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Attachment bonding to impacted teeth at the time of surgical exposure

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SUMMARY This study examines the relative success of bonding an attachment to an impacted tooth at the time of surgical exposure, compared with placing it on a subsequent occasion. In addition, the relative merits of various attachments, the choice of bonding site and whether or not pumice prophylaxis is necessary, were tested. The results showed that bonding at the time of exposure is superior to its performance at a later date, that the use of an eyelet attachment has a lower failure rate than the use of a conventional bracket, that the palatal aspect offers the poorest bonding surface and that pumicing the exposed tooth offers no advantage over immediate etching of the exposed enamel. The results of this study refute the view that the circumstances prevalent at the time of surgical exposure are not conducive to the reliable bonding of an attachment to an impacted tooth.

Introduction

Surgical exposure of an impacted tooth is necessary to allow the orthodontist access to the unerupted tooth, in order to bring it into the dental arch and into alignment. In some simpler cases, the exposure is performed by the oral surgeon before the commencement of orthodontic treatment, occasionally before the orthodontist sees the patient, in the hope that the tooth will then erupt unhindered and thus simplify the orthodontic treatment. However, a comprehensive approach to the treatment of impacted teeth is required to provide answers to the wide variation in degree of severity of tooth displacement that is to be found, particularly in the more complex cases, where spontaneous eruption may not occur.

Should it be necessary to supplement the eruptive force of the impacted tooth with assistance from an orthodontic appliance, a means of attachment to the tooth will become necessary.

The placement of an orthodontic attachment on the tooth may be performed at the time of surgery or at a later date. Many orthodontists prefer not to be present during the surgical procedure and thus request the surgeon to open the area more widely and to place a surgical pack over the exposed tooth. This is done in order to prevent re-closure of the tissues during the healing period, which would deny access to the tooth, when bonding would subsequently need to be performed. This approach is often justified with the claim that conditions at surgery are not conducive to acid-etching and bonding, due to haemorrhage and the presence of saliva. The point is made that bond failure would entail a second surgical exposure (Fournier *et al.*, 1982).

By placing the responsibility for the extent of the exposure on the surgeons, we are unfairly expecting them to make many decisions that relate to orthodontic treatment considerations and technique. The result may be over-aggressive surgery, with more radical bone removal, cemento-enamel junction exposure, bone-channelling procedures and the pushing of a surgical pack into the sensitive cemento-enamel junction area (Hitchin, 1956; Kettle, 1958; Rayne, 1964; Johnston, 1969; Wraith, 1969; Lewis, 1971; Moss, 1972; Jarabak and Fizzell, 1972; von der Heydt, 1975). These procedures are often performed in an effort to encourage spontaneous eruption and to avoid re-healing of the tissues over the exposed tooth. Accordingly, by managing the case in this manner:

a) There is delay in the application of force to the impacted tooth.
b) There is still the possibility that the distance of the impacted tooth from the exterior and the healing of the tissues will not allow adequate access for the placement of the attachment and a second surgical episode will be required.
c) The use of surgical packs commits the surgeon to aim for 'healing by secondary intention', a process which is much slower, less hygienic and less comfortable for the patient.
d) Plaque accumulation around the exposed tooth is very significant, due to an inability to brush the area effectively. This results in a chronically inflamed, swollen and haemorrhagic gingiva surrounding the partially exposed tooth. The ability of the operator to achieve effective bonding in these circumstances is seriously impaired.
e) The periodontal status and prognosis of the aligned tooth, at the end of treatment, is likely to be compromized (Lappin, 1951; Hitchin, 1956; Kettle, 1958; Johnston, 1969; von der Heydt, 1975; Heaney and Atherton, 1976; Vanarsdall and Corn, 1977; Becker *et al.*, 1983; Kohavi *et al.*, 1984).

The ability to place an attachment at the time of surgical exposure permits a more conservative surgical exposure and the application of immediate orthodontic traction (Becker and Zilberman, 1975, 1978; Jacoby, 1979; Fournier *et al.*, 1982; Becker *et al.*, 1982, 1983; Kohavi *et al.*, 1984; McDonald and Yap, 1986; Kornhauser *et al.*, 1995). 'Healing by primary intention' is then promoted, which allows rapid healing under conditions that do not require the use of surgical packs.

