Figure 1.174. Tooth crown fracture.

INDICATIONS FOR ENDODONTIC TREATMENT

General indications for endodontic treatment may include any pathological changes in the pulp and periapical tissues and consequent symptoms, which may be due to an infection, continuous physical or chemical irritation, trauma and iatrogenic effects.

Infections of the dental pulp and periapical tissues are most often of exogenous origin, but in rare cases, they can also be endogenous (Fig. 1.173). This mainly happens due to polymicrobial infection resulting from the progression of caries lesions. Continuous physical and chemical irritations have already been mentioned in the description of the aetiology of non-caries lesions, but also in the description of the aetiology of degenerative pulp changes, which can cause pathological changes in the pulp and periapical tissues.

Complex dental trauma, where, in addition to damage to the enamel and dentine, the dental pulp is also exposed, or luxation and avulsion of the tooth are indications for endodontic therapy and possible prosthetic rehabilitation (Fig. 1.174). In such cases, it is difficult to consider endodontic treatment as a pre-prosthetic phase. To be more specific, it is an integrated multidisciplinary therapy in which prosthetic therapy is the final stage.

Iatrogenic or accidental opening of the dental pulp during cavity preparation in caries therapy or during preparation in prosthetic therapy is an unwelcome treatment complication (Scheme 1.21). Although direct pulp capping can be used as a therapeutic option in caries therapy, endodontic therapy, i.e., tooth devitalisation, is recommended during prosthetic therapy because of the relatively uncertain outcome of iatrogenic open pulp therapy. It should be noted that the success of the procedure of direct pulp capping in older people is highly questionable and should be avoided in pre-prosthetic

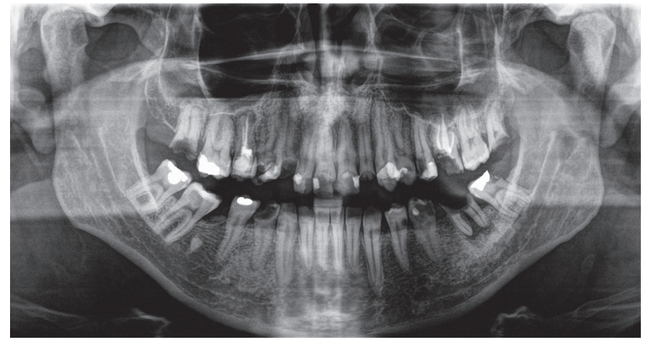
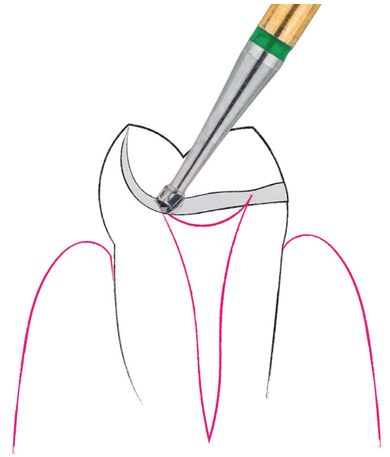


Figure 1.173. Panoramic radiograph of teeth destroyed by caries lesions.



Scheme 1.21. Iatrogenic or accidental opening of the dental pulp.

Figure 1.434. Portrait photograph with a serious face.

Figure 1.435. Portrait photograph with a smile.

Figure 1.436. Portrait photograph with retractors.

Figure 1.437. Portrait macro photograph of a smile.

Figure 1.438. Portrait macro photograph of a smile, 12 o'clock view.

Analogue planning

When opting for prosthetic therapy with analogue restoration making, for example, feldspathic or glass-ceramic veneers, metal-ceramic fixed partial dentures or zirconium dioxide crowns, the dental technician initially starts the planning based on the information received from the dental office.

