the paste can be removed with a mixture of air and water combined with suction.

An already open sulcus can be dried efficiently by using pastes (e.g. 3M™ Astringent Retraction Paste or Expasyl™, (Pierre Roland))[64].

For single teeth, the use of retraction sleeves (e.g. Peridenta) to open the sulcus is an alternative to retraction cords.

Recommended 3M product:
- 3M™ Astringent Retraction Paste

Fig. 6: Drying of the sulcus using 3M™ Astringent Retraction Paste.

Cleaning the prepared tooth

Before taking the impression, thoroughly rinse off the preparation with water. Remaining disinfection materials can prevent complete setting of the impression material. VPS (A-silicone) and polyether materials, for example, can react with remaining hydrogen peroxide; VPS may generate foam and thus prevent an accurate reproduction of the preparation margin. Also, unset **methacrylate composites** can interrupt the setting process and have to be removed carefully with alcohol and then with water *(see "Material incompatibilities", chapter 3.6.)*. Dry the preparation with a gentle air stream (Fig. 7).

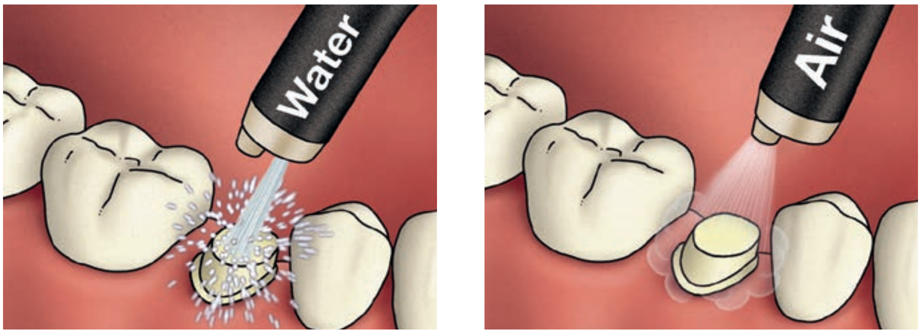


Fig. 7: Thorough rinsing and drying of the tooth using water spray and air.

2.3. Anaesthesia

Impressions taken under local anaesthesia are often more successful than those taken without[12;13]. Without **anaesthesia** it is almost inevitable that the patient will endure pain during the impression procedure; especially during the positioning of the retraction cords and the drying of the prepared abutments. The reaction of the patient to pain often leads to inappropriately placed retraction cords or insufficiently dried teeth. If this happens, the result is a relatively bad impression. Furthermore, most anesthetics contain vasoconstrictors which cause anemic conditions around the anesthetized area, counteract sulcus bleeding and favor a positive impressioning result.

2.4. Choice of tray and specific impression techniques

Both the selection of the proper impression tray for the specific indication and technique as well as the choice of the appropriate impression technique for the indication have significant influence on the final result. That is why we have dedicated a full chapter to each **(chapters 4 and 6)**.

3. Properties of today's impression materials

(J. M. Powers)

3.1. The history of precision impressions

The introduction of reversible hydrocolloids in the mid-1930s heralded a new age in the impression sector. For the first time, the impression of undercuts became possible. With the appearance of polysulfides at the beginning of the 1950s, an elastomeric impression material was used in dentistry for the first time. More than sixty years ago, the world of dentistry saw the introduction of a category of materials – the C-type silicones (condensation-cured) – which, like another condensation-cured class of materials, the polysulfides, were not originally intended for oral applications.

The great disadvantage of these products still remains: shrinkage intrinsic to the system – be it due to the evaporation of water with the hydrocolloids or of low-molecular side-products in the case of the condensation cured elastomers[17;18].

In 1965, ESPE (today 3M Oral Care) introduced polyethers to the market (Fig. 9). Polyether is a hydrophilic impression material cured by cationic ring-opening polymerization, which is far superior to the hydrocolloids and C-type materials. It has high mechanical properties, good elastic recovery and is subject to virtually no shrinkage. The main advantages include hydrophilicity, unique flow and setting behavior. Since the impression material is in close contact with wet soft and hard tissue, hydrophilicity is one major feature of a modern precision impression material. **Hydrophilicity** is defined as an affinity for water (Fig. 8).

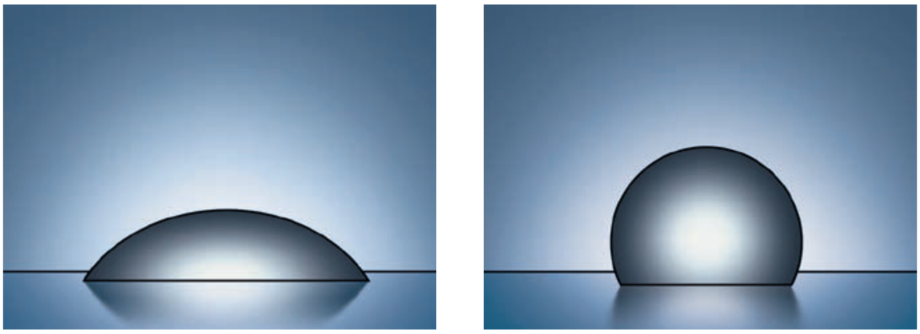


Fig. 8: On hydrophilic material, water can spread easily (left) whereas its contact surface is minimized to hydrophobic material (right).

Ten years later, silicones in their enhanced form, the **addition-cured silicones (vinyl polysiloxanes)** were introduced as impression materials. However, they are hydrophobic by their molecular chemistry (hydrophobic = repels or does not absorb water, the opposite of hydrophilic). It has been possible to reduce the level of hydrophobicity by the addition of soap-like molecules (surfactants). These increase the **hydrophilicity** of the material, especially in the set stage[19 – 21]. Set vinyl polysiloxanes have a very high dimensional stability over time and temperature, even in a humid environment. They are known for their superior elastic recovery. Some of the most recent materials, like 3M™ Imprint™ 4 VPS Impression Material, have been improved with regard to the clinical problem of tearing.

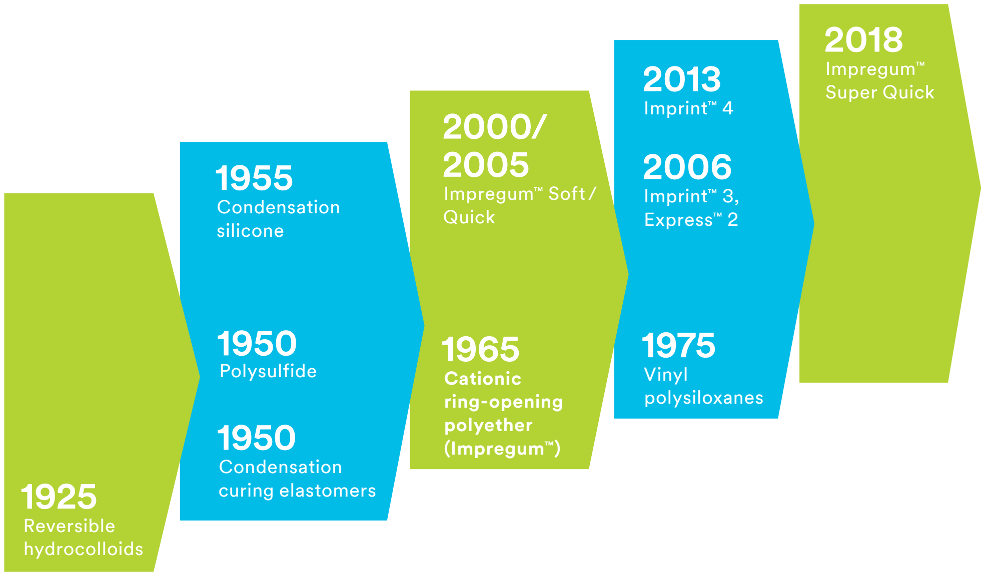


Fig. 9: History of precision impression materials.

With the launch of 3M™ Impregum™ Soft/DuoSoft™ Polyether Impression Materials, new polyether-based impression materials became available, combining all the positive characteristics of polyether with simpler handling both chairside and in the laboratory.

The most recently introduced fast-setting Impregum Super Quick Polyether Impression Materials, which are recommended for one to two units, offer all of the benefits of polyether, with improved taste and patient comfort while saving chair time.

3.2. Addition curing precision impression materials

Vinyl polysiloxanes (VPS/PVS, addition silicones, A-silicones)

Vinyl polysiloxane exploits the principle of "addition reaction curing". As opposed to condensation curing materials that experience shrinkage as a result of evaporation of by-products, vinyl polysiloxane remains dimensionally stable.

With vinyl polysiloxane, different pre-polymeric silicon-functionalized hydrocarbon chains (hydrogen siloxane, vinyl siloxane) and a platinum catalyst are involved in the reaction. The addition of hydrogen siloxane (-O-Si-H) to vinyl siloxane (CH_2=CH-Si-O) is called a **hydrosilylation reaction**. As a result of this reaction the vinyl polysiloxane is formed at the platinum catalyst[20;22;23]. **The platinum catalyst** is a platinum compound which, starting from H_2PtCl_6, is adjusted through reduction and serves as a molecular "docking station" for the two reacting partners, which leave the platinum compound once they are linked to each other (see Fig. 10).

Vinyl polysiloxane impression materials are hydrophobic by their chemical nature – they are more or less apolar hydrocarbon chains – and can be made hydrophilic using suitable molecules. However, these are always extrinsic molecules; a true **intrinsic hydrophilicity**, as in the case of the polar polyether molecules, cannot be established for these molecules. Some degree of hydrophilicity can be achieved after a certain period of time by the use of surfactants. **Surfactants** contain a hydrophobic part, which ensures miscibility in the formulation and a hydrophilic part which is responsible for improved wetting.

To convert the liquid siloxane parent compounds into a paste, inorganic fillers are added. The thixotropic properties of the vinyl polysiloxane can be controlled using appropriate fillers. The colors of the materials are adjusted through the addition of dyes and pigments.

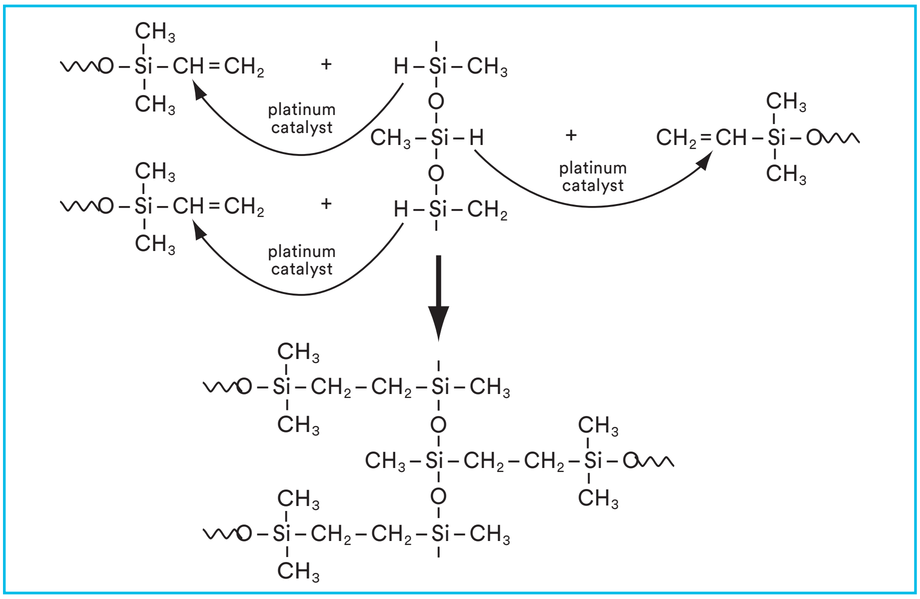


Fig. 10: Polymerization mechanism for vinyl polysiloxane.

Recent vinyl polysiloxanes, such as 3M Imprint™ 4 VPS Impression Material, contain tailor-made cross linkers. These materials are designed for high **tensile strength**, resulting in high tear-resistance and high **elastic recovery**.

A-silicones have almost no limits with regard to disinfection and are compatible with most model materials[24].

3.3. Polyether precision impression materials

Polyethers cured via ring-opening polymerization

The polyether contained in the base paste, which is already a longer chain polyether (macromonomer), is a tailor-made copolymer of ethylene oxide and butylene oxide units (Fig. 11). The ends of the **macromolecular chain** are converted into reactive rings, which form into the cross-linked final product (Figs. 11, 12) under the influence of the cationic initiator of the catalyst paste.

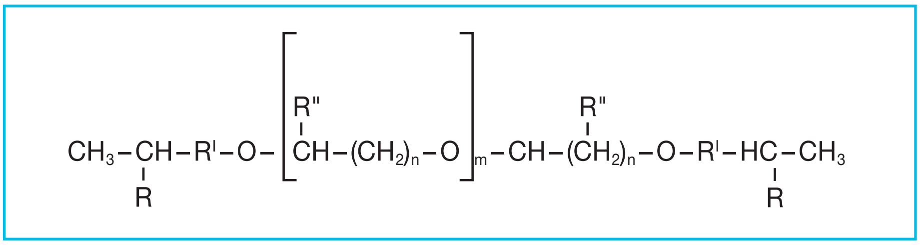


Fig. 11: Polyether macromonomer – the chains are terminated by the highly reactive ring groups (marked with an R).

