

IPR in orthodontics

Why, how and how much?

Interproximal reduction (IPR) is used to create space for orthodontic treatment in crowded arches. Paul Humber looks at the ways to best employ this technique

The concept of reducing the width of teeth as a means to create space for orthodontic treatment is a procedure largely popularised by Sheridan in the 1980s, but in fact can be traced back to the 1950s and before. Hudson in 1956, when reviewing the practice, took the perfectly reasonable view that before reducing the mesio-distal width of the enamel of a tooth it may be useful to first ascertain the amount of enamel available on an average tooth in the first place. He concluded that the largest incisor in an arch 'did not necessarily have the thickest enamel but, generally speaking, the larger teeth had more enamel thickness than smaller teeth.' Because the width of lower incisors is much less than the width of the upper incisors, particular attention has been given to measuring the thickness of incisal proximal enamel in the lower arch. Hudson reported that the average thickness of enamel at contact points in the lower central incisors was found to be 0.59mm, whereas the figure for lower lateral incisors was 0.66mm and lower canines 0.82mm. Another study by Harris et al in 1998 showed that the enamel on the distal aspect of an incisor is marginally thicker than on the mesial margin. This difference was found to be an average of 0.1mm in the upper central and lateral incisors.

One concern about interproximal reduction (IPR) is that the surface of the enamel is the most caries resistant, while deeper layers are

progressively weaker and therefore removal of the surface enamel may encourage caries. Wiedmann et al investigated this hypothesis in 1967. They analysed the enamel density from various sites from a large number of teeth, from the surface of the enamel down to the amelodentinal junction. They found that on average the enamel density reduced from 3g/ml at the surface to 2.84g/ml at the amelodentinal junction; a difference of 5.6%. The caries risk after interproximal reduction has therefore been monitored in a number of studies.

Jarjoura et al examined forty patients over one to six years and compared caries incidence in teeth that had been treated by IPR compared to teeth in the same dentition that had not received IPR. Their analysis of 376 test and 376 control surfaces showed that there was no statistically significant difference between the groups and, furthermore, they concluded that the application of topical fluoride immediately after IPR appeared to confer no benefit. In another study, undertaken by Zachrisson et al in 2007, 61 consecutive patients were examined ten years after they had IPR applied to all six mandibular anterior teeth. No caries, gingival pathology or bone loss could be detected in this study.

Clearly if it has been shown that IPR does not cause harm to teeth then it represents a very useful mechanism by which we can create space for orthodontics, and it should be considered as one of the first options in treatment planning compared to the extraction of teeth which, by definition, involves the guaranteed loss of a tooth or teeth from a dentition.

If IPR is to be carried out, how best can this be planned and how should it be carried out?

Planning the amount and position of IPR

The correct position of IPR within the dental arch can allow for space to be created in the very area of the mouth where space is most needed. It can be used to differentially target a tooth that is heavily restored, such as an

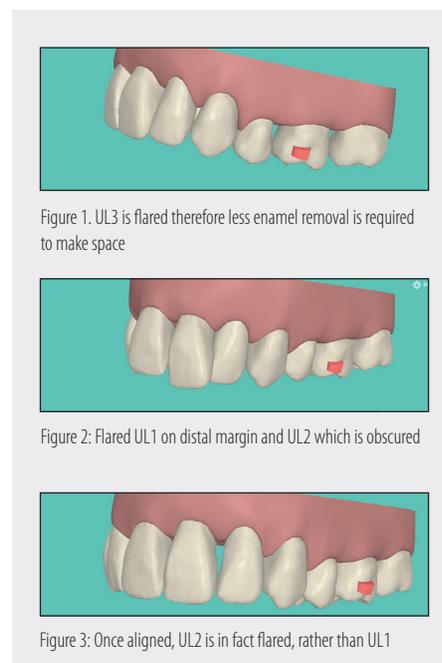


Figure 1: UL3 is flared therefore less enamel removal is required to make space

Figure 2: Flared UL1 on distal margin and UL2 which is obscured

Figure 3: Once aligned, UL2 is in fact flared, rather than UL1

amalgam or composite that is already present in the mouth, and these could be trimmed in preference to losing good enamel. A tooth that is very flared in shape may be chosen over a more rectangular tooth so that a small amount of enamel loss results in a disproportionate amount of created space. For example in figure 1 we can see that if we chose to place IPR on the mesial of the UL3 it would involve less loss of enamel compared to the distal aspect of the same tooth.

Various authorities have suggested that up to the half the interproximal enamel width can be removed. In the lower buccal segments for example, Stroud et al in 1998 stated that there is approximately 10mm of proximal enamel width in the four teeth that make up the premolars and first and second molars, and that if 50% of this was removed on each side, a total of 9.8mm would be created to reduce crowding or arch length discrepancies. Chudasama and Sheridan suggested a maximum of 1mm per interproximal site in the buccal regions, creating a total of 8mm of space per arch. Anteriorly they recommend that up



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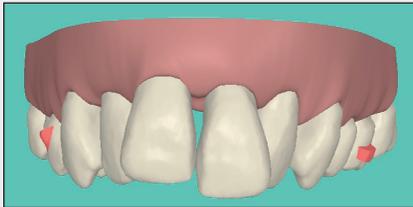


