Precision and security in restorative dentistry: the synergy of isolation and magnification

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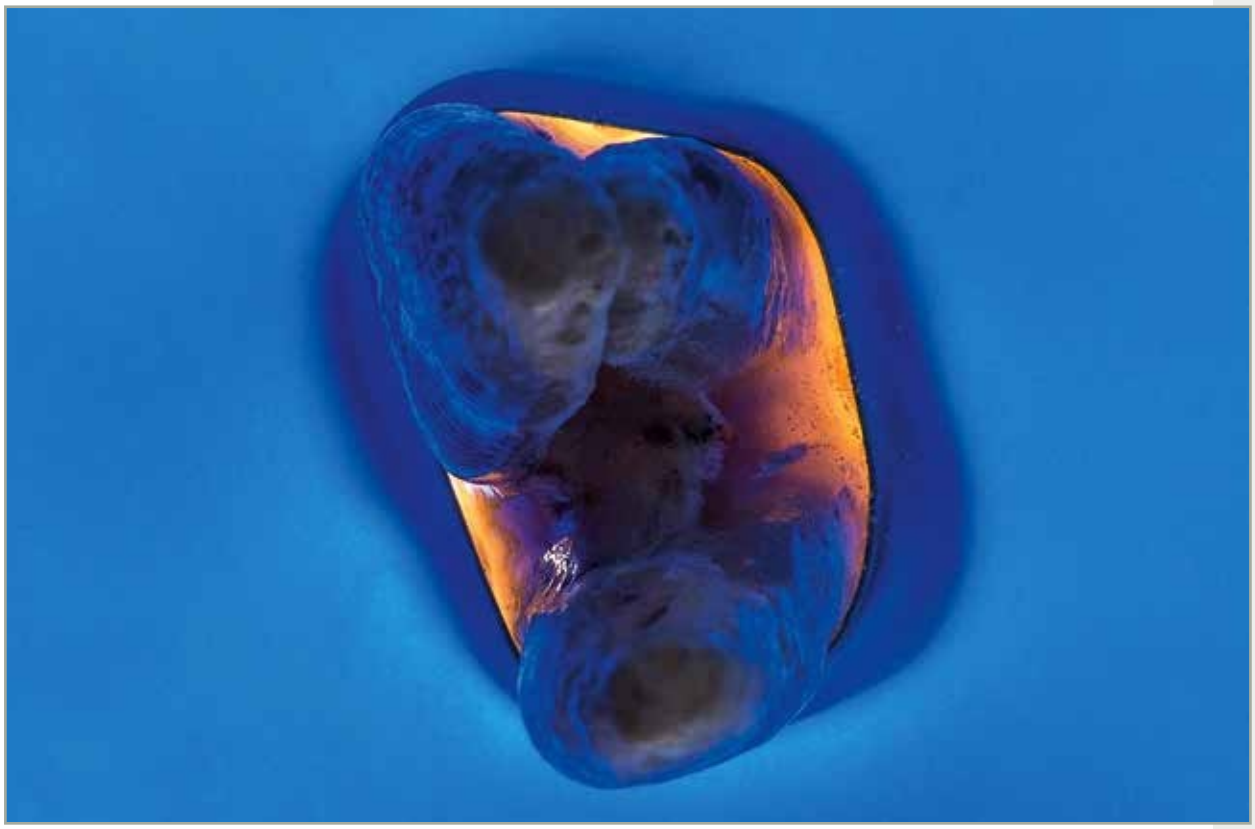

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Abstract

It is often presumed that, since its introduction in 1864, the use of rubber dam in multiple dental procedures has increased. However, its use is not as widespread as one might expect. There still seem to be many obstacles that prevent clinicians from adopting it as a standard of care. Furthermore, it appears very difficult to scientifically prove the impact of its use on the final outcome of a given procedure. The fundamental idea of isolating the operatory field and preventing contamination is simple; the practical execution of it is more demanding. In this article, the authors not only focus on the essential criteria for predictable isolation, they also present an isolation strategy that can be translated into a step-by-step procedure. It is suggested that by adopting this strategy, clinicians can eliminate the most commonly experienced obstacles and optimize the full potential of isolation, even in extremely difficult clinical situations.