The reactive ring of the polyether copolymer (basic polyether molecule) is opened by a cationic starter (Fig. 12) and can then, as a cation itself, attack and open other rings, creating a snowball effect. Whenever a ring is opened, the opening cationic starter remains attached to the former ring, thus lengthening the chain[20]. This unique setting mechanism causes **"snap set"** behavior, which refers to the rapid transition from the working to the setting stage[25] (Fig. 13).

Popular brands:

- 3M™ Imprint™ 4 VPS Impression Material (3M Oral Care)
- Aquasil™ Ultra (Dentsply Caulk)
- Affinis™ (Coltene/Whaledent)
- Honigum™ (DMG)

Popular brands:
- 3M™ Impregum™ Polyether Impression Material (3M Oral Care)
- 3M™ Permadyne™ Polyether Impression Material (3M Oral Care)

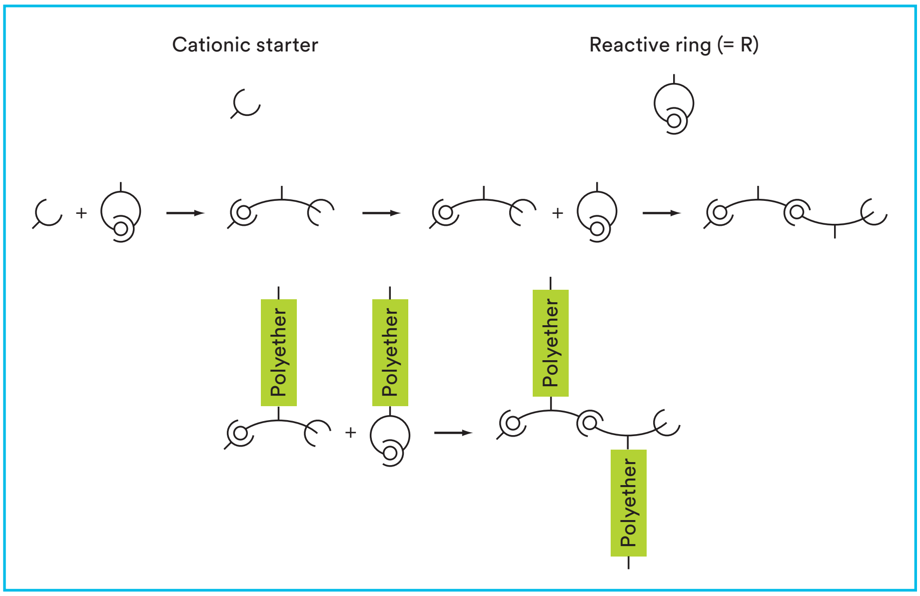


Fig. 12: Polymerization process during setting of polyether.

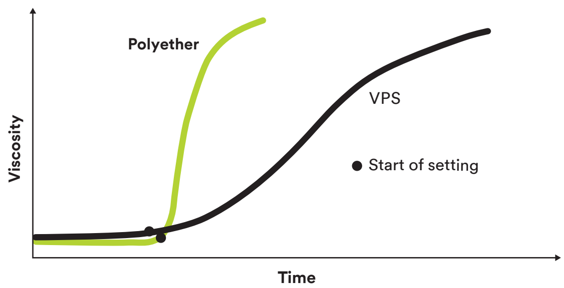


Fig. 13: Schematic comparison of snap-set behavior of 3M polyether impression materials vs. A-silicones.

The actual polyether **macromonomer** (Fig. 11) consists of a long chain of alternating oxygen atoms and alkyl groups (O-$[CH_2]_n$). The high level of hydrophilicity of the polyether itself is due to the large number of oxygen molecules in the long chain and the large polarity difference between oxygen and carbon (or hydrogen). In other words, upon contact with moisture the hydrophilic characteristics will immediately become evident.

Next to addition-cured silicones, polyether materials are the most important products in the sector of high-precision impression materials. The natural hydrophilicity of polyethers – due to their unique molecular structure, formulation and chemical setting reaction – is well-suited for a permanently moist environment such as the mouth. This characteristic is particularly useful when taking impressions of gingival areas or in the sulcus, such as subgingival preparations[26].

Thanks to its hydrophilic macromonomers, polyether offers precise flow behavior, which also explains the strong initial adhesion of the polyether impression upon removal. Triglycerides are responsible for these special flow characteristics, which ensure optimal wetting of the preparation surface after syringing around the preparations. Inorganic fillers produce the high rigidity of the impression and contribute to dimensional stability following removal of the set polyether material.

Given the identical chemical basis, all three consistencies of 3M polyether impression materials can be freely combined with each other, e.g. for taking edentulous impressions. A chemical bond after curing is guaranteed.

3.4. Condensation curing elastomers

Polysulfides (Thiokols)

Cross-linking of polysulfides is brought about by a polycondensation reaction in which water is the reaction product. Some polysulfides may be categorized as toxic substances, primarily due to the heavy metal (esp. lead) oxides contained in the reactor paste[27].

Compared to polyethers and silicones, polysulfides do not have a good elastic recovery. After the clinically recognizable hardening, the cross-linking continues. During this ongoing curing reaction, the elasticity and elastic recovery increase considerably. Polysulfide impressions should be left for at least another 5 minutes in the mouth – beyond the clinically recognizable setting[28].

Today, polysulfides do not play an important role in the market[20;22], but are still in use for some indications[29].

TM **Popular brands:**
- Permalastic™ (SDS/Kerr)

Condensation silicones

The base component of the **condensation silicone** category consists of oleaginous polydimethyl siloxane with hydroxyl-terminated groups and fillers such as diatomite, TiO_2 and ZnO. The base component contains tetrafunctional alkoxysilanes which, in the presence of a catalyst such as dibutyl tin dilaurate or zinc octoate, will react with the hydroxyl groups, splitting off a condensate (usually alcohol) and cause cross-linking. After setting, subsequent and inevitable evaporation of the alcohol results in shrinkage of the material.

Another problem commonly encountered is the difficulty of obtaining the correct proportions of the individual components when hand-mixing condensation silicone impression materials. With the standard dispensing of C-type silicones, a deviation of +/– 25 percent from the set point can be expected. This may cause the working and setting time of the material to vary, thus indirectly affecting the quality of the impression[20 – 22].

C-silicones are compatible with most model materials. However, allergic reactions to the catalyst paste have been reported. Therefore, skin contact during mixing should be avoided.

TM **Popular brands:**
- Optosil / Xantopren (Heraeus Kulzer)
- Speedex (Coltène Whaledent)

Reversible hydrocolloids

The main constituent of hydrocolloids is water, which sets together with agar-agar, a long-chain galactose polysaccharide. This produces a gelatinous mass that is solid at room temperature. If the mass is heated, a sol-gel transition occurs and the material becomes liquid. As this process is reversible, the material solidifies again after cooling. Both solidification and liquefaction temperatures depend on, among other factors, the purity of the agar and the addition of other substances. Talcum, lime and borax are added to hydrocolloids, affecting their flowability.

When properly handled, hydrocolloids offer a high level of accuracy. This is comparable to, although not surpassed by, other elastomeric impression materials. On the other hand, the handling when taking a hydrocolloid impression is sometimes cumbersome. Wider use is additionally discouraged by limited shelf-life and insufficient tear-resistance.

As a result, the use of hydrocolloids has dwindled to a small number of users over the years, and agar impression materials are by no means as important as they used to be before the introduction of polyether and vinyl polysiloxane[20;22]. Hydrocolloid impressions need to be cast immediately (within 20 minutes).

TM **Popular brands:**
- AccuLoid™
- Identic™ (Dux Dental)

3.5. Impression materials for preliminary impressions

For the fabrication of a prosthetic restoration a model of the opposing arch is necessary, as there is no other way to ensure a correct occlusion. For these reasons, it is important that materials used for preliminary impressions are discussed:

Alginates – irreversible hydrocolloids

Alginates are irreversible elastic impression materials. The basic substance of alginates is alginic acid, a polyglycoside of D-mannuronic and L-gulonic acid which itself is not soluble in water. Usual alginate powders contain, besides fillers, sodium or potassium alginate, calcium sulphate as a reagent and sodium or potassium phosphate as a retarder.

Alginates are usually mixed by hand. With the available mixing devices – depending on the type of device – the material properties can only be slightly improved.

Alginate impressions should be cast within 15 – 30 minutes, since during further storage the impression inevitably shrinks due to syneresis and evaporation of water from the alginate gel. Additionally, alginate impressions cannot be stored, show a low tear-resistance[19] and the elastic recovery after deformation is not as good as with precision impression materials[30]. The use of an alginate impression for the preparation of temporary restorations is limited since it cannot be stored over a prolonged period of time.

Popular brands:

- 3M™ Palgat™ Plus/ Quick Alginate Impression Material (3M Oral Care) – *not available in all countries*

Although the handling of alginates as well as their material properties are not very efficient, their low tear-resistance offers advantages in some situations, i.e. when taking an impression of a periodontally affected tooth or over fixed orthodontic appliances which cannot be reproduced with tear-resistant materials since the impression could not be removed from the mouth.

Alginate replacement materials

To avoid the disadvantages of alginates, so-called alginate replacement materials (e.g. 3M™ Imprint™ 4 Preliminary Penta™ and/or Penta™ Super Quick VPS Preliminary Impression Material) were developed. Since they are processed with an automatic mixing system like the 3M™ Pentamix™ 3 Automatic Mixing Unit (see chapter 5.4.) or a hand dispenser such as the 3M™ Garant™ Dispenser, mixing and processing errors are virtually eliminated.

Alginate replacement materials are cost-effective VPS materials which, like other VPS materials, have a high dimensional stability.

When used with prefabricated single-use impression trays (3M™ Impression Trays) (***see chapter 4***), alginate replacement materials quickly and efficiently provide preliminary impressions.

Especially for the **fabrication of temporary restorations,** the use of alginate replacement materials in combination with such trays offers several advantages: Their smooth silicone surface facilitates the trimming of temporary restorations considerably; and because of the unlimited shelf-life of the impression, the impression can be used to remake temporaries later if needed.

Popular brands:
- 3M™ Imprint™ 4 Preliminary Penta™/ Penta™ Super Quick VPS Preliminary Impression Material (3M Oral Care)
- AlgiNot (Kerr)

3.6. Material incompatibilities and impression disposal

General incompatibilities

Metal salts which are contained in many astringents used for hemostasis can inhibit the setting of impression materials. The result is – at least partly – an insufficient setting of the material especially in the critical sulcus region ***(see also chapter 2.2.)***.

Generally, only materials of the same material class should be used together ***(see e.g. chapter 4.2. "Customization of stock trays" or chapter 6.1. "1-step impression techniques")***. All 3M polyethers (cationic ring-opening polymerisation, ***chapter 3.2.)*** can be combined with each other, yet, not with other material classes.

If a **methacrylate composite** material has been used for core build-up, or a temporary restoration of methacrylates or composites was placed before the impression, the resulting **smear layer** has to be removed with alcohol and cotton pellet, otherwise the impression material will not set at the contact areas. Grinding and polishing is not enough in this case.

Therefore, the impression area should always be thoroughly cleaned and dried before the impression is taken ***(chapter 2.2.)***.

When working with hand-mix VPS putty materials, the material of the gloves can negatively influence the setting behavior of the impression materials ***(chapter 5.1.)***.

Warning: Incompatibilities may arise during
- Retraction (→2.2.)
- Tray customization (→4.2.)
- Putty/wash technique (→6.1.)
- After core build-up or fabrication of temporaries

3.7. Overview of material types and consistencies according to ISO 4823:2015

Type 0 **Putty consistency**

Alternative terminology:
Kneadable material/putty

Use (technique):
Tray material (1-step, 2-step)

Type 1 **Heavy-bodied consistency**

Alternative terminology:
Heavy-body/tray

Use (technique):
Tray material (1-step, 2-step)

Type 2 **Medium-bodied consistency**

Alternative terminology:
Medium body, medium viscosity, regular body

Use (technique):
Tray/syringe material (1-step, monophase)

Type 3 **Light-bodied consistency**

Alternative terminology:
Light body/wash/light viscosity

Use (technique):
Syringe material (1-step, 2-step)

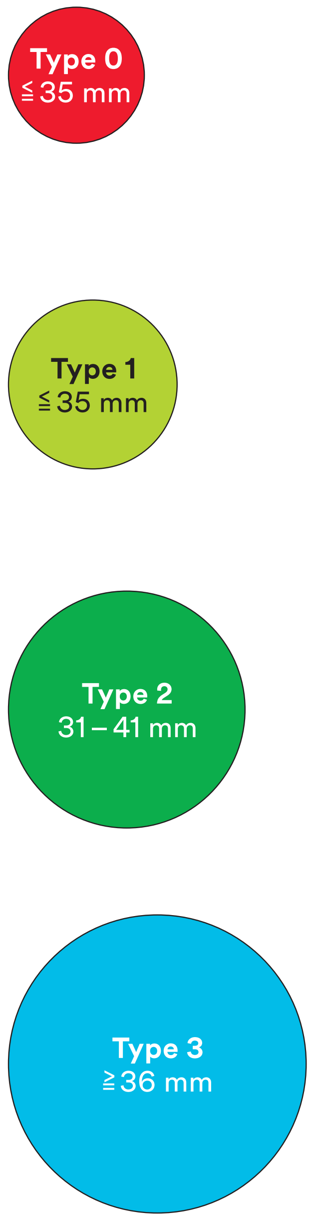


Fig. 14: Material types and consistencies according to ISO 4823:2015.
Materials are classified according to the disc diameter they achieve in the ISO test 4823:2015; The larger the disc, the thinner the material, i.e. the lower the consistency of the impression material, and the more it flows.