This information must be as precise and clear as possible in order for the treatment plan to be completed by creating a wax-up. The wax-up is a mandatory part of therapy, especially when it comes to oral rehabilitation or treatment of the aesthetic zone. It is debatable whether individual crowns and small fixed partial dentures in the posterior region require this type of planning, but they are generally not a challenging aspect of the clinical practice protocol. The purpose is to present and standardise the work protocols in complicated and demanding functional and aesthetic cases. In order for the technician to make a wax-up, the therapist must transfer the situation from the oral cavity to the dental laboratory as precisely as possible. The dental technician must be provided with the following in order to create a wax-up:

- Dental photographs;
- Anatomical impressions;
- Facebow registration;
- Bite registration;
- Any additional information.

Individual stages and the final wax-up will be elaborated in the following text. It is important to emphasise that the patient has not actually begun the therapy (except for the initial examination and pre-prosthetic treatment) and that the completion of this phase will result in a prototype prosthetic restoration. This prototype will first be tried, analysed and possibly corrected in order to meet the functional and aesthetic requirements, so that it can be successfully implemented in the therapy. This phase has been neglected for many years, but it is the key to contemporary minimally invasive dental medicine, as well as to this protocol.

DENTAL PHOTOGRAPHY

COMMUNICATION

Dental photography was described in detail in the chapter after the first examination because it is of great importance not only for planning, but also for analysis, documentation and commercial purposes. The transfer of information through dental photographs to a dental technician will be presented as a key part of this phase, with the aim of facilitating the creation of the prosthetic restoration. It is not always necessary to send all photographs, but it is essential to send every photograph the dental technician needs. The key planning photographs are:

MANDATORY:
PORTRAITS:
– Serious (Fig. 1.434);
– Smile (relaxed/full) (Fig. 1.435);
– Retracted (Fig. 1.436).
MACRO PORTRAITS:
– Smile (relaxed/full) (Fig. 1.437);
– 12 o'clock photograph (Fig. 1.438).

Figure 1.474. Different types of amelogenesis imperfecta.

Figure 1.474 (cont.). Different types of amelogenesis imperfecta.

Figure 1.520. Wax-up of the maxillary and mandibular teeth.

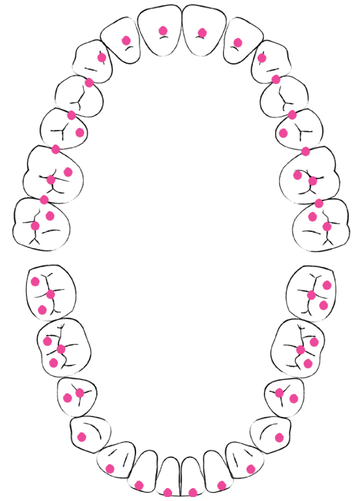
FUNCTION AND THE POSTERIOR TEETH

The wax-up of the posterior teeth is somewhat more complicated (Fig. 1.520). The most important role of the posterior teeth is that of function, rather than aesthetics. Functional wax-ups require a great deal of knowledge of gnathology and arch movements. The shapes of the occlusal surfaces, ridges and tooth cusps are created based on this knowledge. The technician needs information related to maximal intercuspation or, more often, centric relation (oral rehabilitation), protrusion and laterotrusion records. Knowledge of the concepts of occlusion (described in the previous chapter) is of extreme importance.

There are also several methods of making a wax-up. One of them is wax-up on an occlusal compass, where mandibular movements, from protrusion to lateral movements, are analysed, and waxed on that basis.

Wax-up begins with the tooth cusps and continues with ridges. Those that carry the occlusion, i.e., the supporting cusps, are created first. The supporting cusps are buccal in the mandible and palatal in the maxilla. They obtain contacts and are, therefore, regularly more prominent than the non-supporting cusps. There are several types of contacts and they usually depend on the class in which the arch is located. In normal occlusion (ideal Class I), the contacts on the mandibular posterior teeth go over the buccal cusps, so that (Scheme 1.80):

- the mandibular first premolar is in contact with the mesial ridge of the maxillary first premolar;
- the mandibular second premolar is in contact with the distal ridge of the first and the mesial ridge of the maxillary second premolar;
- the mandibular first molar is in contact with the distal ridge of the second maxillary premolar and the mesial ridge of the first mandibular molar with the mesial cusp, and with the central fissure of the maxillary first molar with the central cusp;
- the mandibular second molar is in contact with the distal ridge of the first and mesial ridge of the maxillary second molar with the mesial cusp, and with the central fissure of the maxillary second molar with the distal cusp.