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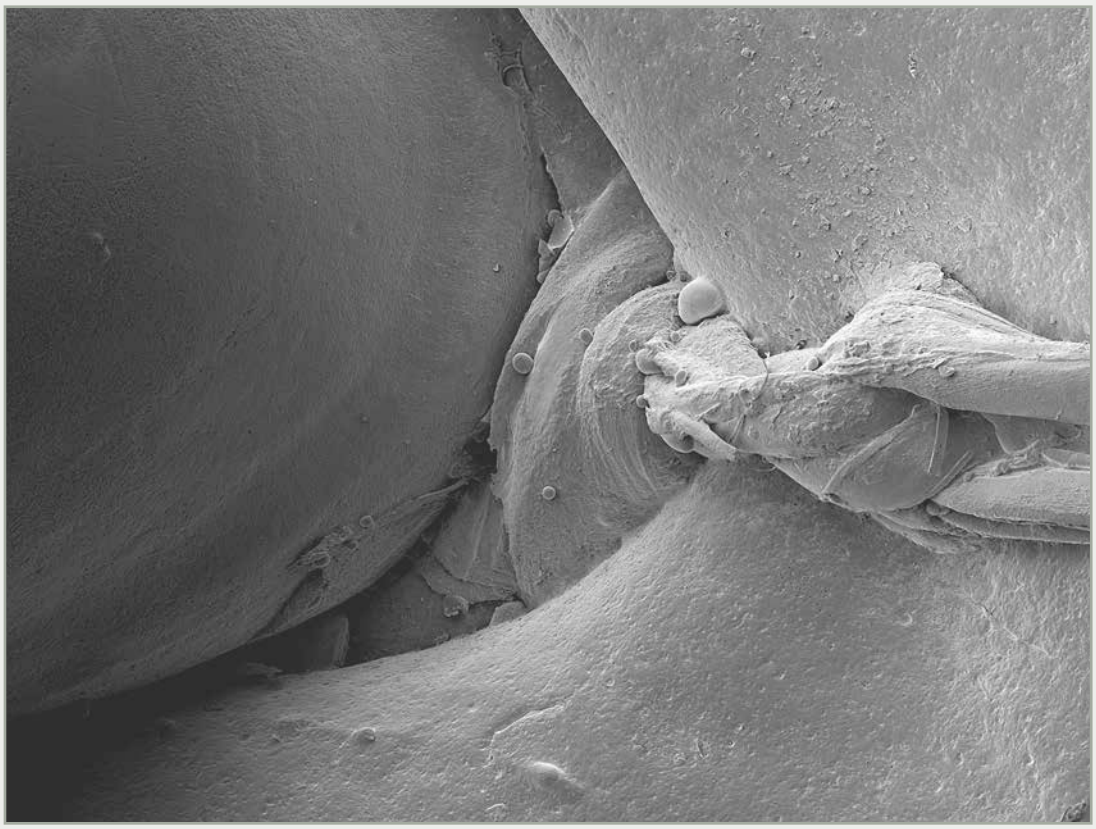

Introduction

Isolation should prevent contamination of the operatory field by moisture, bacteria, saliva, and blood. There are alternatives to rubber dam, but they offer only partial isolation and insufficient soft tissue retraction. It is difficult to scientifically prove the impact of rubber dam application on the final outcome of treatment.[1-7] The focus of this article is on the practical and clinical application of rubber dam. Special attention is paid to a clear protocol and strategy as well as the role of magnification. As isolation becomes more challenging in deeper cavities, the devil is in the detail, and it is especially in this context that high magnification facilitates the delicate and precise measures required to obtain absolute isolation. It is not within the scope of this article to answer the question as to whether the use of rubber dam in restorative dentistry is evidence-based.

After more than 20 years of rubber dam use in clinical practice, the authors suggest that there are three key points that result in successful isolation: the materials, the strategy, and the techniques. Using the right materials without a well-developed strategy and without mastering the techniques will obviously lead to frustration and unsatisfactory results. Using the right techniques and being highly precise and skillful but using the wrong materials will also waste a lot of effort and good intention. It is obvious to the authors that all three of these key points should be equally well understood and applied to obtain the highest quality isolation. Insufficient performance in one or more of these key areas will dramatically lower isolation quality. Overall, one should strive for simplification of techniques and procedures to ensure a more predictable final outcome. There is little advantage to developing a complex technique that will only give satisfactory results to a limited number of clinicians.

When looking at the main obstacles that prevent clinicians from systematically using rubber dam, we see that technique does not necessarily play a major role. Many obstacles are not technique related, such as communication, time, finances, and prejudice, all of which are intimately related to each other (Fig 1).[8,9]

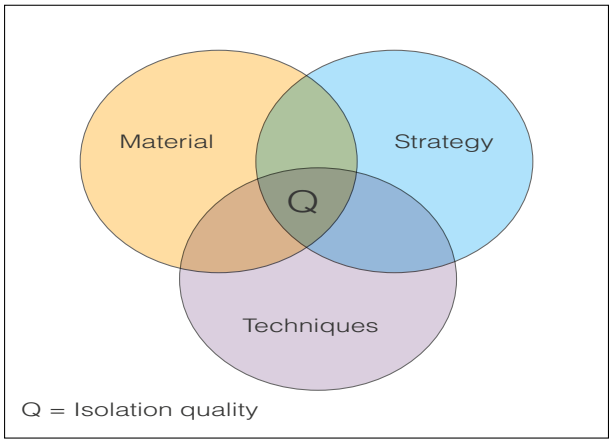

Fig 1 Diagram showing isolation quality

Materials

Sheets (composition, thickness, color, size)

Despite the fact that a growing number of clinicians use non-latex rubber dam sheets, the latex versions still offer the best properties for predictable isolation. Non-latex sheets are generally more

Table 1 Functional properties for sheets

	Tissue retraction	Proximal passage	Quadrant
Latex	+++	+++	+++
Non-latex	++	++	++
Heavy gauge	+++	++	+++
Medium/thin gauge	+	++	-

elastic, thus offering a little less tissue retraction, and they demand slightly smaller perforations. The preferred gauge for both latex and non-latex sheets is heavy, as this delivers the best retraction of the peripheral tissues, papillae included (Table 1).