4. Impression trays

(B. Wöstmann)

4.1. Choice of tray

Unless you take an impression of an edentulous situation, you normally have to cope with **undercuts**. These undercuts are either in the natural shape of the unprepared teeth or result from the opposing inclination of the tooth axes. Most of the time even the alveolar ridge shows undercuts. In all cases, the impression is inevitably compressed during removal from the mouth. Elastomeric impression materials can be deformed both elastically – which is reversible – and plastically, irreversibly. So care must be taken not to compress the materials too much that they undergo plastic deformation. Material compression can be controlled by sufficient space between teeth and the impression tray wall. A rule of thumb is to compress VPS and polyether materials by *no more than 1/3* of their original length or thickness. For tray selection, that means that around undercuts, the distance of the tooth to the tray wall needs to be at least twice the depth of the undercut (Fig. 15).

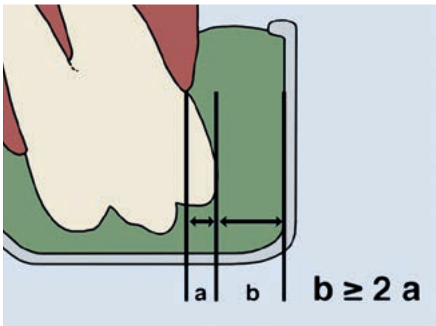


Fig. 15: Silicones and polyethers require twice the undercut depth as a distance to the tray wall (3-fold depth of the undercut from tooth to tray in total).

4.2. Stock trays for full arch impressions

Metal stock trays which completely cover the arch should be the preferred choice. If this is not possible a tray extension can be produced individually ***(see "Customization of stock trays" in this chapter)***. For polyethers, the use of non-perforated trays is recommended. VPS putty materials can be applied in perforated trays since the perforation increases the retention of the materials in the tray.

Using putty materials in a simple plastic tray (stock tray or custom-made tray) can cause problems as the tray may be deformed when inserting the impression. The impression material then sets in this position and is uncontrollably deformed after mouth removal due to the elastic recovery of the tray. If a custom tray or a plastic stock tray is used, heavy- or regular-bodied consistencies should be chosen for the impression ***(see also Fig. 14, chapter 3.7.).***

Customization of stock trays

If there is not an adequately fitting impression tray available, it is possible to customize a stock tray. Customization can be done with a composite tray material, wax or a putty impression material. If the tray has to be lengthened, a stable composite tray material is preferable. In general, the damming material used needs to be compatible with the impression material. If, for example, an addition-cured silicone (VPS) is used for impressioning, C-silicones should not be used for damming, since the catalyst of the C-silicones inhibits the setting reaction of the VPS material.

Dorsal damming (Fig. 16a – d) helps the dentist to find an exact, reproducible position of the impression tray in the distal area and increases the patient's comfort since it prevents the impression material from flowing down the throat.

Occlusal stops (Fig. 16c, d) avoid the contact of the tray and the occlusal surface, especially during pressureless impressions (e.g. with polyethers) or when using low-viscous materials. Occlusal stops are mainly applied with composite tray material in the incisal area and/or molar area at places distant from the preparation.

Additionally, the application of a support in the palate area, with a VPS putty material is possible (Fig. 16c, d). This is customized to the patient by quick insertion and removal of the tray with a fast setting putty material.

The optimized fit of customized trays reduces the appearance of **flow defects** ***(see also chapter 6.1.).***

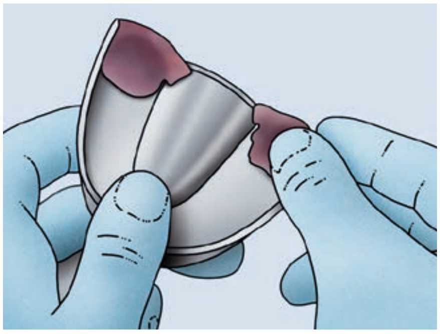


Fig. 16a: Application of dorsal stops.

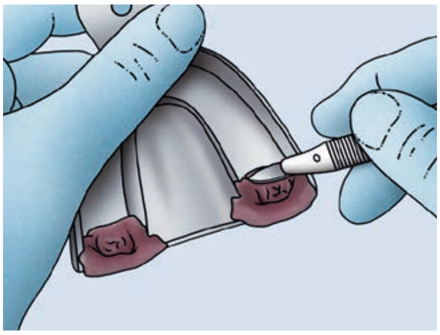


Fig. 16b: Try-in and reduction with scalpel if necessary.

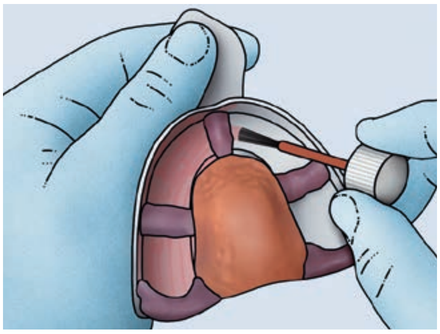


Fig. 16c: Palate (putty material, customized to the patient) and occlusal stops added, application of the tray adhesive followed by drying per instructions for use.

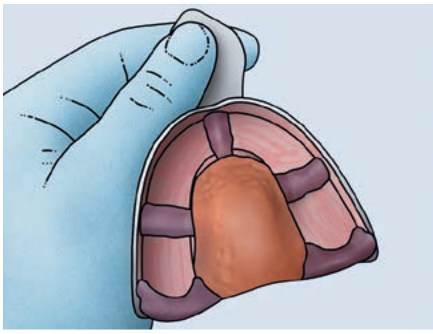


Fig. 16d: Example of a customized tray with palate and occlusal stops, dorsal damming and applied adhesive.

4.3. Stock trays with optimized fit

While choosing a tray for impressions of the upper jaw is usually quite easy, you might encounter problems with a fully-toothed lower jaw. Most lower jaw stock trays may be wide enough, but then dorsally too short, or if they are long enough, they are too wide[31;32]. Thus, the use of impression trays which have been developed for the impression of fully-toothed lower jaws are advantageous*.

For preliminary and final impressions, 3M™ Impression Trays can be used (Fig. 17). As this tray set was developed from an analysis of jaw shapes of test subjects in Europe and the U.S., it is usually possible to find a matching tray[31]. Ready-to-use 3M™ Impression Trays have an integrated self-retentive fleece strip which reliably keeps the impression material in the tray. The application of a tray adhesive is not needed – saving valuable preparation time.

Fig. 17: 3M™ Impression Trays (3M Oral Care) – available in the three sizes S, M an L – for upper and lower jaw.

For precision impressions, autoclavable carbon fiber trays** can be used as an alternative to metal stock trays. These trays are almost as stable as steel trays.

4.4. Custom trays

Requirements

A custom tray is intended to create optimum flow to the teeth and an evenly thick layer of the impression material in all areas of the impression. Thus, the absolute value of the inevitable dimensional change of the impression remains low[33;34].

This ideal can only be realized if the area of which the impression should be taken is free of undercuts. If there are undercuts, their threefold depth needs to be blocked out on the gypsum model before the tray is made. This avoids excessive compression of the impression material[35] and facilitates easy removal from the mouth – analogous to the stock tray.

The main indication for custom trays is the edentulous or partially edentulous jaw. The fabrication of a custom tray is also necessary for special situations, such as above-average small or large jaws, and exceptional abutment positions. Custom trays require careful fabrication. Mainly light-cured tray materials are used today, since they are sufficiently rigid and dimensionally stable[38;39].

Thermoplastic materials (e. g. wax) are highly deformable and, only conditionally suitable for the fabrication of custom-made trays[36;37]. Autopolymerizing materials are subject to both prolonged polymerisation shrinkage and tend to expand due to water sorption.

* Aesculap, Tuttlingen, Germany
** Clan BV, Eindhoven, Netherlands

Fabrication

A study model is needed for the fabrication of a custom tray. Draw the prospective tray margins onto the model (Fig. 18a). Then, the undercuts are blocked out sufficiently ***(see chapter 4.1)***. Subsequently, the teeth are covered with wax plates up to the later tray margins (Two stacked wax plates resulting in a layer thickness of approx. 2.5 – 3 mm (Fig. 18b)). If traditional autopolymerizing resins are used ("cold polymer"), the wax should be covered with a thin tin or aluminum foil to protect it from the polymerization heat. After that, the soft plastic plate is adapted to the model (Fig. 18c). Take care that the plate is not thinned out by stretching it too strongly, which would result in reduced stiffness of the tray. Then, the tray material is cured. To improve its stability it is recommended to adapt another plastic plate (double thickness → 8-fold flexural strength). Finally a tray handle can be attached by polymerisation, if desired. Before using the tray, the inside should be roughened to improve the effect of the tray adhesive[40].

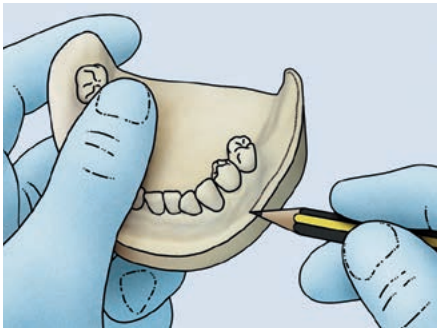


Fig. 18a: Marking of prospective tray margins.

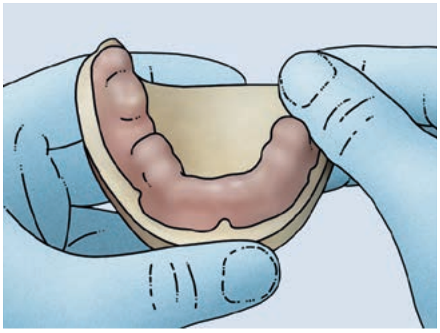


Fig. 18b: Covering of teeth with wax plates. The wax layer thickness defines the space available for the impression material later on.

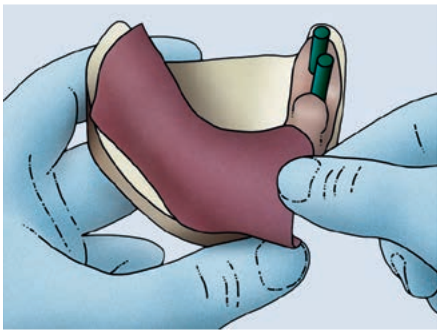


Fig. 18c: Adaptation of resin plates here with spacers for an open tray implant impression.

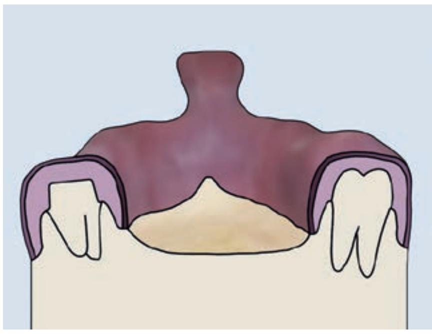


Fig. 18d: Cross-section of well fitting custom tray with optimized impression material layer thickness.

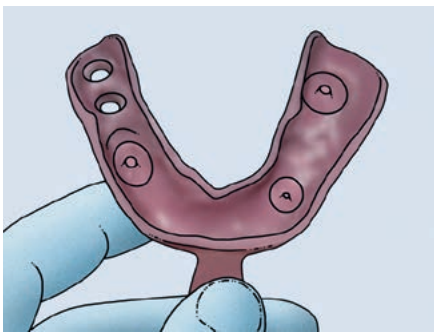


Fig. 18e: Custom tray for an open implant impression, with occlusal stops.

4.5. Dual-arch trays

Especially for single-tooth restorations, the time needed for the actual precision impression of the prepared tooth, an additional impression of the opposing jaw and the bite registration is time consuming.

In order to work more efficiently in this situation, **dual-arch impression** trays are offered. The advantage of this impression technique is that a (partial) impression of the upper and lower arches and a bite registration are taken simultaneously. To do so, the impression support/tray is designed in such a way that the patient can close the jaw in almost maximum intercuspitation while the impression is taken. The impression tray is mostly U-shaped. In between the arms, there is usually a fine metal or plastic net which separates the tooth rows of the upper and lower arch during impressioning (Fig. 19). When the patient bites, the loop of the "U" lies distal to terminal teeth.