Scheme 1.80. Occlusal contacts of teeth in normal occlusion.

In the case of the maxillary teeth, the contacts are realised by the palatal cusps, so that:

- the maxillary first premolar has no contact with cusps;
- the maxillary second premolar is in contact with the central fissure of the mandibular second premolar;
- the maxillary first molar is in contact with the central fissure of the mandibular first molar with a mesial cusp;
- the maxillary second molar is in contact with the central fissure of the mandibular second molar with a mesial cusp.

The occlusal compass is extremely useful in the final wax-up stage of the cusps, but also in controlling the main movement of the mandible, which gives guidelines for the height and shape of the cusps.

The final wax-up of the inclination and length of the posterior teeth should also be accompanied by occlusion curves, the curves of Spee and Wilson. The curve of Spee is a line in the mandible that goes over the incisal edges of the anterior teeth and the buccal cusps of the posterior teeth. It exists as a concave curve in the mandible and as a convex curve in the maxilla; however, the slope of this curve also depends on the skeletal class, so Class II is more accentuated, whereas Class III is less

Execution

This phase is manually demanding for the therapist. It is the stage when the plan begins to be implemented, and this part of the therapy requires skills that are partially acquired at university, but also afterwards, through lifelong education as well as through everyday work.

As important as the first phase of the protocol may be, it is not overly manually demanding for the therapist. The dental technician/designer has much more work and responsibility in the planning phase. As for the therapist, knowledge of the protocol and the information that the technician needs is more important than manual dexterity. On the other hand, this phase is explained in the most detail in this book because it represents the biggest deviation from everyday work. In analogue dental medicine, the planning phase was skipped for years due to both the speed of work and the lack of knowledge of the therapist or dental technician. After a preliminary conversation and review of radiographs, patient consent to begin with treatment was sought without having provided them with real insight into what the outcome would be. It was primarily a case of simply trusting the therapist and their skills as well as their experience. Only recently, with the development of Digital Smile Design (DSD) (Madrid, Spain) and other planning concepts, has the planning phase become more integrated into the work protocol, although, unfortunately, still not to a sufficient extent. This is an essential element of digital dentistry and does not cause many difficulties for the designer/technician, so it became a part of therapeutic procedures very early on. Once again, in both the digital and the analogue protocol, treatment plans and mock-ups greatly facilitate work and communication. Therapeutically, it is extremely important that the first try-ins of the proposed treatment plan take place in the initial phase and not very late in the final phase as used to be the case, as this meant that the restorations sometimes had to be repeated or changed significantly. It is much easier to change the wax-up (manually or digitally) and repeat the mock-up than the finished restoration. In addition to the increased amount of time and materials repeating the finished restoration requires, patients are not likely to trust this approach.

is in practice often referred to as four- or six-handed dentistry. One assistant is required for four-handed dentistry, usually positioned to the left of the therapist, and two are required for six-handed dentistry, positioned to the left and right. Such assistance is not difficult to provide and the requirements are grasped quickly. It is important that the therapist move their head as little as possible and therefore change the focus minimally. Replacement instruments, burs or handpieces are requested verbally and are placed in the hand without changing the direction of view.

For microscopy, special micro-instruments are available, in particular mirrors (Fig. 2.55). The mirrors used should offer an optimal image of the operating site with a high reflection rate (Fig. 2.56). The procedure is largely performed indirectly using mirrors, so their quality should be exceptional. The technique for working with mirrors is extremely important because just a small movement of the mirror can change the angle of view and thus reduce the need for to make changes on the microscope. It should also be noted that optical devices allow the mirror to be far away from the area of preparation and provide a good, sharp image. The mirror is fixed away from the tooth being prepared and focus is found in the mirror by using a varioscope. This makes it possible to obtain an image without water drops on the mirror. There are other ways to reduce the impact of water on visibility in the mirror. One way is to use coatings that reduce the water surface tension, but it is even easier to run the mirror along the outlet of the parotid gland (buccal area of the maxillary first molar), thus obtaining a layer of mucous saliva on the surface. An assistant can blow air onto the mirror using an air/water syringe and thus disperse the drops. There are also mirrors that rotate and thus disperse any droplets independently (Fig. 2.57). Finishing touches can also be performed without water if sonic or ultrasonic instruments are used, as well as burs on low-speed handpieces (Fig. 2.58).