Passing thin rubber dam interproximally may seem easy to achieve, yet it tears more easily when passing tighter or less-smooth contacts. It is also more likely to be pulled away from the cervical area when under tension, especially when perforations are too big. Thinner versions of sheet, such as medium or thin, should only be used for single tooth isolation.

Color is more than just a matter of personal taste. Light blue sheets considerably increase the luminosity of the operatory field, which also becomes more clearly visible in the photography.

The size of the sheets can be 5 × 5 inch or 6 × 6 inch; the choice depends on the size of the patient's mouth and the clinician's preference. Moreover, combining a 6 × 6-inch sheet with a slightly smaller frame offers a little more room for adjustment, and less extreme tension on the rubber dam if the overall positioning of perforations is slightly off.

Punch

The punch should be able to deliver perfectly cut and complete perforations. In order to do this, it is critical to use an undamaged punch; both the pin and the metal perforation should be undamaged. The punch should always be used with the pin well centered above the perforation while pushing firmly, and eventually pulling the rubber dam over the pin to confirm the final cut.

Frame

The frame is preferably positioned on top of the rubber dam (on the clinician's side) so that it remains available to attach the floss ligatures and keep them under tension (Fig 2a and b). Metallic U-shaped frames are generally very efficient. They can be used in a regular way or they can be inverted, depending on the need for ligature anchorage.

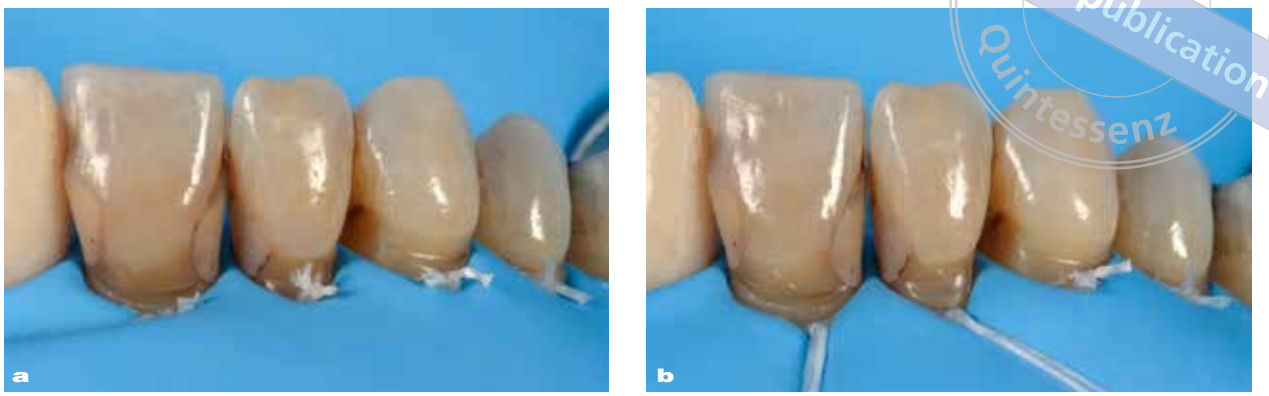

Fig 2a and b Providing tension on ligature. When the metal U-shaped frame is deliberately placed upside down, ligatures can find an anchorage point from where traction will offer additional gingival retraction in an apical direction.

Clamps

No existing clamp kit meets all the criteria for managing the wide variety of situations one encounters in daily practice. The listing of clamps here would thus be pointless. What is more important is to understand the function of a specific type of clamp in a given situation. Understanding strengths and weaknesses is key.

The main parts of a clamp are the bracket, the anchorage points or tips, and the lateral (and possibly anterior) wings.

The bracket offers most of the stiffness and part of the stability. It is preferably thick and wide. The further a bracket reaches distally and away from the occlusal surface in height, the weaker it is. On the other hand, access to the clamped tooth would then be easier.

The tips should at least grip under the line of greatest contour, touching the tooth at four points. Apically angulated tips offer a better grip on partially erupted teeth, but will reduce access to buccal and lingual surfaces, complicating a perfect seal around this anchor tooth.

The lateral wings allow the clamp to be attached in the rubber dam (on the clinician's side), while the anterior wings spread the rubber dam to prevent it from getting caught between the tips and the tooth contour, allowing an easier view of the targeted anchor tooth.

Wingless clamps can also be attached in the rubber dam with the bracket on the clinician side, while the forceps hold the clamp on the patient's side. In this way, the sheet can be held up like a parachute during clamp placement.

During quadrant isolation, the most distally placed clamp will resist traction from the rubber dam toward the frame. Elsewhere in the isolated quadrant, additional clamps could offer localized gingival retraction.

Forceps

This instrument should allow for fast and secure clamp placement without the clamp pivoting mesiodistally in the for-

ceps. Ideally, the instrument should be rigid and thick enough in the horizontal section, and thinner at the working end. It should be inclined between 60 and 90 degrees, without its extremities interfering with more mesially positioned teeth than the anchor tooth. The ideal forceps has yet to be designed.