However, given the criticism that has been levelled regarding the compatibility of the open surgical field to the acid-etch bonding technique, it was considered appropriate and important to test these clinical observations objectively. The purpose of this article, therefore, has been to collect retrospective data representing the accumulated experience of 15 clinicians in Israel, who treat patients with impacted teeth on a regular basis, and to analyse its relative success.

To properly compare the different ways in which various practitioners approach the problem of surgical exposure, the bonding of attachments and the application of traction, the following parameters were studied: (i) whether prophylaxis (pumice) was performed before etching; (ii) the type of attachment bonded (Edgewise or Begg brackets, eyelets or buttons); (iii) the position of the attachment on the crown of the tooth (ideal, buccal but off-centre, mesial or distal, palatal); (iv) the quality of bonding (success or failure); (v) when the bonding was performed (at surgery or at a subsequent visit).

Materials and methods

In order to record the necessary information accurately and efficiently, a questionnaire was prepared, in which each of the parameters was listed. In Israel, 15 clinicians whose methods and techniques varied and whose selection was based on their level of qualification, their experience and the volume of patients treated, participated in the study. One of the authors (N.S.) visited each of the practices at a pre-arranged convenient time and studied the record cards of each of that particular practitioner's patients who were treated for an impacted tooth. He completed each of the questionnaires at that time, with the assistance of the clinician.

This retrospective study made no attempt at the standardization of bonding method. In this way, the experimental sample comprized 155 patients who participated in the study, with 187 impacted teeth in total. The majority of teeth involved were maxillary permanent canines, although there were 36 incisors, 14 premolars and 14 mandibular canines. A statistical analysis was performed on the 2×2 tables to find the level of significance, using Fisher's exact (two-tail) test.

Results

The results are summarized in Tables 1–4. Because of the small number of Begg brackets that were bonded to the impacted teeth, these cases were combined with those with Edgewise brackets, into a single group of conventional, broad and rigid-based, brackets. For similar reasons, the few cases in which button attachments were used were combined with the much greater number of eyelet cases, to form the small and pliable-based attachment group.

From the results in Table 1, it is evident that the success rate of eyelets, whether pumice prophylaxis was used (96.4 per cent) or not

Table 1 Reliability of bonding a bracket versus an eyelet.

	With pumice preparation				Without pumice preparation			
	bracket		eyelet		bracket		eyelet	
	n	%	*n*	%	*n*	%	*n*	%
Success	8	66.7	53	96.4	36	75	68	94.4
Failure	4	33.3	2	3.6	12	25	4	5.6
Total	12	100	55	100	48	100	72	100
		$P=0.0078$				$P=0.0046$		

Table 2 Reliability of bonding at surgery or at a later visit.

	With pumice preparation				Without pumice preparation			
	bracket		eyelet		bracket		eyelet	
	n	%	*n*	%	*n*	%	*n*	%
Success	57	95.0	4	57.1	88	92.6	16	64
Failure	3	5.0	3	42.9	7	7.4	9	36
Total	60	100	7	100	95	100	25	100
		$P=0.013$				$P=0.0083$		

Table 3 Reliability of bond related to site of attachment.

	All attachments				For brackets				For eyelets			
	palatal		other		palatal		other		palatal		other	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Success	41	75.9	118	92.9	14	58.3	25	80.6	27	90.0	93	96.9
Failure	13	24.1	9	7.1	10	41.7	6	19.4	3	10.0	3	3.1
Total	54	100	127	100	24	100	31	100	30	100	96	100
		$P=0.015$				$P=0.083$				$P=0.146$		

In six cases, the exact siting of the attachment had not been recorded by the orthodontist and these were eliminated.

Table 4 Reliability of bond related to surgery.