Figure 2.55. Microsurgical instruments.

Figure 2.56. A mirror offering good reflection that does not produce double images while using the microscope.

Figure 2.57. A rotating mirror that removes water droplets from the glass.

Figure 2.58. Sonic attachments for tooth preparation.

Mock-up and guided tooth preparation

The mock-up is the final element of the planning phase and the first element of the execution phase. In the standard way of working, however, teeth are prepared without using a mock-up.

If a wax-up is designed, it is mainly used to create a silicone index and control the preparation. With the advent of guided preparation for veneers, as advocated by Galip Gürel, the era of preparation over mock-ups began (Figs. 2.59 to 2.63). It is rarely mentioned in the literature if unrelated to veneers (Fig. 2.64). Preparation control is essential for all types of restorations. It makes it possible to perform minimally invasive therapy and implement the plan agreed to by the patient, provides controlled space for designing the proposed restoration in the given material, reduces the possibility of error on the part of the therapist, and improves communication between the dental office and laboratory (Fig. 2.65). The greatest advantage is certainly obtained for the

Figure 2.59. Mock-up on the patient's teeth.

Figure 2.60. Preparation over the mock-up begins with the use of burs for depth marking.

Figure 2.61. The notches are emphasised using a graphite pencil.

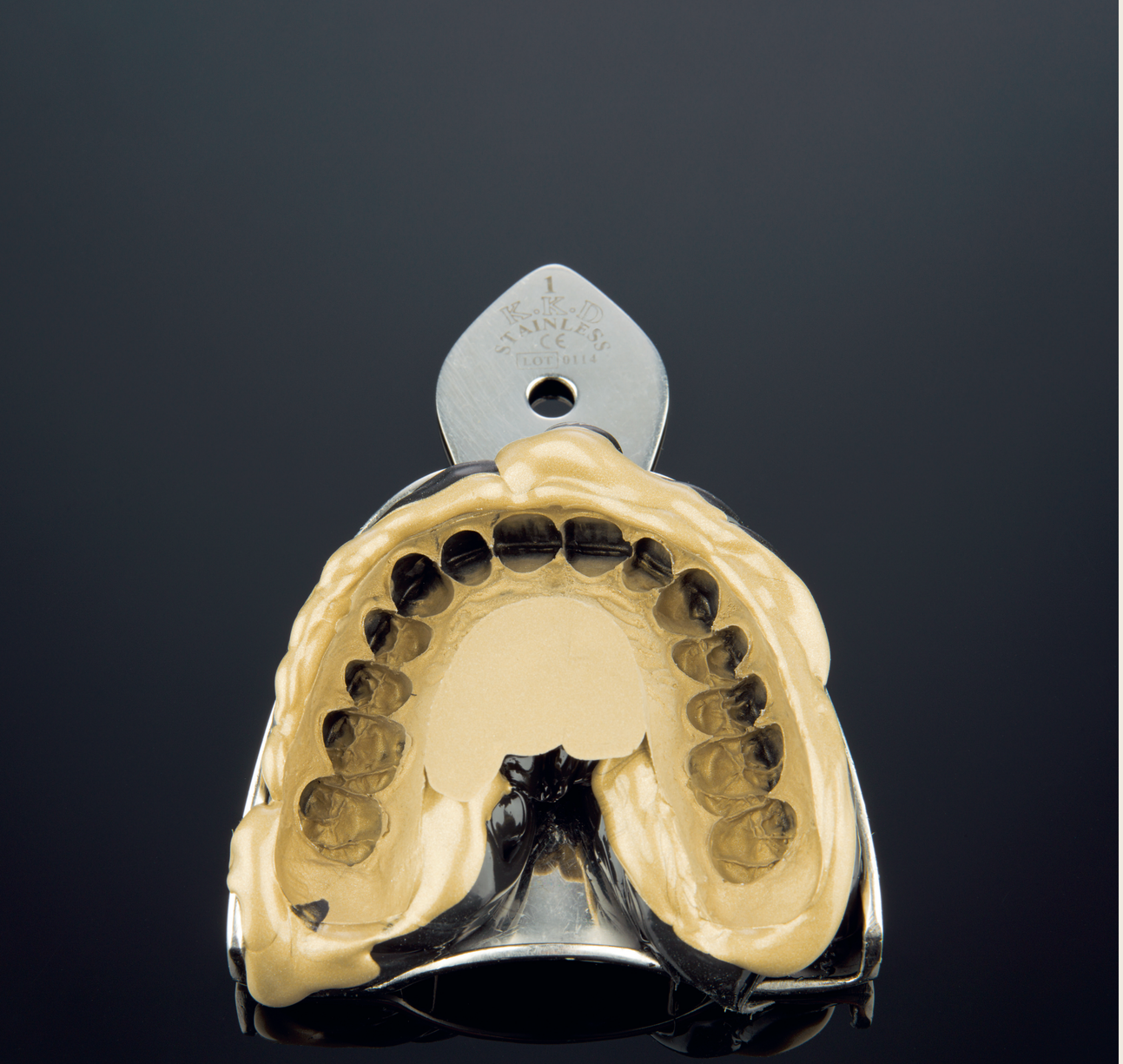


Figure 2.116. The impression.

Impression taking

Impression taking is the most demanding and important part of the execution phase (Fig. 2.116). Although the preparation is considered crucial, it is not possible to register a good preparation without a good impression, either in the laboratory or using a computer.

This does not diminish the importance of preparation; however, preparation amounts to creating space for the implementation of the treatment plan, and the impression implies a transfer of information from the mouth to the laboratory or computer. Impressions may be analogue or digital. With the advent of digital impressions (scans), the definition of impressions has changed. An impression is defined as a negative of the hard dental and soft surrounding tissues (Fig. 2.117); however, if a digital protocol is used, analogue impression taking is replaced by scanning and, if

Figure 2.117. Analogue impression of abutments with silicone and antagonist impression with irreversible hydrocolloid.

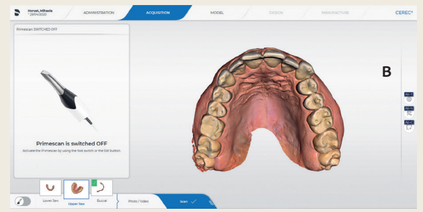


Figure 2.118. (a) Digital impression of the mandible. **(b)** Digital impression of the maxilla.