Popular brands:
Triple Tray®
(Premier Dental)

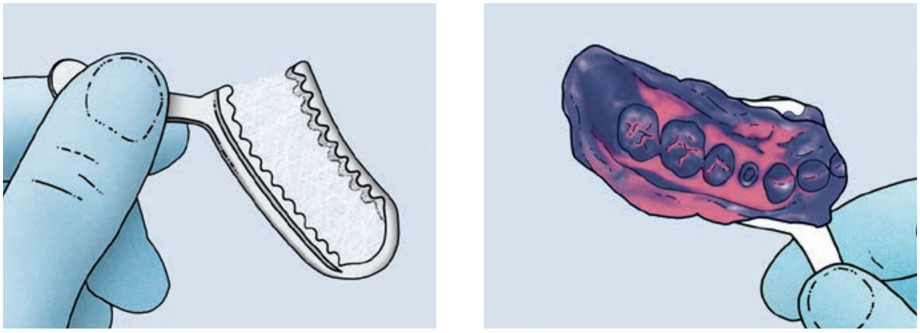


Fig. 19: Dual-arch tray (posterior).

These trays only allow for one-step impression techniques with tray materials having sufficient flowability ***(see chapter 6.1.)***. Since correct occlusal relations have to be ensured, the impression of more than one prepared tooth or of terminal teeth should be avoided with dual-arch trays. In order to give the impression sufficient stability for the production of the stone model, it is important to use an impression material which has a high shore hardness after setting[41]. With correct indication and use, impressions in dual-arch trays are similar or only slightly differ from that achieved with conventional impression trays under comparable conditions[42].

4.6. Tray adhesive

The use of a tray adhesive improves reliable adhesion of the impression material to the impression tray, an essential factor for standardizing impression taking. All impression trays should be coated with a thin layer of a adhesive before use. The adhesive should match the impression material type to ensure adhesion. For the same reason, the drying time recommended by the manufacturer should be observed.

Sufficient drying time simplifies cleaning the tray later.

When using 3M™ Impression Trays no adhesive is necessary, since the retention fabric provides adhesion to the impression material.

5. Mixing of impression materials

(3M Oral Care)

The importance of a **standardized workflow** has been discussed in chapters 1.3. and 1.4. Modern impression materials are high-tech products with a sophisticated chemistry which are produced by the manufacturer within tight tolerance limits.

All impression materials have to be mixed from at least two components (usually named base and catalyst paste) before use. Only a homogenous, void-free mixture with a correct mixing ratio of the components allows a perfect precision impression.

The majority of impressions worldwide are still performed with hand-mixed materials, although automixing systems based on hand dispensers with dual-barrel cartridges have been available since 1983 (3M™ Garant™ Dispenser) and **automatic mixing systems** for foil bags since 1993 (3M™ Pentamix™ Automatic Mixing Unit).

Meanwhile, all 3M impression material consistencies, including the especially high-viscous putty material can be mixed automatically, homogenously and void-free, using the Pentamix™ System.

Today's most common mixing procedures are:

5.1. Hand-mixing of impression materials

For paste type materials (type 1 – 3), dispense equal length strands of base and catalyst paste next to each other on a mixing pad (Fig. 20a). If using a polyether (e.g. from 3M), dispensing too much or too little of the catalyst will have no effect on the working time, but can impair the quality of the impression.

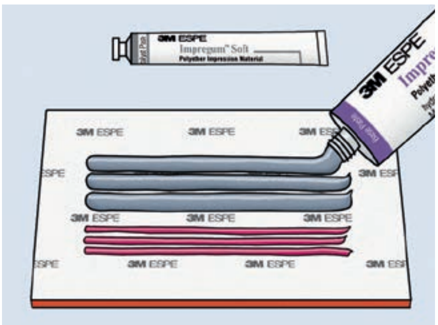


Fig. 20a: Dispensing of correct ratio of base and catalyst pastes.

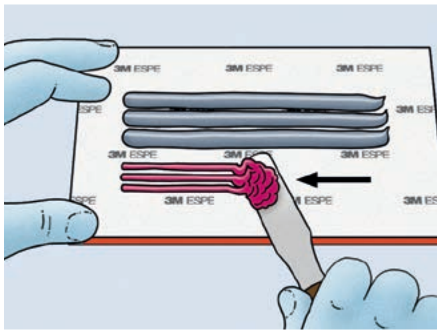


Fig. 20b: Hand-mixing of polyether impression material.

Use a spatula to mix the strands of paste to form a homogenous mass until even color results (Fig. 20b). Repeated spreading over the mixing pad and then picking up with the spatula will produce a homogenous mixture. The mixing process should not take longer than 45 seconds (Fig. 20c – e). Under no circumstances should the pastes be mixed using stirring movements.

Available 3M products:
- 3M™ Impregum™ F Polyether Impression Material
- 3M™ Permadyne™ Polyether Impression Material
- 3M™ Ramitec™ Polyether Bite Registration Material

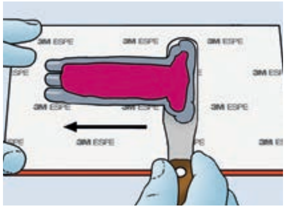


Fig. 20c – e: Hand-mixing of polyether impression material.

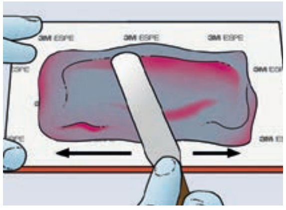


Fig. 20d

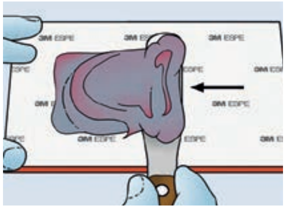


Fig. 20e

For type 2 or 3 materials use a filling device (red) to facilitate filling of the syringe (Fig. 20 f – h). Due to increased viscosity, the polyether pastes cannot be squeezed from the tube at temperatures below 18° C/64° F. When returned to room temperature they become workable again with no loss of quality.

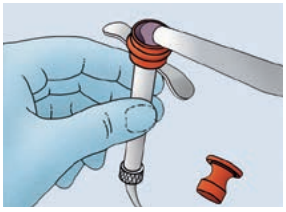


Fig. 20f: Filling of hand-mixed impression material into syringe for intra-oral application.

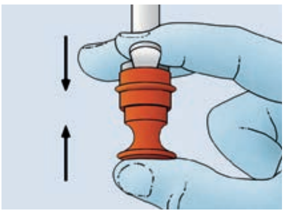


Fig. 20g

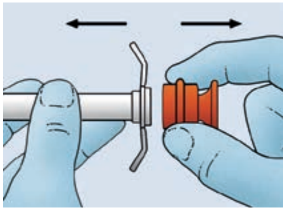


Fig. 20h

For mixing of 3M putty materials, measure equal volumes of putty base and catalyst using the color-coded putty spoons. Mix the base and catalyst with the fingertips until a homogenous color is achieved. The mixing process should not take longer than 30 seconds.

Available 3M product:
3M™ Express™ STD Putty

The putty materials should not be mixed with latex gloves, since components of the **latex** rubber can interfere with the polymerization reaction of the impression material. If possible, use gloves made of other materials, such as nitrile.

5.2. Hand dispenser system

Automix systems with hand dispensers and dual-barrel cartridges have been used since 1983 (3M™ Garant™ Dispenser). These systems have been developed continuously and today are the standard for light-bodied syringing materials. Even many monophase materials or tray materials for the 1-step technique are offered in this application (e.g. **3M™ Garant™ System**). Such systems usually consist of a 50 ml double-barrel cartridge filled with base and catalyst paste, the corresponding mixing tips, application tips and hand dispensers.

The mixing principle is a repeated separation and blending of paste strands in the so-called **static mixing tips.** With an increased number of strand separations (number of mixing elements) in the mixing tip, the quality of the mix increases, but also the extrusion force.

This undesired effect can be overcome by enlarging the diameter of the mixing tip. However, the higher the consistency of the materials to be mixed, the more difficult it is to combine acceptable extrusion forces, good mixing quality, and an acceptable amount of waste material. These systems have an upper consistency limit with respect to tray materials and are therefore unsuitable for putty materials.

For 3M impression materials, use the 3M™ Garant™ Dispenser 1:1/2:1. In order to ensure optimal mixing, it is important to use the correct color-coded mixing tips and intra-oral tips for each material (Fig. 22).

Insert the cartridge with the impression material into the dispenser. Before applying the tip, check that the two cartridge openings are not clogged, and bleed the cartridge until the base and catalyst paste are evenly extruded.

Attach the 3M™ Garant™ Mixing Tip, and if necessary, the intra-oral tip for syringing.

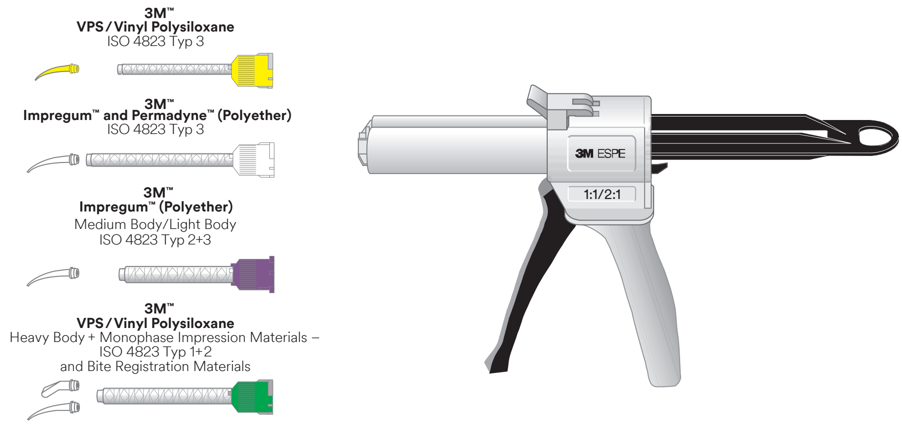


Fig. 22: 3M™ Garant™ Dispenser, Mixing Tips and Intra-oral Tips.

Make sure that base paste and catalyst paste are mixed completely and are extruded in uniform color. Alternatively, the 3M™ Penta™ Elastomer Syringe can be filled directly from the mixing tip, which may offer easier handling while syringing.

The used mixing tip should be kept on the material cartridge as a seal.

5.3. 3M™ Intra-oral Syringe Green/Purple for VPS and Polyether

The 3M™ Intra-oral Syringes Green/Purple (Fig. 21) can be (pre)loaded directly from a hand dispenser cartridge – up to 12 hours before application without setting of the material. They enable a precise and convenient application of the wash material.

With its slim and ergonomic design, these syringes provide easy access to the entire sulcus. They also allow for exact individual dosage of one to four preparations, according to requirements.

Fig. 21: 3M™ Intra-oral Syringes Green/Purple for VPS and Polyether.

5.4. Automatic mixing system

Exact dispensing and thorough, homogenous mixing of the materials are fundamental requirements for successful precision impressions. That's why 3M developed the fully-automatic **3M™ Pentamix™ Automatic Mixing Unit,** which entered full-scale production at the end of 1993.

The name Pentamix is derived from the Greek word for five (penta), reflecting the mix ratio of base paste to catalyst paste (5:1). This system has helped to standardize clinical workflows, eliminating the strain and uncertainty of hand-mixed materials for many practices. The 3M™ Pentamix™ 3 Automatic Mixing Unit delivers a completely homogenous and void-free mix for highly accurate impressions and perfectly fitting restorations (Fig. 23).

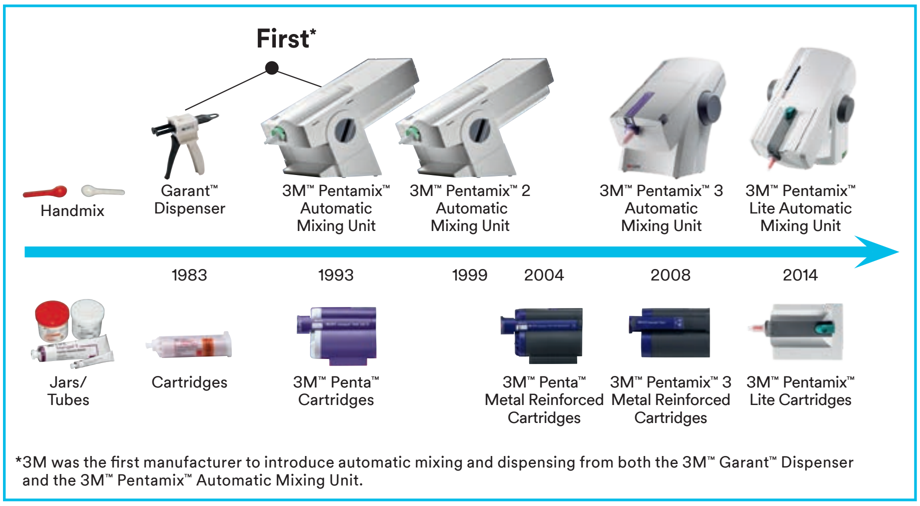


Fig. 23: Important milestones.

Direct filling of trays and syringes from the automatic mixing unit is hygienic, and is more efficient as less time is spent cleaning and disinfecting guns and cartridges. The risk of cross-contamination is also reduced.