	For brackets				For eyelets			
	at surgery		later		at surgery		later	
	n	%	*n*	%	*n*	%	*n*	%
Success	29	82.6	15	60.0	116	96.7	5	71.4
Failure	6	17.4	10	40.0	4	3.3	2	28.6
Total	35	100	25	100	120	100	7	100
		$P=0.075$				$P=0.035$		

(94.4 per cent), far exceeded that of brackets, with (66.7 per cent) or without (75.0 per cent) pumice. These results achieved a high degree of statistical significance.

Table 2 clearly shows that attachments bonded at surgery were considerably more reliable than those bonded at a later visit. The success of bonding all attachments at the time of exposure was 95.0 per cent with pumice, and 92.6 per cent without. Taken together, this

reaches a successful overall average of 93.5 per cent, when bonding is performed at surgery. Performed at a later visit, the same parameters were 57.1 and 64.0 per cent respectively (therefore averaging 62.5 per cent). The level of statistical significance was high.

Bonding attachments to the mesial, distal, buccal but off-centre and ideal (mid-buccal) positions showed no significant difference between one and the other and were therefore combined into a single group. Against these, the success of bonding to the palatal aspect of the tooth was compared. As before, the results were not affected significantly with or without pumice preparation and Table 3 is therefore presented to show the combined results for all types of attachment, taken together. The relative success of bonding to the palatal surface was found to be much lower, 75.9 per cent, while the other surfaces demonstrated a significantly higher rate of 92.9 per cent.

In the same table (Table 3) this is broken down into conventional brackets versus eyelets. When bonded to the palatal surface, the eyelets performed considerably better than the brackets, with a success rate of 90.0 and 58.3 per cent respectively. On the other surfaces a similar superiority was demonstrated, 96.9 and 80.6 per cent respectively.

Bonding conventional brackets to a palatal tooth surface failed much more frequently than to any other surface, but, due to the relatively small numbers, the level of statistical significance of the results was low. Bonding eyelets to a palatal surface was notably more successful, by comparison with the conventional brackets, but marginally less reliable than an eyelet bonded to any other surface. While the number of cases was high, the small difference did not reach statistical significance. From Table 3, it may be noted that eyelets bonded to the palatal surface were even more successful than conventional brackets bonded to the more favourable sites.

No appreciable difference was noted between the bonding of attachments to impacted teeth, whether or not pumice preparation of the surface of the teeth was used, prior to etching. This was seen to be consistent with regard to attachment type, whether at surgery or subsequently and regardless of which surface the attachment was placed on.

For this reason, Table 4 compares the relative success rates of the bonding of standard brackets to the impacted teeth, at and subsequent to the exposure, in the combined pumice and non-pumice groups. Similarly, Table 4 compares these parameters for the bonding of eyelets. The success rate for each type of attachment was greater when performed at the time of surgical exposure and the eyelet was superior in each category. However, only the values regarding the use of the eyelets reached statistical significance.

Discussion

All the orthodontists participating in this study perform a prophylaxis in the routine preparation for the bonding of brackets to the erupted dentition, during a given orthodontic case treatment. Nevertheless, several of them did not do this when bonding to an impacted tooth, whether at the time of surgery or at a subsequent appointment. This would appear to be in direct contradiction to accepted bonding practice and to the explicit instructions that the various manufacturers provide with their bonding materials.

Accordingly, the first parameter tested was whether this practice could be validated. Brackets bonded to impacted teeth, with and without an initial prophylaxis, experienced a similar failure rate, demonstrating that this criterion is not significant under these special circumstances. The reasons for this are 3-fold. Firstly, erupted teeth in most patients are covered to some degree by a plaque coating and this will undermine the bond, unless thoroughly removed by prophylaxis (Sharawy and Yeager, 1991; Ten Cate, 1994). Newly-exposed impacted teeth do not have this covering. Secondly, enamel matures after eruption, becoming less permeable with age particularly by the crystals acquiring more ions from the saliva (Sharawy and Yeager, 1991; Ten Cate, 1994) which may render the enamel of erupted teeth more resistant to the bonding process. Thirdly, virgin enamel has different surface properties, such as porosity, which may make for a better bonding capability (Ten Cate, 1994).