Floss

Primarily, floss serves to pull the rubber dam interdentally so that it can come around the teeth to be isolated. A floss ligature helps to stabilize the rubber dam in an inverted position in the sulcus in a more apical position. This inversion of the margins of the perforation in the sulcus is a fundamental part of the isolation procedure. Only an effective inversion can really seal off the operatory field (like a cardiac valve closes and prevents blood reflux), while offering gingival retraction without being traumatic.

Waxed, round floss with a large diameter is ideal for passing the proximal contacts. The floss thickness separates the tooth effectively and allows a safer passage for the rubber dam, preventing tearing. The technique used to pull rubber dam through the contacts is critical. First, the proximal contacts should be tested with floss alone so danger zones such as irregular restorations and overhangs can be identified. If the floss passes undamaged, then the heavy gauge rubber dam will also pass. If the floss does not pass or is damaged when passing, these proximal areas will need some smoothening or separation prior to continuing the procedure. The use of a lubricant is unnecessary because a thin film of saliva is sufficient to allow the smooth gliding of the rubber dam over the surfaces. It is crucial to have one single thickness of rubber dam without folds engaging the proximal space. The passage should be progressive, like paper fed into a printer. Wide-diameter floss should also engage the proximal area, starting from a free occlusal or incisal surface. The floss should then be pulled downward along the corresponding free surface. In this way, the clinician separates the target tooth from its neighbor, while feeding through one single thickness of rubber dam during passage. This procedure may need to be repeated several times until the total rubber dam between both perforations is brought under the contact point. Between repetitive movements, the floss should only be removed from the interdental space horizontally so as not to bring the rubber dam back up from between the contact (Fig 3).

For simple ligatures, a thinner waxed floss is preferable. The wax secures the first knot while the second counter-knot is made.

A flatter, unwaxed Teflon floss is ideal for double ligatures, since it allows a smooth sliding of the two loops while the knot is tightened around the tooth. Double self-tightening ligatures offer more gingival retraction than single ligatures.

Retraction cord

Retraction cords mainly offer vertical retraction (apically). They are usually added as an extra means of retraction, after the procedure of securing with a ligature. The diameter is chosen depending on the sulcular anatomy and the amount of retraction required (Fig 4).

Fig 3 An example of proximal contact passage between two premolars. When the rubber dam is put under buccopalatal tension, the clinician can identify the occlusal surface least covered by the rubber dam (in this case, the first premolar). Large-diameter waxed floss is progressively inserted between the two teeth, while keeping constant pressure on the occlusal surface, then against the distal surface of the first premolar. In this way, the clinician moves this tooth toward the mesial, opening the proximal contact, and guiding a single thickness of rubber dam **(a and b)**. The rubber dam sheet should progressively pass the contact, in the same way a paper sheet is fed to a printer **(c and d)**. This movement should possibly be repeated several times to pass the contact completely. Finally, the full-latex septum arrives below the contact point, covering and enveloping the papillae **(e)**.

Teflon tape (polytetrafluoroethylene - PTFE)

PTFE has many uses in dentistry, especially in the form of tape. It offers exceptional anti-adhesive properties because it is soluble in hardly any solvents and is autoclavable, being able to resist temperatures as high as 260°C.

During isolation procedures, it is very effective for packing one or more layers to create additional gingival retraction, both vertically and horizontally. Its mechanical properties allow for the folding and refolding of multiple layers of the tape on itself, while modulating its volume and the direction of the retraction. For these reasons, the authors choose Teflon tape in many cases over retraction cord.

Teflon is hydrophobic and is not porous, unlike retraction cord that is braided and quickly absorbs liquids during preparation (Fig 5).

Teflon is placed after invagination of the rubber dam into the sulcus. If a ligature is used, Teflon is placed on top of the ligature. Consequently, it can be compacted at will in the available space. This compaction also helps to stop possible gingival bleeding, merely by exerting pressure on the tissues.

Technique and strategy

Good isolation is more the result of a well-applied strategy in a specific clinical situation than the application of a sequence of particular steps or tricks.

Perforations

Perforation diameter and position is key to achieving a seal in the operatory field. Unfortunately, punch-hole diam-

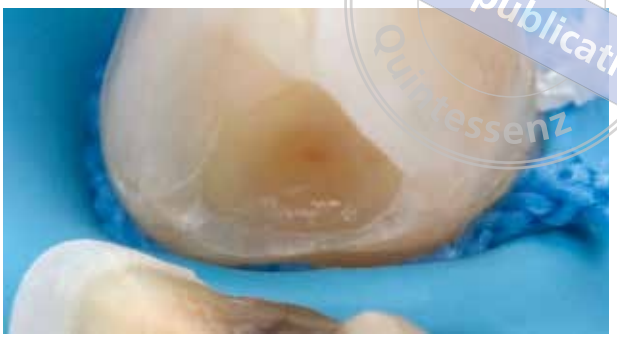

Fig 4 The use of gingival retraction cords. A single ligature is placed by default on the canine to invert the rubber dam into the sulcus and to offer an initial gingival retraction. However, the distal cavity margin remains at the same level of the rubber dam, complicating the removal of the composite. A non-impregnated retraction cord is placed into the sulcus, compacting the ligature and the rubber dam together in a more apical direction. The retraction cord diameter creates both vertical and horizontal retraction, moving the rubber dam away from the cavity margin.