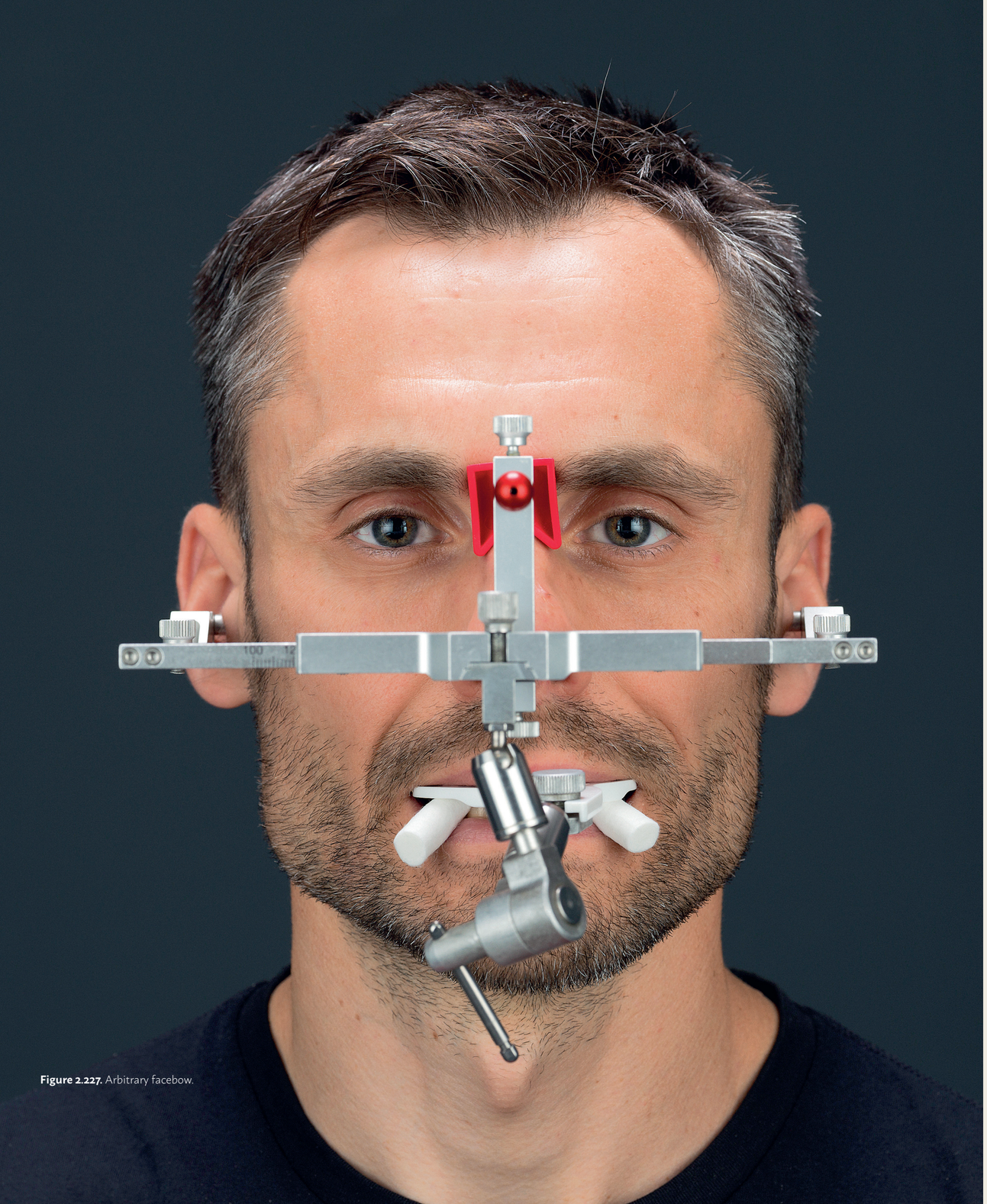


Figure 2.227. Arbitrary facebow.

Additional information

Additional information is required so the technician/designer can create highly aesthetically and functionally satisfactory work. At this stage, it is again advisable to take certain photographs so that the technician/designer has an insight into the condition of the oral cavity, which should be as accurate as possible.

The first series of photographs are taken to assist planning, but at this stage, they are important because of the mock-up, preparations and in-office provisionals (Figs. 2.228 to 2.234). Of these, photographs of the patient when smiling and retracted portrait photographs are important because they show the harmony of the teeth and face (Figs. 2.235 and 2.236). In addition, if the height of the bite changes significantly, it is advisable to take serious portrait photographs because they can be used to analyse the facial proportion and physiognomy thoroughly.

Arbitary facebows contain essential additional information for analogue prosthodontics (Fig. 2.227). When performing more preparations in the mouth, the dental technician cannot use the facebow record from the planning phase because the shape of the teeth has changed. Therefore, it is crucial to take such a record every time any changes are made to the maxillary teeth (unless it is a smaller

Figure 2.228. Photograph of maxillary teeth with a mock-up.