Eyelets bonded with and without pumice preparation also showed a similar level of reliability (Table 1), confirming that pumicing is superfluous in this particular circumstance, although the eyelet adhesion proved to be con-

siderably better than that of the brackets. From the above figures, it may be calculated that when brackets were bonded, approximately one bracket in every three failed. The eyelet figures show that 1 in every 21 failed (3.6–5.6 per cent), which is a 7-fold superiority in performance.

Maxillary palatal canines comprized the majority of the cases examined in this study. The anatomy of the palatal surface, on the other hand, is convoluted, offering a surface configuration which is extremely difficult to build into an attachment base. It must therefore be considered to be a much poorer bonding site and a greater failure rate is to be expected. This was indeed found in this study, with one failure expected for every four attachments to the palatal surface, compared with one in 14 for the other sites. When this was categorized to determine whether the use of an eyelet had any advantages over the use of a conventional bracket, the results were found to be in favour of the eyelets. For the palatal surface, a 58.3 per cent success rate for conventional brackets meant that one such attachment in two failed while, on the same surface, the failure rate for an eyelet was one in 10. The explanation for this is almost certainly due to the shape and the lack of adaptability of the bracket base. It must be remembered that the base of an orthodontic bracket is designed to fit the mid-buccal position of a particular tooth. This base is very rigid and, with a large bracket, its shape is difficult to re-adapt to fit any other tooth surface. The mesial and distal aspects of the canine are more convex, which allows a reduced but adequate surface contact, between base and tooth surface. However, the form of the palatal surface is totally unsuited to that of the bracket base and there will be a two- or three-point contact, only. Furthermore, when space is restricted, due to the proximity of the impacted tooth to the neighbouring teeth, it may not be possible to ideally site a large conventional bracket. The operator will have to choose an alternative and compromise bonding site. Under the same conditions and constraints, a small and low-profile eyelet may frequently be placed in its ideal position.

The eyelet attachment (Fig. 1) is usually made up by the orthodontist's assistant, by welding a simple wire eyelet, supplied by one of the manufacturing companies, to a thin and

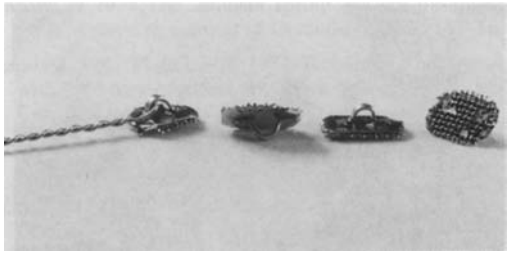

Figure 1 Eyelet attachments showing the eyelet welded to band material and to a mesh pad. One of the attachments has been threaded with a pigtail ligature, preparatory to bonding.

soft length of stainless steel band material, which is in turn welded to stainless steel mesh. The base is cut with a crown scissor to a convenient size, for use in the present context. This attachment is extremely easy to adapt to the shape of the potential recipient site on the crown, to provide a wide contact area for successful bonding.

Table 2 shows that the reliability of bonding all attachments at surgery is considerably greater than when performed on a subsequent visit. Since the group of conventional brackets tested was relatively small (Table 4), it did not reach statistical significance. For the eyelets, on the other hand, the results were statistically significant. The relative success of bonding at the time of surgery was high, with only 1 failure in 30 attachments. In comparison, bonding performed at a later time showed a rate of 1 failure for every 3.5 attachments, which was 8.6 times higher. Comparison of these figures with the earlier quoted 8 per cent failure rate for brackets bonded to erupted and functioning teeth, performed in the course of a routine orthodontic treatment programme (Millett and Gordon, 1994), show that the reliability of bonding an eyelet attachment at the time of surgery is superior. This relatively high rate of failure on erupted teeth may possibly be attributable to their being in masticatory function, which is not the case with impacted teeth. Nevertheless, it appears to confirm that the present approach has a great deal to offer and may be recommended with some confidence, even in cases of multiple impaction, such as in cleidocranial dysplasia (Figs. 2 and 3).