Fig 5 The use of Teflon tape. Prior to any preparation, single ligatures are placed on the neighboring teeth of the ones to be treated, in order to ensure inversion of the rubber dam in the sulcus (teeth 23, 25, and 27). In this case, the teeth to be treated (24 and 26) receive a double ligature to allow for even more gingival retraction. Teflon tape is placed after the removal of the old restorations. The Teflon bands are folded to offer multiple thicknesses, and are placed on top of the double ligatures into the sulcus to achieve ultimate tissue retraction in both the horizontal and vertical directions, allowing for the safe and efficient removal of decay. Compared to retraction cord, Teflon tape offers a more flexible use due to its modular placement, with variable thicknesses and layers in one single piece of tape.

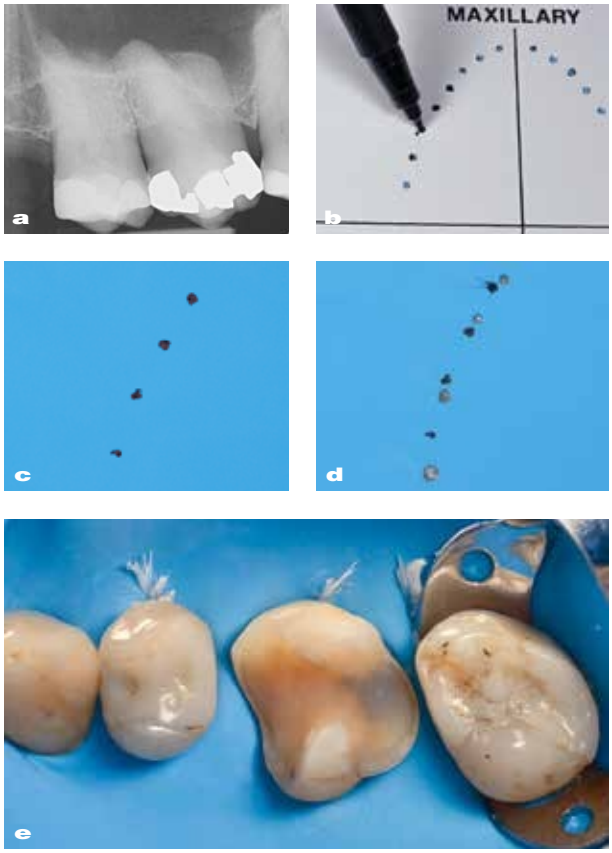

Fig 6 Perforations with correct spacing. Tooth 16 is to be treated. The preoperative radiograph indicates a limited inter-radicular distance on the distal, while on the mesial there is more distance to cover **(a)**. A standard template can be used to mark default spacing **(b and c)**. The final perforation placement is done in relation to this, and the information is collected from the radiograph and the clinical view in the mouth **(d)**. Here, the rotation of the first molar and the presence of a large mesial concavity allows even more space between teeth 15 and 16, while keeping a standard distance between teeth 16 and 17 **(d and e)**.

eter is not standardized for all perforators. Traditionally, the tooth holding the clamp most distal in the isolated field (the anchor tooth) requires the largest perforation. This punch-hole diameter must allow for sufficient stretching in order to pass the bracket and/or lateral clamp wings (depending on the technique used). For all other teeth to be isolated, the authors recommend the smallest possible punch-hole diameter. This facilitates a better cervical tightness close to the root, while at the same time increases the distance between two neighboring perforations to help cover the interdental papillae.

In general, the use of a template can help to determine the overall position of the perforations. Nevertheless, very often this standard situation needs to be modified.

In order to facilitate the most stable rubber dam position and benefit from its full potential in retracting the peripheral soft tissues (lips, tongue, cheeks), the general rule is not to cross the horizontal median line. When the rubber dam sheet is viewed from the front, the perforations for quadrants I and IV are located on the clinician's left side, and for quadrants II and III on the right side. Within the quadrant, the perforation positions should then be adapted individually, case by case. The objective is for the interdental papillae to be completely covered. Working out the correct space between perforations is most predictable when references are taken at the cervical area and not on the cusp tips, incisal edges or occlusal planes of the teeth to be isolated (Fig 6).

When in doubt, it is always better to have a little more space than not enough of it between the perforations. A small fold is easily dealt with by placing a floss ligature, retraction cord or Teflon tape.

