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# Open or Closed Exposure for Palatally Impacted Maxillary Canines? A Review

**Abstract:** Palatally impacted canines (PICs) can be surgically exposed using one of the two exposure methods: open or closed. There is generally lack of consensus with regards to the preferred exposure method, hence the choice of operative technique remains open to discussion. The two techniques are compared and the choice of surgical technique is assessed in terms of patient factors, orthodontic/surgical and radiographic factors. Taking all possible determinant factors into account, a flowchart for the selection of the surgical exposure technique is presented.

**CPD/Clinical Relevance:** As there are no clinical guidelines currently in the literature for the selection of surgical exposure method of PICs, carrying out this review article might help orthodontists and oral surgeons (especially juniors) in the selection process by following the proposed flowchart presented in this article, based on the available evidence in the literature.

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An impacted tooth can be defined as 'a tooth whose eruption is considerably delayed and for which there is clinical or radiographic evidence that further eruption may not take place'.[1] It has been shown that the incidence of canine impaction is 1.7%.[2] Impacted canines are palatally positioned in 85% of the cases.[3]

Displacement of the maxillary canine palatally might be due to the thick mucosa and dense bone palatally, making it difficult for it to erupt. Surgically assisted orthodontic intervention is often required to guide the canine into occlusion.[4-6] Surgical exposure and orthodontic alignment is indicated in patients beyond the age of interceptive treatment, in which the PIC is not severely ectopic, and the adjacent tooth shows no or mild resorption.[7] Accommodation of the canine within the arch can involve procedures of varying degrees of complexity, ranging from the simple interceptive treatment (removal of retained deciduous canine) or any impediments to exposure, up to surgical re-implantation. A strategy which is commonly adopted is surgical exposure followed by orthodontic alignment. The treatment of impacted canines should follow a multidisciplinary assessment involving orthodontist, oral surgeon, periodontist, paediatric dentist and general dental practitioner. With PICs, two surgical methods for exposure are commonly used: open and closed. Currently, there is no general consensus about the choice of operative technique. Various considerations might influence the choice of surgical exposure method, including patient factors, orthodontic/surgical and radiographic factors.

## Search method

A review of the literature was carried out using the following search methods: PubMed, MEDLINE, EMBASE, the Cochrane Central Register of Controlled Trials (CENTRAL) and the Cochrane Oral Health Group's Trials Register. The search was focused on various keywords including:

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'PIC', 'open surgical exposure', 'closed surgical exposure', as well as hand literature searches, which were conducted on studies published until January 2016.

## What are the two surgical exposure techniques?

Surgical exposure of the PIC can be performed in one of two ways (Figure 1):
1. Closed exposure;
2. Open exposure.

### Closed exposure

A full thickness palatal mucoperiosteal flap is raised and the tissues overlying the canine crown are removed and a low profile orthodontic bracket with a gold chain attached is bonded to the canine crown.[8] The overlying tissue is not excised (Figure 1a). Bonding is usually to the palatal aspect of the crown or the most accessible surface in a rotated tooth. The flap is replaced with the gold chain passing through the incision into the gingival margin at the future position of the tooth. The free end of the chain can be retained with composite to an adjacent tooth, sutured to the mucosa (Figure 2), or attached to the archwire, if present.

### Open exposure

This involves either excising the oral mucosa immediately overlying the impacted tooth (gingival sparing procedure) as shown in (Figures 1c and 3), or raising a full thickness mucoperiosteal flap, and removing enough bone to allow for the placement of an orthodontic attachment, followed by the repositioning of the flap with a hole (with or without a Coe-Pack dressing, depending on the vertical position of the canine) (Figures 1b and 4). The progress of canine eruption can be monitored with radiographs, using reference points such as an adjacent tooth or the archwire. If the tooth fails to erupt, surgical removal of any cicatricle tissue surrounding the crown is recommended.

When open exposure is performed, there are two approaches to consider regarding the timing of the attachment placement and application of orthodontic traction, with or without traction.