Clinical timing with the Pentamix mixing unit is reliable and reproducible. Two main advantages of machine mixing become clearer the faster the paste can be extruded:

- Shorter tray filling time leaves more working time for the actual impression.
- Shorter tray filling time gives more time to the assistant for chairside help.

Fig. 27: Superior mixing quality of automatically mixed 3M™ Express™ 2 Penta™ Putty VPS Material using the 3M™ Pentamix™ Mixing Unit (left) compared to a putty mixed by hand (right, 3M™ Express™ STD Putty).

Mixing principle

The 3M™ Pentamix™ System is based on **dynamic mixing**, i.e. the mixing spiral in the mixing tip is driven by a separate motor via a shaft. The rotation of the mixing spiral in conjunction with the extrusion generates a turbulent flow within the material, which results in complete mixing. In comparison, to static mixing systems or hand-mixing the quality of mix is much more homogenous[62,63] (Figs. 24/25).

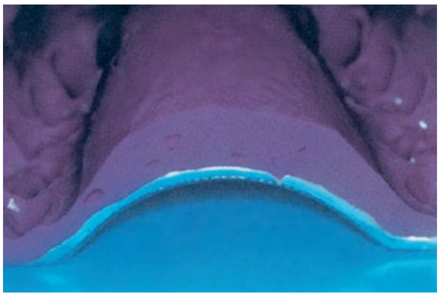


Fig. 24: Example of an impression made with hand-mixed impression material. If such voids occur in the area of the occlusal surface or the prepared abutment teeth, the result may be inaccuracies which jeopardize the success of the work.

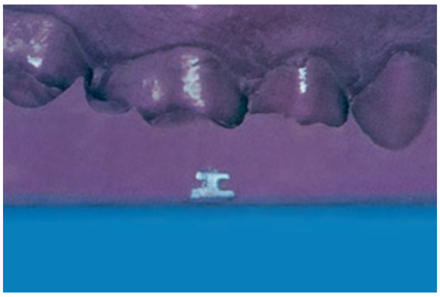


Fig. 25: Absolutely void-free, homogenous impression made with an automatically mixed impression material using a 3M™ Pentamix™ Automatic Mixing Unit.

Another advantage of the dynamic mixing principle is that it also allows highly viscous materials such as type 0 putties to be mixed automatically.

3M™ Pentamix™ System and components

The core of the Pentamix system is the 3M™ Pentamix™ Automatic Mixing Unit, which permits a more relaxed and cost-effective work. Over time, system components were improved to enhance the robustness and reliability of thesystem.

3M™ Penta™ Mixing Tips Red

Fig. 28: 3M™ Penta™ Mixing Tips Red.

The Penta Mixing Tips Red (Fig. 28) are easy to insert with a grey cover plate (instead of translucent) which provides better visibility and gives you more control of the insertion. Unlike generic or counterfeit products, the authentic Penta Mixing Tips – Red have been tested to ensure they work with all Pentamix Automatic Mixing Units.

3M™ Penta™ Foil Bags

Fig. 29: 3M™ Penta™ Foil Bags with Penta™ Authentification Label.

The Penta Foil Bags (Fig. 29) require no separate activation and are color-coded. A Penta™ Authentification Label ensures genuine 3M quality.

3M™ Penta™ Cartridges

Penta Cartridges (Fig. 26) are reinforced with steel inner tubes and are less sensitive to fatigue than the original plastic cartridges.

Fig. 26: 3M™ Pentamix™ 3 Automatic Mixing Unit with steel-reinforced, color-coded 3M™ Penta™ Cartridges.

Mixing with the Pentamix™ Automatic Mixing Unit

Insert the 3M™ Penta™ Foil Bag into the corresponding 3M™ Penta™ Cartridge (Fig. 30a).

Place the cartridge into the 3M™ Pentamix™ Automatic Mixing Unit (Fig. 30b) and attach a 3M™ Penta™ Mixing Tip Red.

Push and hold the start button. When starting a new pair of foil bags, it might take 10 – 15 seconds for both foil bags to open automatically. Extrude a little material until its color is consistent (Fig. 30c).

Dispense the material into the tray and the 3M™ Penta™ Elastomer Syringe (Figs. 30d, e).

Leave the used mixing tip attached to the foil bags for tight sealing. Always store filled cartridges horizontally or with the mixing tip pointing down (Fig. 30f).

Automatic mixing and dispensing of impression materials with the 3M™ Pentamix™ 3 Automatic Mixing Unit

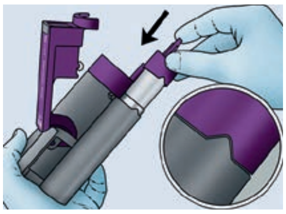


Fig. 30a: Insertion of 3M™ Penta™ Foil Bags into a matching, unlocked 3M™ Penta™ Cartridge.

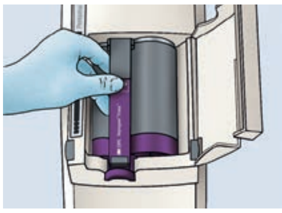


Fig. 30b: Insertion of the cartridge into the 3M™ Pentamix™ Mixing Unit parallel to the unit opening.

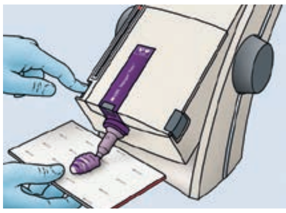


Fig. 30c: Material extrusion until mix is homogenous.

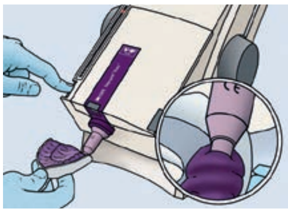


Fig. 30d: Direct filling of the impression tray.

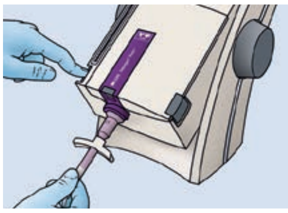


Fig. 30d: Direct filling of the 3M™ Penta™ Elastomer Syringe.

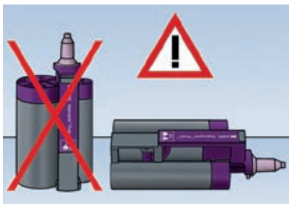


Fig. 30d: Store cartridges horizontally.

All available 3M impression materials for automatic mixing and dispensing with the 3M™ Pentamix™ System are listed in the overview at the end of this brochure. This overview comprises materials covering all indications and techniques for precision impressions, including putty type consistencies, occlusal registration and alginate replacement materials (or download at 3M.com).

6. Impression techniques (B. Wöstmann)

In general, inserting the impression tray very slowly (take 5 seconds) helps to reduce flow defects.

6.1. 1-step impression techniques

1-step putty/wash, sandwich, single-stage two-phase, 1-step heavy body/light body technique

In the **1-step putty/wash technique,** a putty or "soft" putty material is used as a tray material in combination with a light-bodied material (type 3 or 2, ***see chapter 3.7.)***. If the prepared tooth is syringed with the light-bodied material, the term 1-step putty/wash technique is used as opposed to the **sandwich technique** where the light-bodied material is applied as a second layer ("sandwich") on the putty tray material[43].

The 1-step technique allows for very good reproduction of epi- and supragingival areas which are state of the art in today's esthetic, minimally invasive approach to dentistry. The reproduction of areas deep in the sulcus can be difficult, since often only low insertion pressure can be applied to push the material into the sulcus and, impress subgingival areas of the tooth[6;44;]. Sometimes flow defects, pulls and drags around the undercuts of the impressed tooth are visible. They always run parallel to the insertion direction of the tray. These flow defects can appear if the tray material slides over an edge during insertion and then the impression material is not able to completely fill the undercut lying behind (Fig. 31). This can be avoided by applying sufficient pressure using the 2-step impression technique. Alternatively the problem can be solved by using a tray which is better suited for the anatomical shape of the jaw or a customized tray ***(see chapters 4.2. – 4.4.)***. Another alternative is the use of a light body material with very good flow properties.

Fig. 31: Pulls or drags in the impression appear if the tray material slides over a protruding shape and fails to fill the undercut lying behind. The pulls/drags always run parallel to the insertion direction.

Heavy body/light body technique

The **heavy body/wash (or heavy body/light body) technique** is – like the sandwich or putty/wash technique – a single-stage, two-phase impression technique. In this technique a high-viscous material (heavy-bodied, type 1, ***see chapter 3.7.)*** and not a kneadable material (putty, type 0, ***see chapter 3.7.)*** is used. Sometimes a medium consistency (type 2, ***see chapter 3.7.)*** is used as a tray material. The use of a custom or customized tray or another tray with optimized fit is advantageous to support the material flow into small gaps and to avoid flow defects.

With all two-phase impression techniques, only materials of the same material class can be combined since the impression material would not set otherwise.

Monophase technique

In the **monophase technique**, a type 2 ***(see chapter 3.7.)*** material consistency is used as a tray material and for syringing the preparations. Since stock trays usually create less pressure upon insertion, the monophase technique is best suited for use with a customized tray or another tray with optimized fit and an impression material with excellent flow properties. With custom trays and an automatically mixed polyether or VPS material, extremely precise impressions can be achieved[22;45].

6.2. 2-step impression techniques

2-step putty/wash technique

In the **2-step putty/wash technique** with silicones, a first impression taken after preparation is "corrected" with a more flowable material. The initial impression is made with a stock tray and a putty (type 0, ***see chapter 3.7.)*** or heavy body (type 1, ***see chapter 3.7.)*** consistency. Then careful removal of all undercuts and interproximal septa is essential for the success of the impression. If undercuts are not removed, displacement of the first impression material will occur through the pressure of the flowable material during the second impression step and, errors in the impression are inevitable.

Figs. 32a and 32b show a carved first impression. All interfering areas have been cut with a scalpel to enable easy re-insertion. Also, channels are carved in order to allow excess wash material to be displaced. Otherwise, deformations will occur that result in ill-fitting restorations, e.g. too tight crowns. The impression has to be cleaned with plenty of water (or alcohol) and air to remove excessive or detached debris. During this procedure, saliva has to be removed completely from the impression and then dried thoroughly, otherwise the adhesion of the wash material to the first material could be compromised.

Fig. 32a: Properly carved initial impression made with 3M™ Imprint™ 4 Penta™ Putty VPS Material in the 2-step putty/wash technique. Since the impression is carved for the use of 3M™ Imprint™ 4 Super Quick Ultra Light VPS Material (which forms very thin layers), the impression was not carved extensively.

Fig. 32b: Impression made with the 2-step putty/wash technique.

Carving of 2-step impressions:

- Do not cut at the prepared surfaces.
- Carving instrument should be sharp, otherwise impression material might partially tear off, e.g. around the gingival septa. Furthermore, the putty material could detach from the tray unnoticed and cause deformation.

In this technique, even carefully carved impressions may result in a reproduction with too small teeth and preparations. This is due to the distortion of the tray material, which cannot be completely avoided due to the inherent flexibility of the material[46-48]. The dental technician may compensate for this by applying an additional layer of spacer.

Alternatively, the initial impression can be taken before the preparation of the teeth. In this case, there will be a large space at the site of the prepared tooth in the second impression, so that the second material can easily flow into the space. If that impression is carved carefully, displacement effects can be avoided almost completely.

Another alternative is the so-called **foil technique** (e. g. Plicafol). Here, a highly elastic, approximately 0.2 mm thick plastic foil is placed over the putty-filled tray, and then the initial impression is taken (Figs. 33a, 33b). In this case, the carving is considerably reduced, however, more light-bodied material is used.

Fig. 33a: Initial impression made with 3M™ Imprint™ 4 Penta™ Putty VPS Impression Material using the foil technique (Plicafol).

Fig. 33b: Second impression using with 3M™ Imprint™ 4 Light VPS Impression Material.

The 2-step impression technique slows down the procedure in the dental operatory since the impression is carried out in two steps and can minimize errors associated with exceeding the working time of the materials. The disadvantage of the 2-step impression technique is that it is more time-consuming than 1-step impression procedures.

The 2-step impression technique is not recommended with 3M polyether materials.

6.3. Impression taking

Syringing the preparation

Immediately before syringing the prepared teeth, retraction cords are removed and the teeth are lightly dried with air. If **retraction solutions** have been used, the sulcus should be carefully rinsed and dried to avoid setting problems. When using the two-cord technique, rinse carefully before taking the impression and take care that the cord remaining in the sulcus does not contain any more retraction agents.

The tip of the application syringe with the impression material is placed at the sulcus opening. Then, starting in the sulcus, the preparation is syringed without interruption, and using plenty of material. The prepared tooth is used as a guiding support. The syringe tip should always remain within the material to avoid air bubbles and possible voids in the impression (Fig. 34).

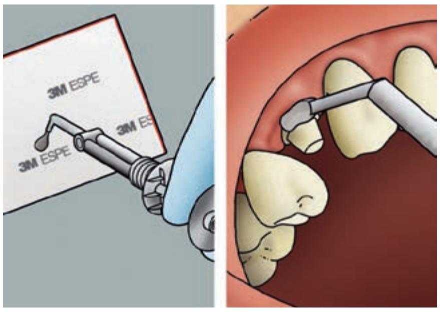


Fig. 34: Syringing the prepared tooth.