The strategy used is simple and repeatable. In short, it can be summarized as follows: Inversion of the rubber dam in the sulcus is the key element for successful isolation. The latex should be placed at the base of the sulcus primar-

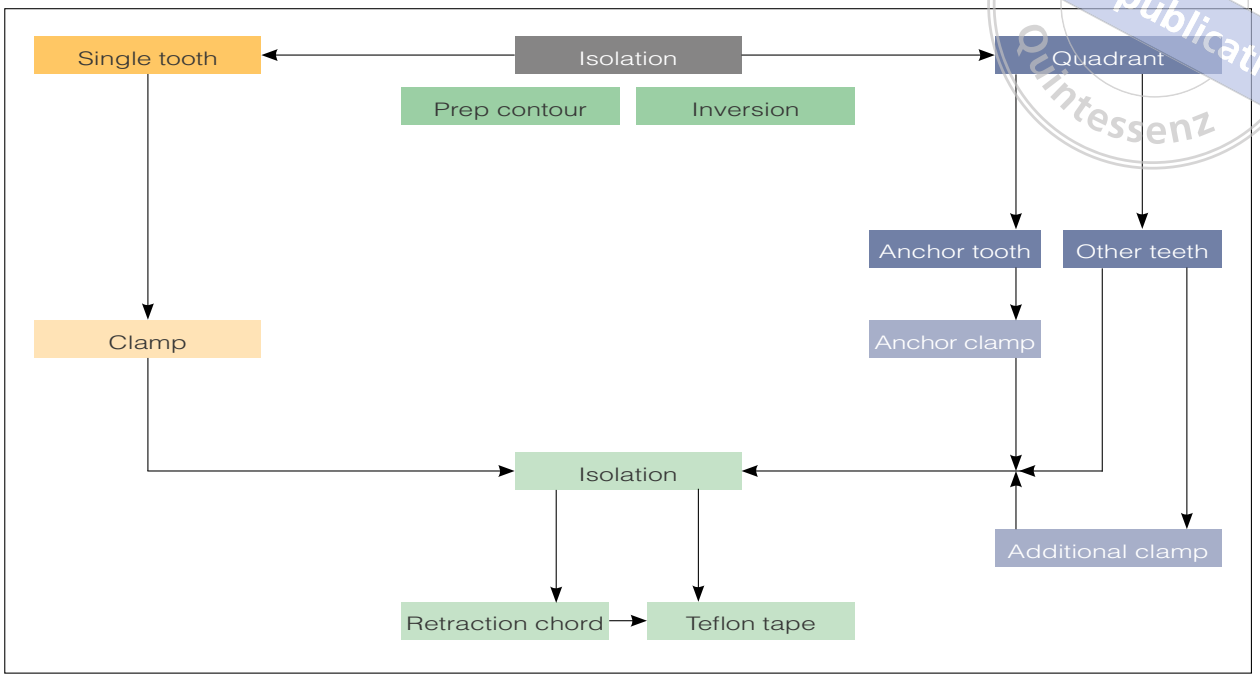

Fig 7 Placement strategy. The objective of every isolation procedure is to position the sheet beyond the limits of a possible cavity contour, and invert into the sulcus. In the case of a single tooth isolation, the clamp is by definition placed on that tooth. Inversion is not automatically achieved, since the tips of the clamp touch the tooth contour before the rubber dam. In most situations, a floss ligature will help by pulling the rubber dam into intimate contact with the tooth surface under the clamp tips, while at the same time inverting the rubber dam. This can be further achieved by adding retraction cord or Teflon tape, where necessary. In the case of a quadrant isolation, the anchor tooth is designated to be the most distal tooth in the isolated quadrant, and will receive an anchor clamp. The same protocol is followed as for the previous situation, since seal and inversion are difficult to achieve without floss ligature. Retraction cord or Teflon tape can also be used, if needed. At the level of the other teeth, inversion and additional retraction is mostly needed on the teeth to be treated and their neighboring teeth. For this, a single or double floss ligature will suffice; but if not, the aforementioned protocol of retraction cord or Teflon tape should be followed. In the case of an extreme deep cervical challenge, an additional clamp is needed to further push and retain the rubber dam more apically. If this should be necessary, the same protocol is followed again: floss ligature, retraction cord, and Teflon tape to finalize retraction, inversion, and seal. Often, the additional clamps lack stability due to their narrow brackets, and so need to be stabilized (eg, with composite or thermoplastic paste such as Kerr Impression Compound).

ily, which can be achieved in several ways. Nevertheless, ligatures, retraction cords or Teflon tape are always placed as a second step, on top of the latex, to ensure an intimate contact between latex and tooth contour. If ligatures, retraction cords or Teflon tape are placed prior to inversion, the sulcus would already be occupied and inversion would not be possible (Fig 7).