### Open exposure without traction

This involves the surgical exposure of the impacted canine in the late mixed dentition with no orthodontic traction.[5,9] This is done only when the tooth has a correct axial inclination assessed from the orthopantomogram.[5,10] Spontaneous eruption can take up to 9 months post-operatively.[9] The main advantage of this technique is to allow for spontaneous eruption, thus reducing the time in active orthodontic treatment.[9] However, it should be noted that spontaneous eruption of the surgically exposed canine might take longer than active eruption.[10] One of the perceived disadvantages of leaving the exposed canine to erupt passively is that gingival regrowth may occur, necessitating re-exposure. However, there is little evidence regarding the success or otherwise leaving palatal impacted canines to erupt, as opposed to applying traction after surgery during the mixed dentition phase.

### Open exposure with traction

Surgically exposed canines rarely erupt into a created space, without aid, if root formation is complete and the canine has unfavourable axial inclination, as determined from the orthopantomogram.[5,10] Therefore, after exposing the canine with the open technique, attachment is bonded to the canine and traction is applied. Bonding an eyelet was found to be more successful (94%) compared to an orthodontic bracket (75%), especially if it was bonded at the time of exposure[11] (Figure 3).

Two options are suggested with regards to the timing of attachment placement:[10]

- *Two-step approach*: firstly, the canine is surgically exposed. Wound healing usually takes up to 8 weeks. At this point, an attachment is bonded to the crown of the impacted tooth.[12] This approach can be recommended when bleeding compromises attachment bonding during surgery.
- *One-step approach*: in which the attachment is placed on the tooth at the time of surgical exposure (Figure 4). The main advantage with this approach is that it avoids the delay in application of orthodontic traction.

## Are there any factors to consider when selecting open vs closed surgical exposure?

The first factor to consider when exposing impacted canines is the gingival biotype and amount of keratinization. Since palatal gingiva is attached, thick and keratinized, both open and closed exposures can be carried out. A thorough search of the literature revealed that there are four important factors to consider when selecting one surgical exposure method over the other. These factors are:
1. Presence of a dentigerous cyst;
2. Age of the patient;
3. The vertical level of impaction; and
4. Resorption of adjacent incisors.

Taking these factors into consideration, a flowchart (Figure 5) was constructed to present clinical selection criteria for selecting the appropriate exposure technique.

### Presence of supernumerary, odontome or dentigerous cyst

Impacted canines can be associated with supernumerary teeth, odontomes or dentigerous cysts. If the impacted canine is not severely ectopic, the tooth can be preserved after elimination of the associated pathology. This is done by surgical removal of the supernumerary or odontome. The

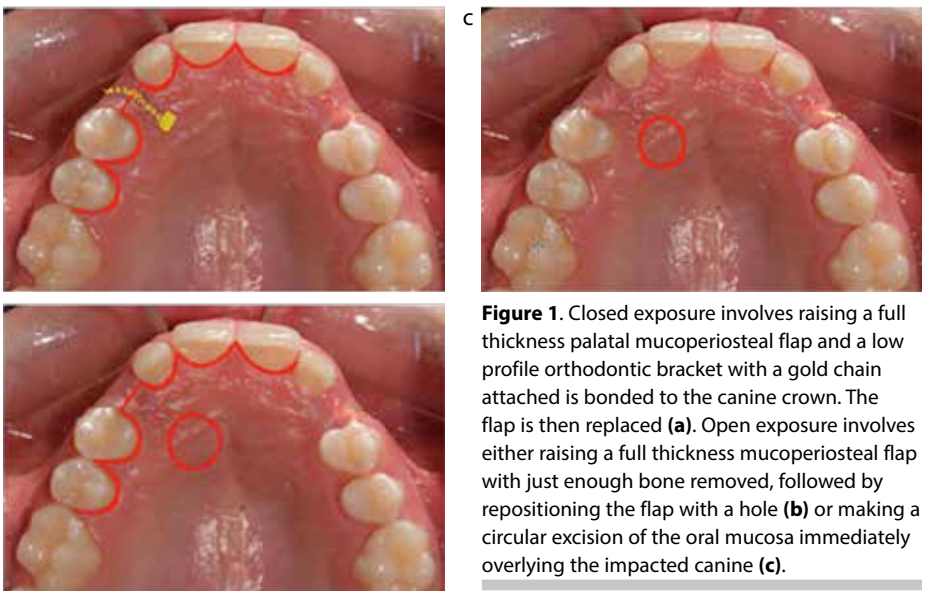


**Figure 1**. Closed exposure involves raising a full thickness palatal mucoperiosteal flap and a low profile orthodontic bracket with a gold chain attached is bonded to the canine crown. The flap is then replaced **(a)**. Open exposure involves either raising a full thickness mucoperiosteal flap with just enough bone removed, followed by repositioning the flap with a hole **(b)** or making a circular excision of the oral mucosa immediately overlying the impacted canine **(c)**.