Insertion of the impression tray

Utilize a tray size which fits in place without touching any teeth or bony prominences. When inserting the filled tray into the mouth, at first only one end of the tray is inserted (Fig. 35a). Then, the other cheek is pulled back and the tray is completely inserted (Fig. 35b) and positioned into the mouth with a rotating movement.

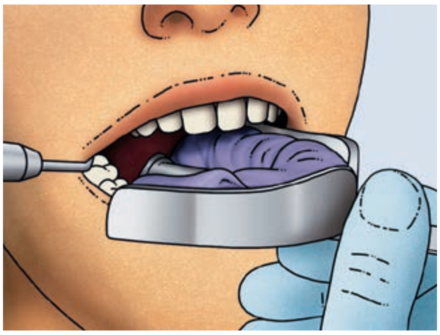


Fig. 35a: Pulling back the opposite cheek and inserting the tray at side…

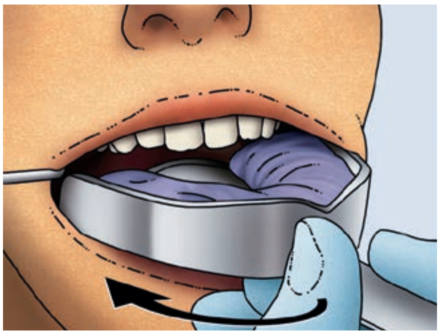


Fig. 35b: … with a rotating movement.

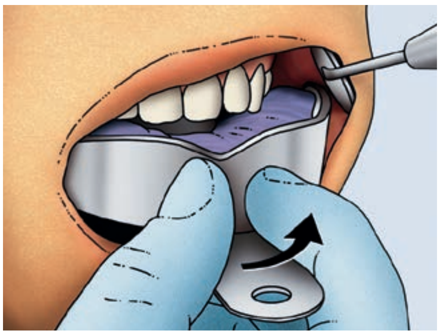


Fig. 35c: If necessary at the end of tray insertion, the cheek can also be pulled back with mirrors on the other side.

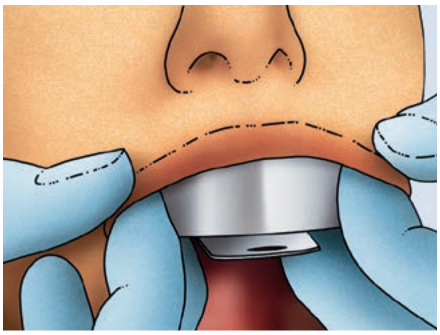


Fig. 35d: Adaptation of the lip to the tray margin to reproduce the area of the gingivobuccal fold correctly.

Tray insertion:
Avoid contact of teeth and tray, e.g. use occlusal stops if necessary (see chapter 4.2.) and choose tray size carefully (see chapter 4.1.).

If necessary, the cheek can also be pulled back with mirrors as shown (Fig. 35c). The tray is slowly inserted into position, without pushing too hard or causing the teeth to contact the tray. The tray should be held in the same position without exerting additional pressure until the material is set.

Setting of the impression material

When taking an impression of the upper jaw, you can easily find support on the chin or cheek bone of the patient (Fig. 36). This prevents blurring of the impression and the movements of the patient can be followed. With impressions of the lower jaw, it is recommended to support the tray on the mandibula. Also, the patients should close their mouth as much as possible to avoid deformation of the mandibula and errors in the impression.

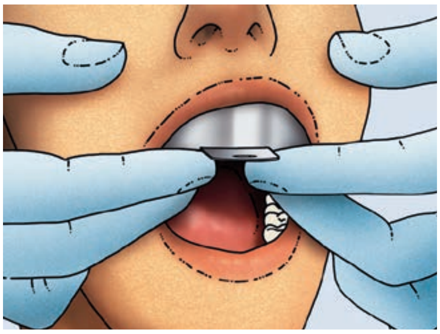


Fig. 36: Extra-oral finger support on the zygomatic bone and intra-orally on both sides on the distal sections of the impression tray.

Please note that the working time stated in the manufacturers' instructions for use (according to ISO 4823) mostly relate to room temperature. Some manufacturers, like 3M, additionally list a clinically relevant working time (e.g. at mouth temperature), as higher temperatures cause the wash material to set faster. In an optimized workflow, syringing the teeth and filling the tray should be coordinated so that both procedures are finished simultaneously.

6.4. Removal of the impression from the mouth

Even with a seemingly uncomplicated task such as the removal of the impression from the mouth, some basics have to be observed to avoid **permanent deformation** of the impression material. Since the **tooth axes** on both sides are not parallel, but either converge (lower jaw) or diverge (upper jaw), the preferred removal technique, especially when using full arch trays, depends on the location and number of prepared teeth. Permanent deformation of the impression at the prepared tooth site can only be avoided if the impression is removed exactly in the direction of the tooth axis *of the prepared tooth*. With preparations in the lower jaw posterior area, this can be achieved best if the impression is loosened at the side of the prepared teeth so that it rotates around a support in the contra-lateral vestibule (Fig. 37). Impressions of prepared teeth in the upper arch posterior area, however, are preferably first loosened at the opposite side (Fig. 37). In the case of front teeth, the primary loosening of the impression should be laterally on both sides. If not removed carefully, the impression material could be compressed considerably, which results in deformation of the material. If an impression with preparations on both sides of the jaw has to be taken, deformation of the impression material around the preparations is inevitable. In such situations carefully choose the impression tray and take care that the tray is large enough around the undercut areas ***(see "Impression trays", chapter 4).***

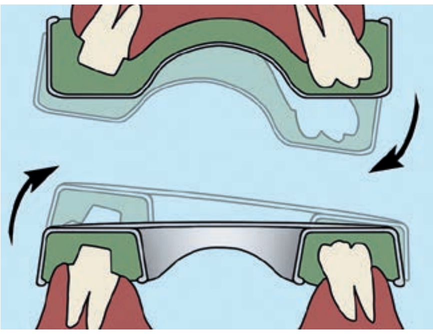


Fig. 37: Optimum removal of impression tray: For upper jaw loosen tray on opposing side, for lower jaw, loosen tray on prep side.

Especially for high precision impressions a vacuum between the teeth and impression material develops during material setting, which complicates the removal of the tray. In order to disrupt this vacuum, open the tight seal by mobilizing or pressing on the oral mucosa with an in-rotating movement of the forefinger at a suitable place in the posterior. Additional application of compressed air can be helpful (see Fig. 38).

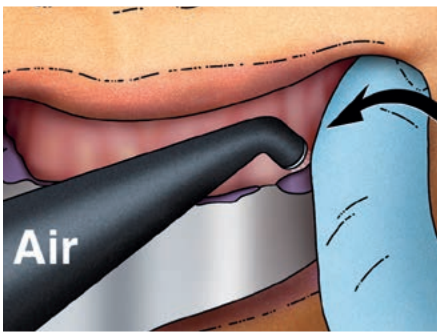


Fig. 38: Use of finger and air stream to loosen impression.

7. Indications

(B. Wöstmann)

Impressions of unprepared tooth structure (e.g. for a study model or the fabrication of an orthodontic splint) is not subject to as many considerations as a true precision impression for a laboratory-made restoration.

7.1. Orthodontic splints

An impression for the fabrication of clear **aligners** (e.g. Invisalign®) has to reproduce the tooth arch completely and precisely. The impression tray should be large enough and be filled fully to completely capture the terminal molars. Since no subgingival details have to be reproduced, a 1-step impression technique like the sandwich technique with a heavy- or medium-bodied tray material (not type 0) is the most efficient variant in this case (Fig. 39). Alternatively, the 2-step impression technique could be another option for aligner fabrication (Fig. 40).

Fig. 39: Impression made with 3M™ Imprint™ 4 Preliminary VPS Preliminary Impression Material for study model.

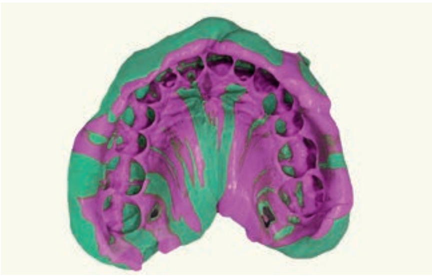


Fig. 40: 2-step impression made with 3M™ Imprint™ 4 Penta™ Putty and 3M™ Imprint™ 4 Light VPS Impression Material.

The impression of prepared tooth structure requires a differentiated, indication-dependent procedure. The choice of a suitable impression technique and impression material for a specific indication has an essential influence on the quality of the final restoration. Depending on the clinical situation, the different impression techniques have both advantages and disadvantages.

7.2. Veneers

The fabrication of veneers requires utmost precision of the impression (Fig. 41). Usually the preparation margin is located supragingivally; deeply subgingival preparations should occur very rarely. In these cases, 1-step impression techniques are preferred.

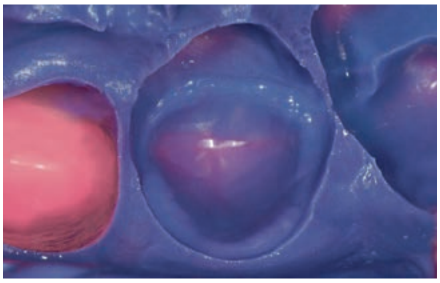


Fig. 41: Impression for a porcelain veneer with 3M™ Permadyne™ Polyether Impression Material. (Courtesy of Dr. Zafiriadis, Zurich, Switzerland)

7.3. Adhesive bridges

Usually, preparation margins for adhesive bridges are supragingival and visible, so the impression should be uncomplicated from that aspect. In order to achieve optimum fit, it is recommended to take the impression using the monophase technique. However, the 1-step heavy body/light body or sandwich technique can also be used if the tray component is not too viscous (e. g. use 3M™ Impregum™ Penta™ H DuoSoft™ or 3M™ Permadyne™ Polyether Impression Material) (Fig. 42).

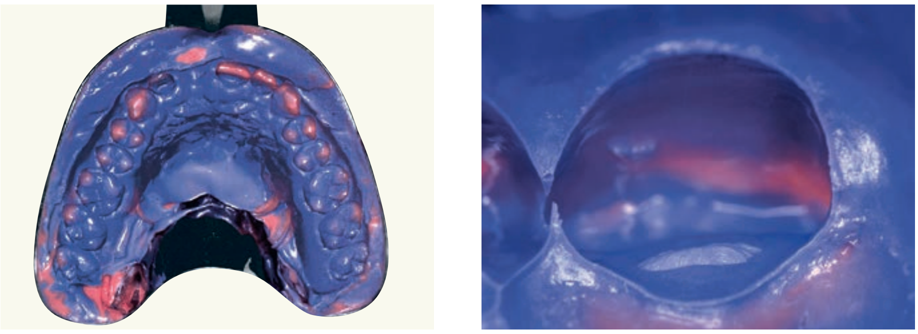


Fig. 42: 1-step heavy body/light body impression for an adhesive bridge using 3M™ Permadyne™ Polyether Impression Material.

7.4. Single-unit restorations (inlays, partial and full crowns)

Partial crown and inlay preparations are the most difficult to reproduce since they mostly have a complicated geometrical shape. Therefore, 1-step impression techniques with an addition-cured silicone or 3M polyether impression material should be used (Fig. 44). Especially for single restorations, the dual-arch impression technique is an efficient and fast alternative (Fig. 43). The 2-step putty/wash technique is only recommended with limitations since careful carving is time-consuming and often impossible when undercuts are directly located at the prepared tooth.

Fig. 43: 1-step heavy body/light body impression for an inlay restoration using 3M™ Imprint™ 4 Penta™ Super Quick Heavy and 3M™ Imprint™ 4 Super Quick Light VPS Material in a dual-arch tray.

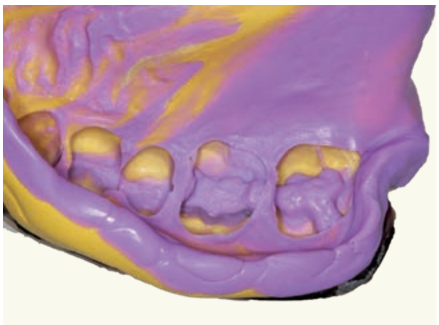


Fig. 44: Impression for two partial crowns made with 3M™ Imprint™ 4 Penta™ Super Quick Heavy and 3M™ Imprint™ 4 Super Quick Light VPS Material using a conventional tray.

When taking an impression for a full single-unit crown in the 1-step technique, flow defects can happen quite often, especially with a putty/wash impression in a stock tray. This can be avoided by using a heavy-bodied or monophase material for the tray instead of a putty material (Fig. 46). The use of a tray with optimized fit (e.g. Border-Lock® or 3M™ Impression Tray) or a custom tray is also recommended. Alternatively, the dual-arch impression technique could be used if applied carefully **(see also chapter 4.5).**

For preparations with deep subgingival preparation margins, the 2-step putty/wash impression technique is suitable: the pressure during the second impression reliably pushes the light-bodied impression material into the sulcus.