Strategy and technique in the posterior region: combining rubber dam and matrix

In the posterior region, combining efficient isolation with matrix placement can

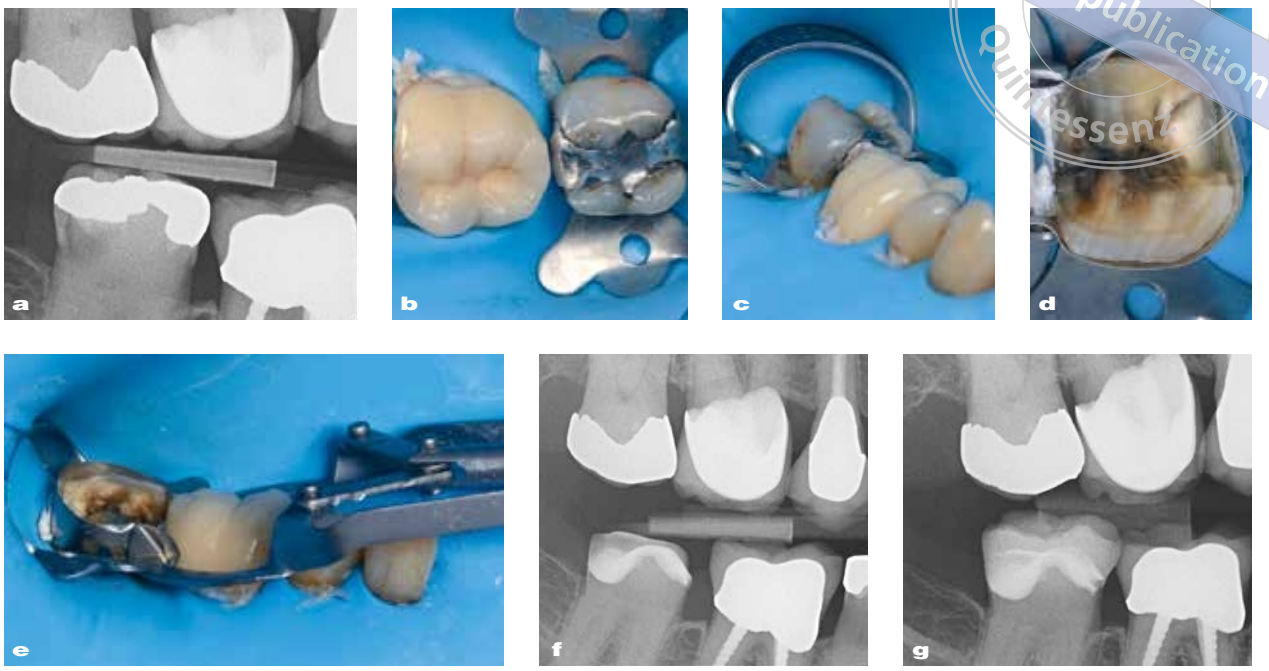

Fig 8 Rubber dam, matrix, and subgingival distal decay. Tooth 47 presents a deep subgingival distal decay **(a)**. It responds positively to vitality testing. Several treatment options can be envisioned in this difficult situation. A conventional approach would most probably suggest crown lengthening, endodontic treatment, coronoradicular reconstruction, and crown. We chose to follow a less-invasive path, with shorter treatment time and less expense: bonded ceramic overlay with deep distal margin elevation. Isolation of the fourth quadrant is achieved, making sure to choose a narrow-enough clamp (Ivory 2A) so that the four tips can be firmly stabilized at a cervical level while freeing up the distal area. The emerging profile of the chosen clamp should also be slightly horizontal to allow for better access to the decayed distal surface **(b and c)**. Caries removal is carried out following the same procedure as the previously described cases. The extremely deep cervical decay does not allow for the predictable registration of the final distal cavity margins, let alone the adjustment of an indirect restoration. Therefore, the distal margin is moved coronally with the aid of composite material. Matrixing this kind of cavity is extremely delicate, given the presence of the clamp. A matrix system such as AutoMatrix (Dentsply) can be considered, since it allows tightening without the need for a real matrix holder or support. The clamp needs to be opened slightly for the matrix band to pass between the clamp and the tooth contour while it is pushed apically, following the root contour. This can be a perilous procedure. Another option is to place the AutoMatrix first, and only then place rubber dam over it. There are two weak elements in this approach: the need to remove decay with the matrix band in place (which demands immense dexterity), and an absence of contact between rubber dam and the distal part of the root, which compromises the good seal. In these cases, we generally prefer to use a matrix holder after rubber dam placement. It should not interfere with the clamp, and its tightening translates into a mesially directed traction against the distal cavity contour **(d and e)**. A postoperative radiograph shows the good adaptation of the composite material and the correct divergent emergence profile. Clinically, only the distal margin has been moved coronally, in a light subgingival position. Impression and bonding of the ceramic overlay are easy in these conditions, following the usual protocol **(f)**. A postoperative radiograph shows the correct adaptation and emergence profile **(g)**.