**Figure 2**. Example of a palatally impacted maxillary left canine exposed with the closed exposure method. A full thickness palatal mucoperiosteal flap was raised from UR2 to UL5, enough bone removal to expose UL3, and the flap was replaced. Note the normal post-operative swelling of the palatal gingiva 1 week post-operatively **(a)**. Attachment was bonded on the palatal surface of UL3; the gold chain passes through the incision into the gingival margin at the future position of the tooth. The free end of the chain is retained with a non-resorbable suture to the labial mucosa **(b)**.

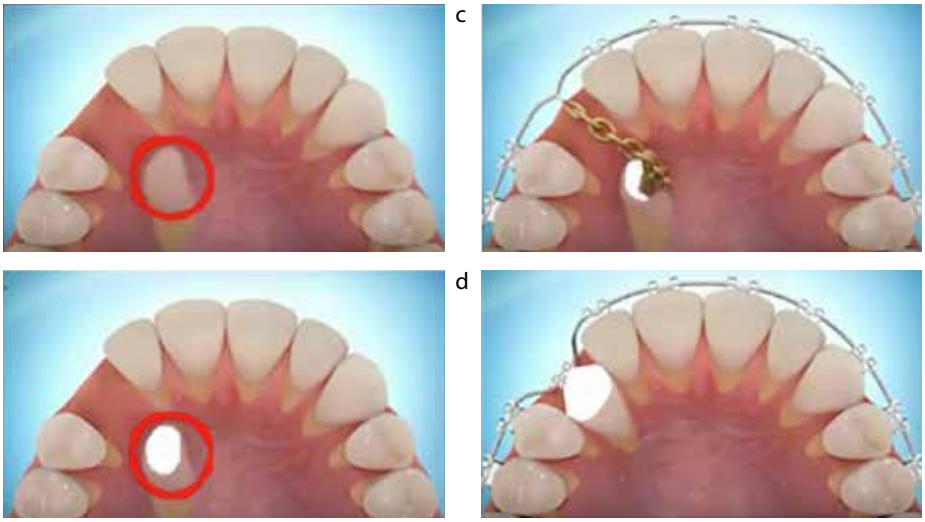

**Figure 3**. These diagrams illustrate the open method (gingival sparing technique) for exposing PICs. UR3 is palatally impacted **(a)**. A window is made by excising the palatal tissues immediately overlying the crown without the need for raising a flap, this is known as the gingival sparing method **(b)**. A bracket is bonded to the most accessible part of the exposed crown with an attached gold chain **(c)**. The canine is engaged to the archwire at the final stages of alignment **(d)**.