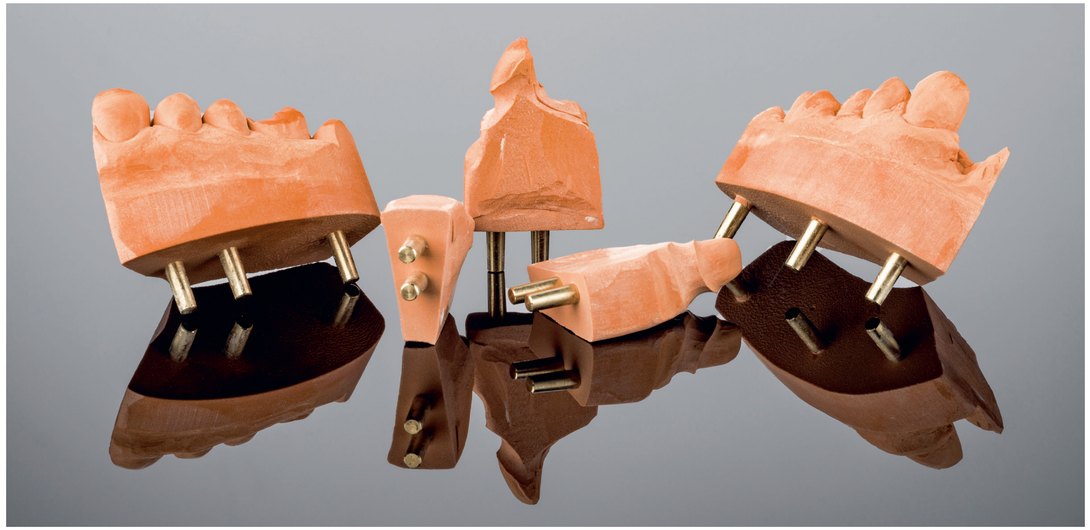


Figure 3.15. Parts of the cast retained in the base using pins.

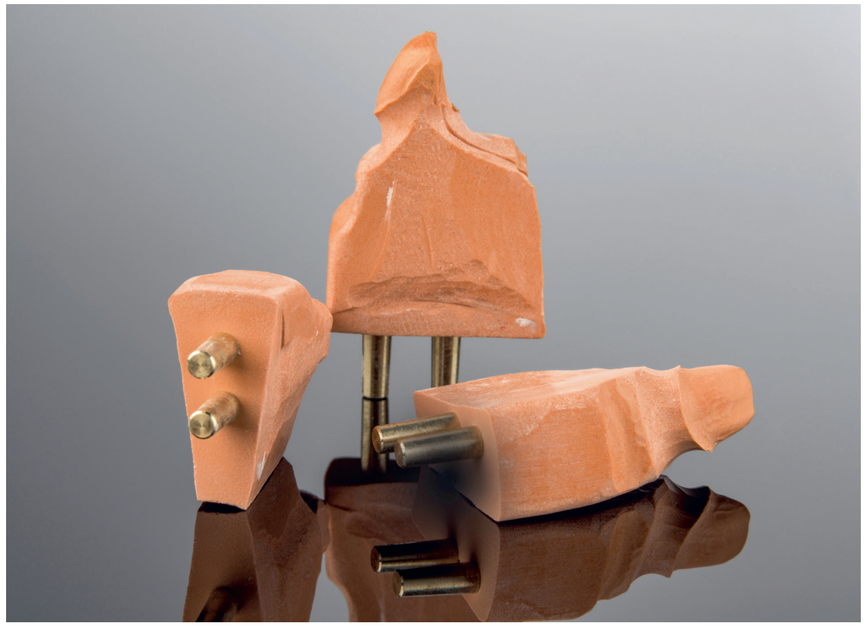


Figure 3.16. Two pins are placed in one die to prevent movement in the cast.

Figure 3.17. Stock plastic base with perforations for retention of casts and dies.