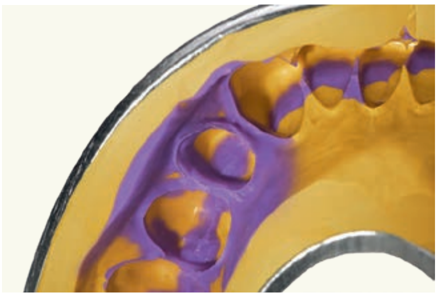


Fig. 45: 2-step heavy body/light body impression for a single crown restoration using 3M™ Imprint™ 4 Penta™ Super Quick Heavy and 3M™ Imprint™ 4 Super Quick Light VPS Impression Material.

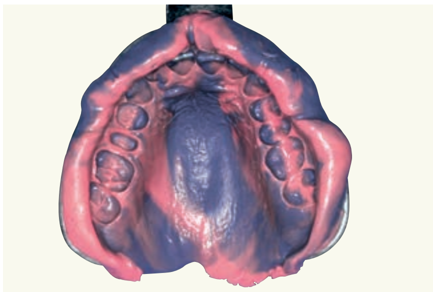


Fig. 46: 1-step heavy body/light body impression for a single crown restoration using 3M™ Impregum™ Penta™ H DuoSoft™ Quick and 3M™ Impregum™ L DuoSoft™ Quick Polyether Impression Material.

7.5. Bridges

From an impression perspective, there is hardly any difference between the preparations for a bridge and a single crown. The more abutment teeth and the deeper the preparation margins, the more difficult it is to use a 1-step impression technique. Choose either the 2-step putty/wash (Fig. 47) or a 1-step impression technique (monophase or heavy body/light body technique), preferably in combination with a custom or customized tray. For small bridges (3-unit) the dual-arch impression technique can be an alternative; for larger units this technique is not suitable.

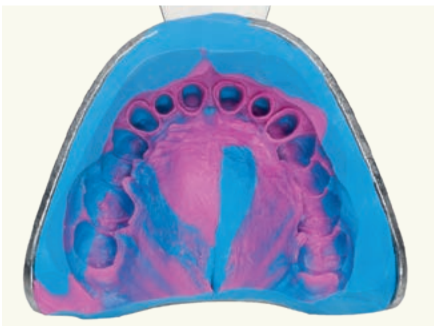


Fig. 47: 2-step putty/wash impression for a 3-unit bridge using 3M™ Imprint™ 4 Penta™ Heavy and 3M™ Imprint™ 4 Light VPS Impression Material.

7.6. Combination dentures

For the fabrication of combination dentures, two different impression problems have to be solved. On the one hand, abutment teeth have to be reproduced and, on the other hand, mucogingival areas and their relation to the teeth have to be reproduced. For the reproduction of the abutment teeth, the same guidelines apply as for the impression of crowns and bridges. After fabrication and seating of the primary copings, the impression is carried out with a custom-made tray (Fig. 48). Here, the use of polyether materials is advantageous, since they favor safe fixation of the primary copings in the total impression due to their high adhesion. Secondly, functional marginal adaptation is possible since the patient can make functional movements during the setting phase of the impression material, and the mobile areas of the mucosa can be reproduced in their maximum extension.

Fig. 48: Monophase impression with fixed primary copings using 3M™ Impregum™ Penta™ Polyether Impression Material. (Courtesy of Dr. P. Chlum, Saalburg, Germany)

7.7. Implants

When taking an impression for implant supported dentures additional aspects need to be considered.

Since implant systems work with prefabricated precision parts, it is no longer necessary to exactly reproduce the implant surface and margin as needed with a preparation on the natural tooth. However, implants are osseo-integrated and compared to natural teeth, do not have the slightest mobility. It is crucial to capture the exact three-dimensional implant positions and their relation to each other, as well as to ensure the flawless transmission of that information to the cast[49–51]. As opposed to implants, a conventional bridge can still be placed in situ if the distance of the abutments on the model slightly deviates from the actual position of the teeth, since the periodontium enables the single tooth to move about 30–50 µm.

The impression conditions for implants differ fundamentally depending on the clinical situation, the chosen implant type and the corresponding transfer technique for the implant position (see table 1 for an overview).

Transfer technique for implant position	Tray	Impression technique	Recommended impression material
Individually prepared core build-up	closed	all	Polyether or VPS
Transfer caps which remain in the impression (abutment level)	closed	1-step impression technique in customized or stock tray	Polyether or VPS
Screwed-in impression posts which remain in the impression (implant level)	open	1-step impression technique in open customized or custom tray	Polyether or VPS
Screwed-in impression posts which will be repositioned* in the impression (implant level)	open	1-step impression technique in open custom tray	VPS

* Repositioning generally is less exact[52] and thus not recommended.

Table 1: Choice of impression technique and material depending on transfer technique and implant system.

Fig. 49: Open custom tray.

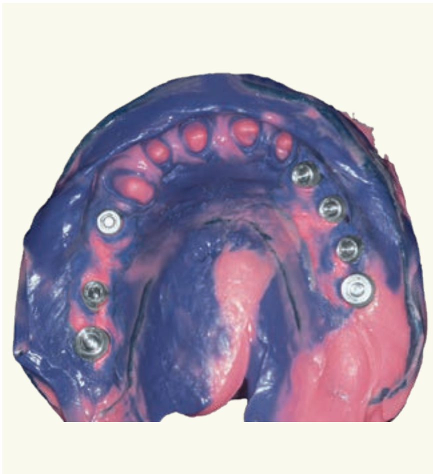


Fig. 50: 1-step heavy body/light body impression for implant-supported restoration and multiple crowns with 3M™ Permadyne™ Polyether Impression Material. (Courtesy of Dr. S. Gracis, Milan, Italy)

7.8. Summary indications and techniques

Indication	Preparation margin: Tissue level or supragingival	Preparation margin: Subgingival	Impression technique	Impression tray	Recommended 3M impression materials
Impressions without prepa-rations (splints etc.)	–	–	Monophase	Stock tray	3M™ Imprint™ 4 Preliminary Penta™/Penta™ Super Quick VPS Preliminary Impression Material
			1-step	Stock tray	3M™ Imprint™ 4 Penta™ Heavy 3M™ Imprint™ 4 Penta™ Super Quick Heavy 3M™ Imprint™ 4 Light 3M™ Imprint™ 4 Super Quick Light
Inlay, veneer, adhesive bridge	x	–	Monophase	Stock or custom tray	3M™ Impregum™ Penta™ Soft
			1-step	Stock or custom tray	3M™ Imprint™ 4 Penta™ Heavy 3M™ Imprint™ 4 Penta™ Super Quick Heavy 3M™ Imprint™ 4 Light 3M™ Imprint™ 4 Super Quick Light
Onlay, partial crown	x	x	Monophase	Stock or custom tray	3M™ Impregum™ Penta™ Soft
			1-step	Stock or custom tray	3M™ Imprint™ 4 Penta™ Heavy 3M™ Imprint™ 4 Penta™ Super Quick Heavy 3M™ Imprint™ 4 Light 3M™ Imprint™ 4 Super Qick Light
Crown	x	(x)	1-step	Stock or custom tray	3M™ Imprint™ 4 Penta™ Heavy 3M™ Imprint™ 4 Penta™ Super Quick Heavy 3M™ Imprint™ 4 Light 3M™ Imprint™ 4 Super Qick Light or 3M™ Impregum™ Penta™ DuoSoft™
			2-step	Stock tray	Imprint™ 4 Penta™ Putty Imprint™ 4 Super Quick Ultra-Light
Bridge	x	x	1-step	Stock or custom tray	3M™ Imprint™ 4 Penta™ Heavy 3M™ Imprint™ 4 Penta™ Super Quick Heavy 3M™ Imprint™ 4 Light 3M™ Imprint™ 4 Super Qick Light or 3M™ Impregum™ Penta™ DuoSoft™
			2-step	Stock tray	3M™ Imprint™ 4 Penta™ Putty 3M™ Imprint™ 4 Super Quick Ultra-Light
Combination denture	x	x	Primary impression 1-step	Stock or custom tray	3M™ Imprint™ 4 Penta™ Heavy 3M™ Imprint™ 4 Penta™ Super Quick Heavy 3M™ Imprint™ 4 Light 3M™ Imprint™ 4 Super Qick Light or 3M™ Impregum™ Penta™ Soft/DuoSoft™
			Secondary/ fixation impression single-stage/ partly functional	Custom tray	3M™ Impregum™, 3M™ Permadyne™

Table 2: Impression techniques for different clinical situations.

TM **Available stock trays from 3M:**
3M™ Impression Trays

Fig. 51: 3M™ Impression Trays (3M Oral Care) – available in the three sizes S, M and L – for upper and lower jaw.

8. Disinfection

(B. Wöstmann)

Infection control is one of the most essential tasks in the dental operatory. Impressions are major carriers of bacteria and viruses since they are contaminated with saliva and often with blood.

Disinfection ensures the interruption of the infection chain between dental operatory and lab and protects the dental technician. Each impression should be disinfected routinely before forwarding it to the dental lab to prevent contamination.

Impressions should be disinfected as soon as they are removed from the mouth. Any delay can cause an increase in the number of microorganisms. Each impression should be carefully rinsed under running water before disinfection, otherwise the bacteria and viruses can grow and fluorish mixed with saliva or blood proteins and the disinfection solution may not reliably destroy the germs in the stated immersion time.

Fig. 52: Rinse impression and completely immerse the impression tray in disinfection solution.

Disinfection reduces the number of germs by at least a factor of 105. In most cases spray disinfection is not enough as complete surface wetting cannot be ensured. Complete immersion in disinfectant guarantees sufficient disinfection[53]. The immersion bath should be in a sealable container to avoid evaporation of the disinfection agent into the air (Fig. 52).

Use only disinfectants which have been especially developed for impression materials (e.g. based on aldehyde or peracetic acid: alcohol as disinfectant is not sufficient for some germs). Make sure that the disinfectant is compatible with the impression material as well as with the stone used for model fabrication[54;55]. Disinfection solutions based on alcohol (instead of water) as a solvent may cause swelling of the impressions and, thus, result in ill-fitting restorations.

Fig. 53: Let the impression drain in the basket after the immersion time and rinse with water. Exchange solution after one week.

Water-based impression materials like alginates and hydrocolloids are prone to swelling and should therefore remain in the disinfection bath for as short a time as possible. Polyether, polysulfides and silicones, (especially addition-cured materials) are less sensitive.

After disinfection, the impression should be rinsed again under running water and dried (Fig. 53).

Please follow the recommendations of the respective associations for hygiene and occupational health and safety as well as the manufacturers' instructions[56].

Fig. 54: Impression material specimens contaminated with human saliva carry a multitude of potentially pathogenic microorganisms despite thorough rinsing with water.

Fig. 55: Immersion disinfectants effectively kill microorganisms. After incubation on blood agar no colony-forming units can be detected.

9. Storage of the impression and transport to the dental lab

(B. Wöstmann)

On the way from the dental office to the dental lab, the impression is best carried in a container, securely fixed in foam. Inappropriate transport and storage conditions can lead to further changes in dimension[57], e.g. by overheating or absorption or release of moisture.

Alginates and hydrocolloids should be poured immediately (usually in the dental practice). If transport is inevitable, the impression should be stored in a resealable plastic bag together with a moist (not wet) paper towel. C-silicone or polysulfide impressions should be poured as soon as possible as well, since they are not dimensionally stable.

Polyether impressions must be sent separately from alginate impressions and should be transported and stored dry, cold and protected from direct sunlight. Under these conditions they can be kept for up to two weeks.

VPS materials have the most favorable material properties for storage. However, they should also be kept and transported dry and not above room temperature. In any case please follow the manufacturers' instructions for use.

10. Fabrication of the stone model

(B. Wöstmann)

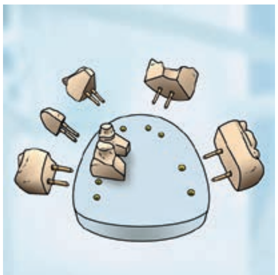


Fig. 56: Sectioned stone model.

Impressions and models are closely connected. Basically, the successfully fabricated model is the completion of the impression.

10.1. Standardization of the model fabrication

The thermal contraction of the material when cooling down from mouth to room temperature should not be underestimated, since the extent of this contraction is comparably high[58], especially for VPS materials. Heating the impression to mouth temperature before pouring is not useful since this process is never reproducible and cannot be standardized. It is much more beneficial to compensate for the dimensional error with targeted dental technician methods. The dental technician adjusts processes in response to impression material, tray and information received from the dentist (e.g. use of spacer, embedding mass, gypsum expansion, control of the milling machine, etc.) and carries out casting of the impression under constant conditions (room temperature, water temperature etc.).

Resin-based model materials, (e.g. **epoxy resins**) are used less frequently. Some of these materials are not directly compatible with polyether impression materials from 3M and can only be used with a separator which completely seals the surface.

Silverplating of 3M polyether impressions in the galvanization bath is possible, but copper plating is not possible for chemical reasons.

10.2. Model systems

The **sectioned model** is still one of the most used model systems (Fig. 56).