Figure 4: Pre-treatment view

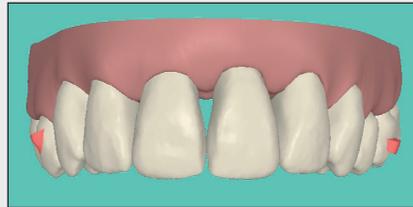


Figure 5: Possible resultant black triangle after alignment

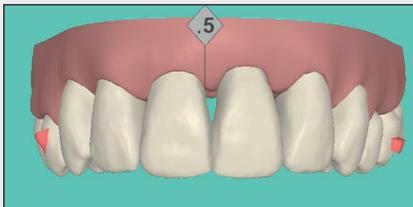


Figure 6: Reduction of black triangle by applying 0.5mm of IPR between UR1 and UL1

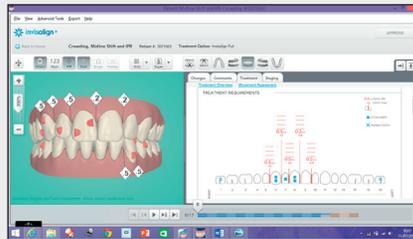


Figure 7: The ClinCheck software shows both the suggested site and the timing of the proposed IPR.

to 0.5mm be removed from the upper lateral incisor contact points and similarly up to 0.5mm from the lower incisor contact points. This is because of the thinner proximal enamel at these sites. Radiographic analysis would be a useful adjunct when assessing all these matters to assess the available enamel width in each area.

Anecdotally, most clinicians prefer to remove less enamel than the figures above, so that for example the ClinCheck software used in the Invisalign technique typically tends to limit IPR values to a maximum of 0.5mm per site in the mouth which would typically mean a reduction of enamel in the order of 0.25mm per proximal surface and would result in a total space creation of about 6mm per arch. Even more conservatively, it is very common that Invisalign treatments are planned by the treating clinician to utilise a mere 0.2mm IPR at most interproximal sites which is typically a reduction of 0.1mm enamel per proximal surface.

Once a tooth or teeth have been selected for IPR, it is important to choose the correct position on the tooth to then apply the IPR. Correct application of IPR can result in an improved interproximal contact point between the teeth concerned, while poor application of IPR could result in a poor contact, creating a food pack or poor aesthetics and unnecessary enamel loss.

Figure 2 shows a typical case involving the imbrication of UL1 UL2. On the face of it, the UL1 is flared in shape on its distal margin and may benefit from the application of IPR. It is difficult to assess the shape of the UL2 at its

mesial aspect because our view is obscured by the UL1. If the teeth are aligned (Figure 3) we can see that the mesial of the UL2 is flared and that it would be of greater benefit to trim the mesial of the UL2 in preference to the distal of the UL1. The advantage would be a better contact point and improved aesthetics. This logic can also apply to teeth which are barrel shaped.

Assessing removal and shaping

How would we be able to assess where it would best to remove some enamel and what shape should we create?

Some orthodontic techniques will necessitate that IPR is carried out 'blind' in that the clinician is forced to trim enamel before the teeth are aligned and so the best place for the IPR is unclear. This can result in poor interproximal contacts at the end of treatment. It would be ideal to either wait until the teeth are largely in line with each other or to use computer simulation to help guide us.

With the Invisalign system we have a huge advantage that at the planning stage of orthodontics we can assess the case and if needed try different amounts of IPR in a virtual environment. Figure 4 shows the same dentition as figures 2 and 3, to now highlight the shape of the UL1 UR1 at the pre-treatment stage. It is clear we may want to trim the width of the mesial of the UL1 UR1; this would create space, improve aesthetics and improve the contact point. Figure 5 shows the same teeth when they are aligned on Invisalign's ClinCheck software; they now form a 'black triangle' between them. Figure 6 shows

the scenario where 0.5mm IPR is virtually applied on the ClinCheck software to assess its potential effect on the interproximal contact point. The software will have virtually removed 0.25mm from the mesial of both the UL1 and the UR1. In a clinical situation the dentist is at liberty to remove the enamel as shown by the ClinCheck or to remove more or all of the 0.5mm from one tooth only and less from the other. This decision would be aided by our greater knowledge of the anatomy afforded by the ClinCheck so that, for example, in the case of figure 3 we may want to remove more enamel from the mesial from the UL2 in preference to the mesial of the UR1.

Planning the timing of IPR

A number of authorities have suggested that IPR could be carried out before any treatment commences, but this should be attempted with caution, if at all. The principal advantage would be that the procedure does not have to be accurately measured by the clinician and can simply be carried out by eye. However, the temporary interproximal space created could easily result in food packing and a further concern is that the clinician is prejudging the amount of IPR needed along with the interproximal shape that will be needed to create good contact points when the teeth are aligned. Now that we have computer assisted treatment planning, such an approach would be largely unnecessary and outmoded.

As we have seen, it is advantageous to have the teeth reasonably well aligned before contouring the enamel so that we can both assess the shape that we would like to create and so that we have good access to the interproximal surfaces. Happily since the invention of the computer, planning the timing of IPR is now more advanced than in previous decades, and in the case of Invisalign, the ClinCheck software will suggest when it is best to shape the enamel. The example in figure 7 shows a case where the software suggests that 0.2mm IPR could be removed from between the UL1 and UL2 before aligner 11 is worn. The clinician may opt to remove this IPR in increments, for example 0.1mm could be removed while wearing aligner 8 and another 0.1mm removed when wearing aligner 10, or all 0.2mm could be removed in one visit. The choice is often a matter of personal preference for the clinician and the patient.

How should IPR be undertaken?

Interproximal strips (figure 8) are readily available and are the most popular option when IPR is needed up to 0.3mm. The strips