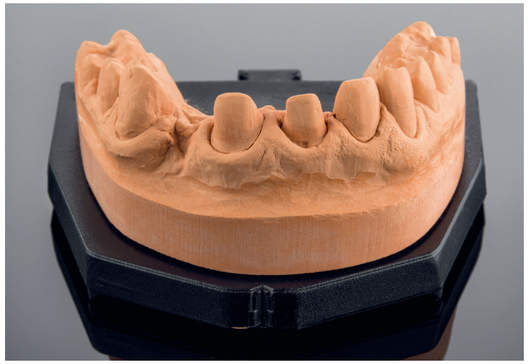


Figure 3.18. Cast placement with pins in a stock base with perforations for cast retention.

Figure 3.19. Separation of dies using a disk on a working cast.

Figure 3.20. Separated dies on the working cast.

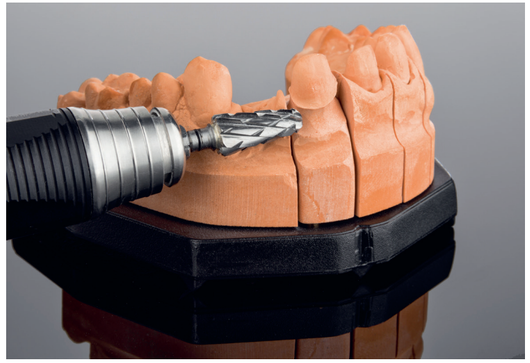


Figure 3.21. Treatment of the dies using a milling tool or etching to see the border of the preparation.

Figure 3.22. Processed working cast.

Figure 4.58. Polymethylmethacrylate (PMMA) try-in on a cast.

Figure 4.59. 3D printed cast and milled PMMA restoration.

Figure 4.60. PMMA crowns and veneers.

Digital laboratory finalisation and try-in

When taking a digital approach, it is easiest, and indeed advisable, to try the restoration in its polymeric form before making it in ceramic material. Laboratory provisionals are certainly an option for try-in and if further corrections are made, they can be additionally printed or milled so as not to increase the costs after milling of the ceramics (Figs. 4.58 to 4.60).

A classic PMMA or another polymeric material may be used. This mode of operation ensures greater safety and speeds up the process. All phases described in the analogue try-in are also performed during this try-in. It begins with an evaluation of the fit and marginal adaptation and continues with an analysis of the contacts with the adjacent teeth, gingiva, retention/resistance and finally occlusion and function. Only the final aesthetic properties (microtextures and colours) cannot be checked in this try-in. If the therapist is satisfied and corrections are minimal, they are made in the computer-aided design (CAD) software and the final restorations are milled.

In order to reach this stage, however, the full digital protocol needs to be followed. The goal of the protocol is to achieve a restoration that is identical or very similar to that at the final mock-up try-in. This restoration is approved by both the therapist and the patient. In order to transfer the final design to the scans of the prepared teeth, wax-up casts and virtual working casts have to be placed in the same position in the coordinate system. There are several ways to achieve this. One option is to cut out parts of the first scan on which the wax-up was done and to re-scan the situation with the prepared teeth, as already described. This way, the technician actually has the same cast, so the software recognises the position in the coordinate system. This requires a good intraoral scanner. If the scanner cannot provide sufficient accuracy, re-scanning is not possible. Another option is to overlap the digital wax-up cast and the digital working cast in the laboratory and the CAD software. In this case, the therapist takes a completely new scan of the prepared teeth, then the technician/designer should place the casts in the optimal position. This is important not only for the later aesthetics of the design, but also for occlusion and function. In order to overlap these scans in the dental laboratory, it is necessary to do everything as accurately as possible from the first to the last scan. This is why the accuracy of the scanner and the method of scanning are crucial. It is important to first scan as many hard and soft tissues as possible occlusally/incisally when scanning each tooth (the tooth to be scanned should be positioned in the middle of the screen accompanying the scan), making sure the scanner is as close to the tooth as possible. Later, the teeth and soft tissues are also scanned vestibularly and orally, with as much detail as possible. Scans should be complete, not missing any scanned parts, and with as smooth and clean margins as possible. They can be merged most accurately by a technician/designer, although there may be minimal (micron level) deviations because it is still a new scan and cast. In addition to the final wax-up cast and the digital working cast, it is possible to have a control intraoral situation scan with in-office or laboratory provisionals. This