In order to work on the model, it is usually necessary to remove the stone tissue around the preparation margin. However, these gypsum parts, often regarded as superfluous, reproduce the soft tissues. In most cases, they facilitate a correct shaping of the crown, since it has to correctly fit to the prepared tooth as well as harmonize with the periodontal tissue. If necessary, a removable tissue (gingiva mask) has to be prepared or an additional uncut model is fabricated.

Alternatively, model systems with prefabricated bases or base molds can be used.

The problem with these systems is that the gypsum arches expand during setting and are then put under stress as they are fixed to the stable base. These stresses are released after removal from the base plate, which might lead to difficulties in correctly repositioning the tooth arch later. The teeth have to be pinned, then sectioned into small segments each of which must be repositioned exactly. Still, highly precise models can be fabricated if this technique is skilfully used[59–61]. Model systems with a finely detailed base plate should be avoided since complete repositioning in the vertical dimension is sometimes difficult or impossible.

10.3. Timing of the model fabrication

Cast

Before pouring the master cast the impression should be trimmed. The excess impression material which does not contain any information for the fabrication of the master cast is removed. Since each impression is deformed upon mouth removal, the impression material needs time for elastic recovery before model fabrication. Usually, the minimum time required varies between 30 minutes to 2 hours. All 3M polyether materials can be cast after 30 minutes.

The manufacturers' instructions must always be followed. Especially with VPS impressions, voids in the stone model may be a result of pouring the impression too early – reflecting a continuing polymerization reaction during which hydrogen gas is released.

The cast should be removed from the mold only after the time stated by the manufacturer. Careful removal of the model is essential. If necessary, it can be carefully loosened at the margin with a knife (this is comparable to breaking the vacuum when loosening an impression in the patient's mouth, ***see chapter 6.4.***) then the impression may be removed in a flowing movement towards the front teeth.

If impression materials with a high final hardness are used, the impression tray can be removed first, if possible. Then, the flexible impression material can be pulled off the cast more easily. If the impression needs to be poured a second time, it must be given time to recover from deformation upon removal of the first pour.

Base

The model base should be of a type IV or V stone or a special base stone with a low expansion coefficient to keep expansion and errors as low as possible. Such special base stones have a lower hardness than type IV stone, but have the same or better (i.e. less) expansion behavior. The usual type III stone is obsolete. It leads to considerable dimensional changes of the model. The highly expanding stone even further expands the finished model.

The model base is ideally immediately prepared after removal of the cast arch, or up to 24 hours later. If the model base is prepared immediately, the tooth arch is not sectioned immediately, since base and arch undergo the same expansion behavior.

After fabrication and final setting of the model base, the tooth arch has to be trimmed off the base. Otherwise the arch is under stress which might cause cracks and tears.

Hardened stone is hygroscopic: It takes up moisture from the air and should be stored dry to avoid surface and dimensional changes.

Fig. 57: Courtesy of J. H. Bellmann, MDT, Rastede, Germany.

11. Conclusion

(B. Wöstmann)

What further developments can be expected in the area of impressioning? High-tech procedures connected to optical impressioning will be improved more and more. This, however, does not solve the basic clinical problems. All available impression methods allow only for the reproduction of accessible areas, irrespective of the use of an elastomeric impression material or a scanner as reproduction media.

Accessible, visible areas can be reproduced predictably, and the subsequent work and material flow is sufficiently exact to achieve good restorations.

Basically, today's impression materials and methods deliver excellent results. In order to take advantage of their full capabilities, it is essential to respect the **clinical** and **process-relevant** parameters discussed in this document. They are often underestimated but are the key to achieving results corresponding to the high levels of material science behind today´s impression materials.

Following a structured procedure during impressioning, in conjunction with good communication and cooperation with the dental technician, you can produce restorations which fulfill the optimal restorative as well as esthetic requirements.

12. Clinical impression workflow – Overview

Diagnosis incl. medical history

Preparatory phase
Planning of restoration
Establishing healthy periodontal conditions

Preparation and precision impression taking

Shade selection

Impression of opposing arch

⚠ Possible interference of methacyclate composite material or cleaning agents

Anaesthesia

Tooth preparation

⚠ Possible interference of astringents with impression material setting

Selection of impression technique
Impression material/technique and type of tray for best impression results and patient comfort

Let dry thoroughly (≥ 5 min)

Tissue management
Retraction and/or hemostasis

Preparation of impression*
- **Tray:** Customization, application of adhesive
- **Preparation of wash material** (e.g. special application syringe)
- **Tray filling**

Impression taking*
- **Application of wash material**
  Avoid inclusion of air
- **Slow tray insertion**
  Hold in place steadily with stable support for your hands
- **Removal of impression**

Lower jaw: Loosen prepared side first
Upper jaw: Loosen opposing side first

Front: Loosen dorsally first

Bite registration

Cleaning/disinfection of impression

Fabrication of temporary

Cementation of temporary

Shipment of impression to the lab
Information on material, time and date

⚠ Provide appropriate transportation conditions

Fabrication of restoration in the dental lab

Restoration seating appointment

* Needs to be performed once for tray material and once for wash material only if 2-step technique is applied.

Fig. 57: Treatment procedure for (subgingival) crown and bridge impressions.

If a tooth is restored with a supragingival or minimally invasive restoration, such as an inlay, tooth preparation and precision impression usually take place during the same appointment. In these cases the temporary restoration is fabricated after impression taking.

13. Get more confidence in every step

Retract

Mix & Syringe

Impress

3M™ Astringent Retraction Paste
Faster and gentler way to retract gingival tissue and control bleeding.

3M™ Intra-oral Syringe Green/Purple
Convenient wash material application with extreme accuracy and less waste.

3M™ Pentamix™ 3 Automatic Mixing Unit
Void-free mixing of impression materials at industry-leading speed.

3M™ Imprint™ 4 VPS Impression Material
Fastest intra-oral setting time among VPS materials.

3M™ Impregum™ Polyether Impression Material
Unrivalled precision for perfectly fitting restorations with fewer retakes and remakes.

3M™ Impression Tray
Easy-to-customise full-arch tray with self-retentive fleece strip and no need for a tray adhesive.

Preliminary impression (optional)

3M™ Imprint™ 4 Preliminary VPS Preliminary Impression Material
No dust, no mess, just low-stress impression. Pouring when convenient and multiple times just from one impression. High hydrophilicity for easy model pouring.

Bite registration (optional)

3M™ Imprint™ 4 Bite VPS Bite Registration Material
Offers great flow properties, no-slump consistency, ample working time and a 60-second setting time.

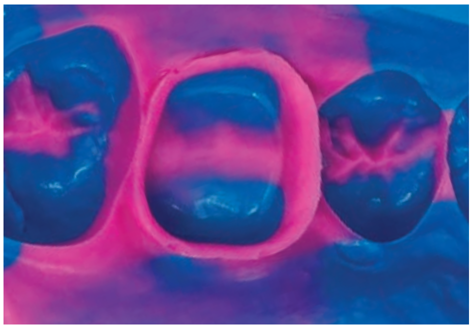
14. A successful procedure starts with the right materials

Everyday impressions

3M™ Imprint™ 4 VPS Impression Material

Make precision an everyday occurrence.
Imprint 4 VPS Impression Material provides:

- Sufficient time to load and seat the tray – no stressful race against the clock.
- Reduced chair time and stress for patients – Imprint 4 material has the shortest intra-oral setting time among leading VPS fast-setting impression materials.



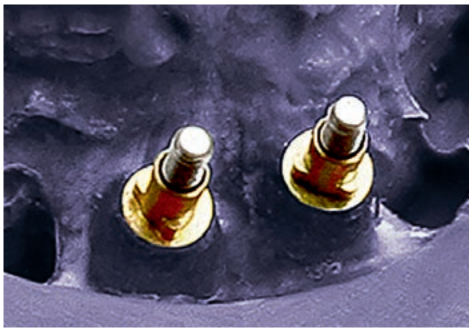
3M™ Imprint™ 4 VPS Impression Material

For challenges and implants

3M™ Impregum™ Polyether Impression Material

Remove the pressure of challenging cases.
Impregum Polyether Impression Material gives you:

- Superior moisture tolerance for void-free impressions, even in wet environments.
- Sustained flowability throughout the entire working time.
- Unique snap-set behavior – setting does not start until working time ends.
- Classic materials offer all the working time you need for large cases.
- New "Super Quick" materials offer a 2-minute set time and improved taste for better patient comfort in small cases.



3M™ Impregum™ Polyether Impression Material

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16. Glossary

17. Overview 3M impression materials and working/setting times

Polyether precision impression materials

Indications	Impression technique	Single-unit crown	Small implant (≤ 2 units)	Inlay/onlay (≤ 2 units)	Small bridge (≤ 3 units)	Veneers	Bridge (> 3 units)	Implant (> 2 units)	Pick-up impression	Functional impression
Super Quick Setting Materials										
3M™ Impregum™ Penta™ Super Quick (Medium Body)	Monophase	✓	✓	✓	✓					
3M™ Impregum™ Penta™ Super Quick (Medium or Heavy Body) 3M™ Impregum™ Super Quick (Light Body)	1-step									
Quick Setting Materials										
3M™ Impregum™ Penta™ Soft Quick (Medium Body)	Monophase	✓	✓	✓	✓	✓				
3M™ Impregum™ Penta™ H DuoSoft™ Quick (Heavy Body) 3M™ Impregum™ L DuoSoft™ Quick (Light Body)	1-step									
Regular Setting Materials										
3M™ Impregum™ Penta™ Soft (Medium Body)	Monophase					✓	✓	✓	✓	✓
3M™ Impregum™ Penta™ H DuoSoft™ (Heavy Body) 3M™ Impregum™ Penta™ L DuoSoft™ (Light Body) 3M™ Impregum™ Garant™ L DuoSoft™ (Light Body)	1-step									
3M™ Impregum™ Penta™ (Medium Body)	Monophase					✓	✓	✓	✓	✓

3M™ Imprint™ 4 VPS Impression Material

Tray Material	Recommended Wash Material
1-step Technique	
3M™ Imprint™ 4 Penta™ Heavy	3M™ Imprint™ 4 Light
	3M™ Imprint™ 4 Regular
3M™ Imprint™ 4 Penta™ Super Quick Heavy	3M™ Imprint™ 4 Super Quick Light
	3M™ Imprint™ 4 Super Quick Regular
3M™ Imprint™ 4 Penta™ Putty	3M™ Imprint™ 4 Regular
2-step Technique	
3M™ Imprint™ 4 Penta™ Putty	3M™ Imprint™ 4 Super Quick Ultra-Light
	3M™ Imprint™ 4 Light

Working/setting times

	Dispensing system	Viscosity low – high	Impression technique	Recommended max. working time (min:sec)	Intra-oral setting time at 37°C (min:sec)
Super Quick Setting Materials					
3M™ Impregum™ Penta™ Super Quick (Medium Body)			Monophase or 1-step	0:45	2:00
3M™ Impregum™ Penta™ Super Quick (Heavy Body)			1-step	0:45	2:00
3M™ Impregum™ Super Quick (Light Body)			1-step	0:45	2:00
Quick Setting Materials					
3M™ Impregum™ Penta™ H DuoSoft™ Quick (Heavy Body)			1-step	1:00	3:00
3M™ Impregum™ Penta™ Soft Quick (Medium Body)			Monophase	1:00	3:00
3M™ Impregum™ L DuoSoft™ Quick (Light Body)			1-step	1:00	3:00
Regular Setting Materials*					
3M™ Impregum™ Penta™ Soft (Medium Body)			Monophase	1:45	4:15
3M™ Impregum™ Penta™ (Medium Body)			Monophase	1:45	4:15
3M™ Impregum™ Penta™ H DuoSoft™ (Heavy Body)			1-step	1:45	4:15
3M™ Impregum™ Penta™ L DuoSoft™ (Light Body)			1-step	1:45	4:15
3M™ Impregum™ Garant™ L DuoSoft™ (Light Body)			1-step	1:45	4:15

* Setting time from start of mixing 6:00 min.

Working/setting times

	Dispensing system	Viscosity low – high	Setting version	Maximum working time (23°C) min:sec	Maximum intra-oral syringing time (37°C) min:sec	Constant Intra-oral setting time (37°C) min:sec
Tray Materials						
3M™ Imprint™ 4 Penta™ Putty		Putty	Regular Set	1:30	–	2:30
3M™ Imprint™ 4 Penta™ Heavy		Heavy Body	Regular Set	2:00	–	2:00
3M™ Imprint™ 4 Penta™ Super Quick Heavy		Heavy Body	Fast Set	1:15	–	1:15
Wash Materials						
3M™ Imprint™ 4 Super Quick Ultra-Light			Fast Set	1:15 **or**	0:35	1:15
3M™ Imprint™ 4 Light			Regular Set	2:00 **or**	1:00	2:00
3M™ Imprint™ 4 Super Quick Light			Fast Set	1:15 **or**	0:35	1:15
3M™ Imprint™ 4 Regular			Regular Set	2:00 **or**	1:00	2:00
3M™ Imprint™ 4 Super Quick Regular			Fast Set	1:15 **or**	0:35	1:15

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