It is often difficult to maintain visual contact and clinical access to a surgically exposed tooth, in the weeks that follow exposure. The tissues

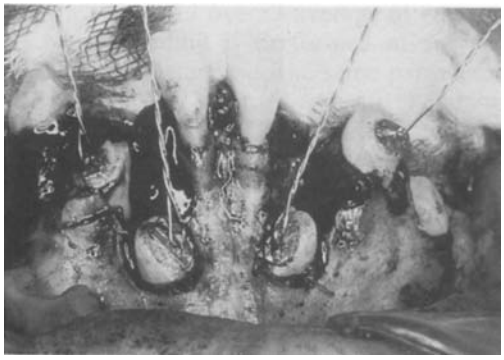

Figure 2 A case of cleidocranial dysplasia, showing erupted mandibular central incisors. Eyelet attachments have been bonded to deeply displaced lateral incisors and to unerupted, but more superficially-placed canines.

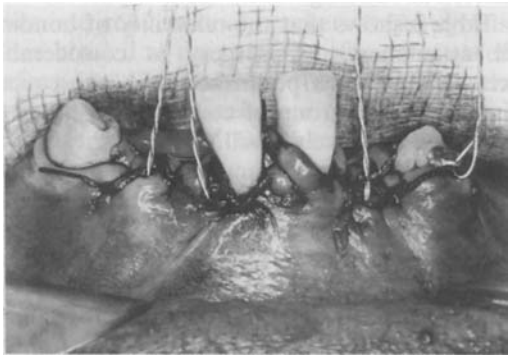

Figure 3 Primary wound closure with full replacement of surgical flaps. The pigtail ligatures may be seen to pass through the approximated and sutured edges.

tend to close over, particularly when the tooth is not superficially placed and isolation is difficult to achieve. As pointed out in the introduction, oral hygiene in these areas is complex and there is a consequent plaque accumulation, which leads to a localized gingival inflammation, with swelling and spontaneous bleeding. The tissue edges are often very tender, making it difficult for the patient to tolerate the manipulation necessary during the procedure of attachment bonding.

With the tooth adequately exposed during the surgical procedure and the surgeon present to maintain haemostasis, conditions for bonding at surgery, by the orthodontist, may be excellent. Furthermore, the surgeon is able to offer a wider choice of bonding sites and to ensure far better access, at the time of surgical exposure, than is possible with the tooth which has been exposed, packed and left for a few weeks. Contrary, therefore, to popular clinical opinion, bonding at the time a tooth is exposed has been shown here to be very much more favourable than at a subsequent time.

To bond an attachment at the time of surgery generally requires the orthodontist to be present, although the surgeon may be prepared to perform the procedure alone. Clinically, there are many advantages if the orthodontist is able to observe, and possibly photographically record, the exact position of the exposed canine, in terms of immediate ligation that is possible while the patient is locally or generally anaesthetized and from the point of view of confirming the desired direction of initial and later traction. Ideal attachment position is more expertly judged by the orthodontist, who may also wish to incorporate a rotatory or palatally-extrusive movement of the tooth, whilst the impaction is resolving. This may be achieved by tying a ligature to a less usual place on the archwire or by ligating to an auxiliary device (Wraith, 1969; Becker and Zilberman, 1975, 1978; Jacoby, 1979; Kornhauser *et al.*, 1995).

Conclusions

Given the results described, the present authors would make the following recommendations, when bonding an attachment to an impacted tooth:

1. Pumicing is superfluous on virgin enamel. It may actually be harmful, in that it is difficult to restrict it from contaminating the open surgical field. Prophylaxis also dictates the need for a wider surgical exposure.
2. Bonding should be performed by the orthodontist, at the time of surgery.
3. Conventional orthodontic attachments should not be used for bonding to impacted teeth. An eyelet should be used initially, until the impaction has been completely resolved and the tooth is in a position close to the line of the arch. At that time, the eyelet should be removed and a bracket matching those on the other teeth should be substituted, to achieve the final detailing and root alignment that may be required.

4. As far as possible, bonding should be as close to the ideal, mid-buccal, position on the crown of the impacted tooth.

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