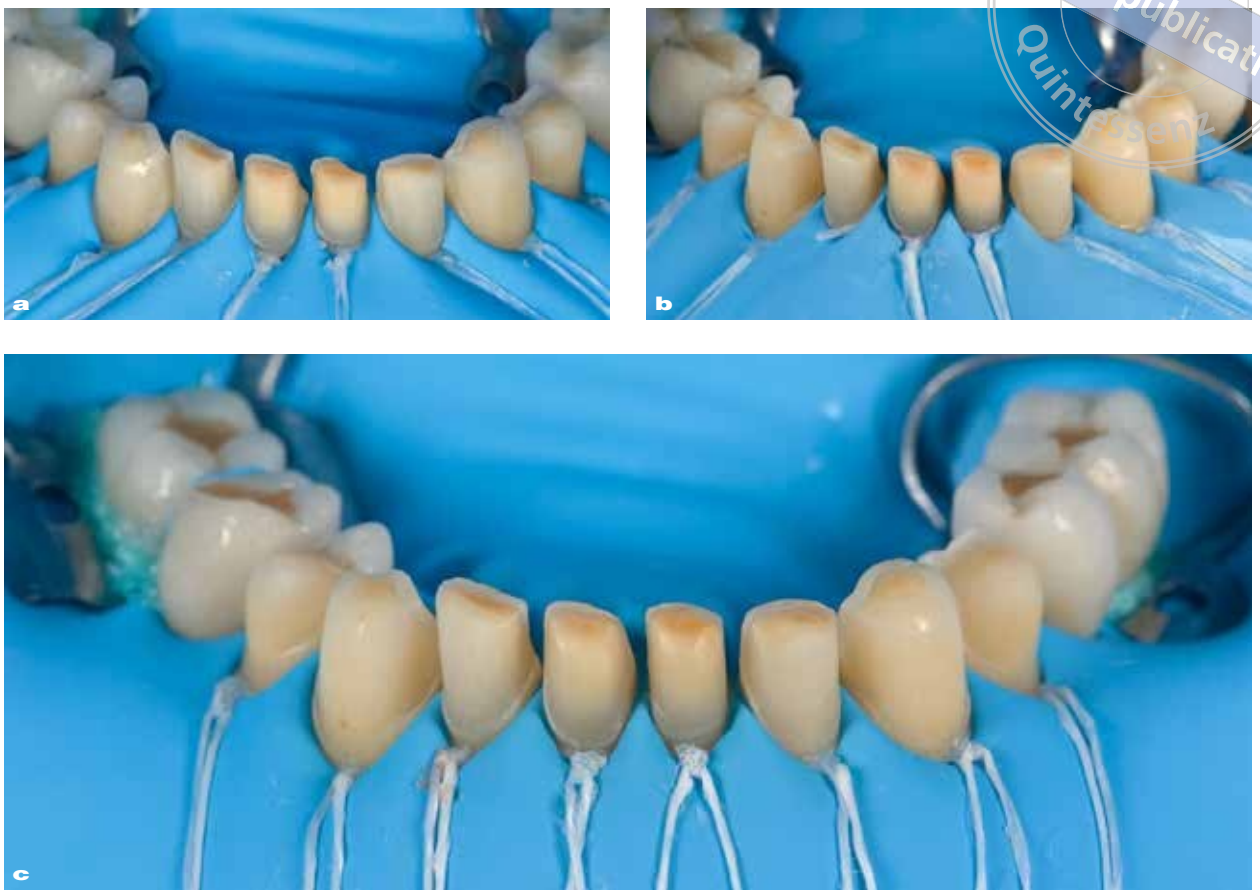

Fig 9 Rubber dam and veneers, a simple situation. For this clinical situation in the mandible, rubber dam was placed after a large part of the preparation was already done, but with the double goal of good isolation during immediate dentin sealing, and being able to perform a precise finishing of the preparations **(a)**. Clinical comfort is improved each time clamp placement on a tooth can be avoided. With this in mind, simple ligatures are placed and put under tension by attaching them to the frame **(b)**. At the time of bonding, a similar technique was used **(c)**.

be quite a challenge, especially in complex and deep cavities (Fig 8).

Strategy and technique in the anterior and cervical regions: combining rubber dam and additional clamps

In the anterior region, especially when access to the cervical areas is required, isolation strategy and the corresponding gingival retraction technique are decisive for a positive outcome (Figs 9 and 10).

Conclusion

The clinical approach presented in this article, together with the various clinical examples, serves to illustrate the key elements in achieving satisfactory isolation, even in challenging situations. The selected materials, the workflow strategy, and the described techniques are of equal importance. The strategy and techniques are repeatable. Many steps in the isolation protocol require

Fig 10 Rubber dam and veneer, a complex situation. For bonding a single veneer, in this clinical case on tooth 11, a butterfly clamp (Hu-Friedy 212) is selected because of its naturally good stability (two brackets offer important stiffness). This clamp is able to push the rubber dam beyond the most apical preparation limit **(a)**. At the level of the tips, the latex is not yet touching the root surface so there is no perfect seal, and the risk of leakage during the procedure is increased. To resolve this, start with a single ligature around the clamp. Friction will pull and drag the rubber dam closer to the root surface at the moment of tightening. Next, Teflon bands are added to increase gingival retraction and improve visual access during this sequence **(b)**. A clear exposure of the buccal preparation limit also allows for a precise polishing of the margin after bonding **(c)**. At the time of rubber dam removal, the amount of tissue retraction manifests itself **(d)**. The amount of retraction may seem inadequate at first, but a 2-week postoperative review confirms the pressure to be only mechanical on healthy tissue, leading to no damage **(e)**. [Ceramist: Patrick Schnider, Oral Design Montreux]

visual validation. This is easier with high magnification tools such as loupes or an operating microscope. The clinical photographs show clearly that many of the clinician's actions in difficult isolations demand precision and control. As a general principle, it is suggested that clinicians should strive for simple procedures that can be performed and repeated by many clinicians, instead of complicated procedures that are only achievable by a few. We believe the presented strategy offers a logical approach, allowing the clinician to work more predictably when meeting isolation challenges.

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