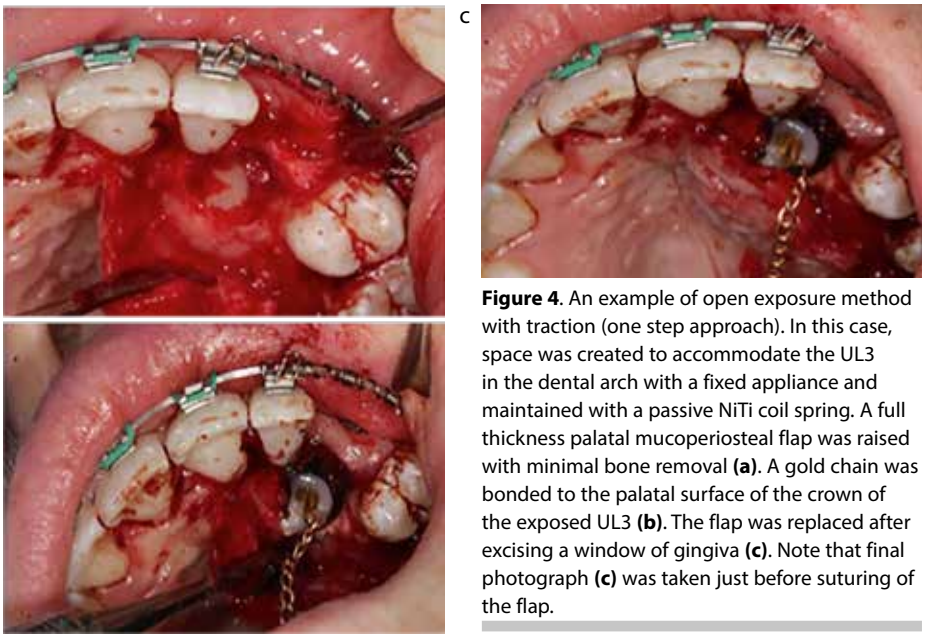

**Figure 4**. An example of open exposure method with traction (one step approach). In this case, space was created to accommodate the UL3 in the dental arch with a fixed appliance and maintained with a passive NiTi coil spring. A full thickness palatal mucoperiosteal flap was raised with minimal bone removal **(a)**. A gold chain was bonded to the palatal surface of the crown of the exposed UL3 **(b)**. The flap was replaced after excising a window of gingiva **(c)**. Note that final photograph **(c)** was taken just before suturing of the flap.

impacted canine can be exposed at the same visit and the type of surgical exposure will depend on the age of the patient, the presence of root resorption of the adjacent teeth and the vertical position of the impacted canine.

In cases in which the PIC is associated with a small dentigerous cyst and the plan is to preserve the tooth, the dentigerous cyst can be enucleated and the impacted canine exposed and bonded at the same visit. However, in large cysts, decompression or marsupialization is indicated to allow bone formation following the reduction in cystic pressure (Figure 6). Therefore, the open exposure technique can provide decompression of the cyst as well as exposing the PIC.

After elimination of the associated pathology, depending on the eruption potential of the impacted canine, spontaneous eruption can be anticipated.

### The stage of root development

The stage of root development is an important determinant factor to consider. The root formation of maxillary canines usually completes by the age of 13–15 years. If the impacted canine's root is not fully developed and in favourable inclination, spontaneous eruption using open exposure without traction might be anticipated. However, if the root apex is fully developed, there is little chance for the canine to erupt. Therefore, the tooth must be exposed (open or closed) with application of active traction.

### Resorption of adjacent incisors

External root resorption of teeth (especially incisors) adjacent to the PIC is not uncommon.[13] The incidence of root resorption of the adjacent lateral incisor caused by PICs was found in 68% of the cases when cone-beam computer tomography (CBCT) is used.[14] Therefore, CBCT should be considered in cases where the prognosis of the impacted canine and/or adjacent incisors is uncertain to justify whether exposure of the canine or removal of severely resorbed incisors is indicated.[15]

If the PIC is associated with severe resorption of the roots of incisors, then an open exposure method is contra-indicated since it might endanger the vitality of the incisors.[14] Closed exposure in these cases is likely to preserve the vitality

| Post-operative factors | Open exposure | Closed exposure | Evidence |
|---|---|---|---|
| **Patient factors** | No clinically significant difference | | Parkin *et al*[18] |
| Comfort (post-op pain/ discomfort) | | | Gharaibeh and Al-Nimri[19] |
| Patient perception of recovery (healing) | Longer healing time | Morbidity is lower | Chaushu *et al*[20] |
| Periodontal health | No clinically significant difference | | Parkin *et al*[21]<br>Smailiene *et al*[22] |
| **Clinical factors** | No clinically significant difference | | Parkin *et al*[18] |
| Surgical time | Closed exposure requires more time compared to open exposure | | Gharaibeh and Al-Nimri[19] Pearson *et al*[23] |
| Ankylosis-related root resorption | 3.5% | 14.5% | Koutzoglou and Kostaki[24] |
| Duration of orthodontic treatment | No clinically significant difference | | Iramaneerat *et al*[25]<br>Fleming *et al*[26] |
| Aesthetics | No clinically significant difference | | Parkin *et al*[27] |
| Risk of re-exposure | 9.6%<br>15.3%<br>Gingival regrowth is the main reason for re-exposure | 2.9%<br>30.7%<br>Bond failure is the main reason for re-exposure | Parkin *et al*[18]<br>Pearson *et al*[23] |

**Table 1**. Advantages and disadvantages of the two surgical exposure techniques.

of both the impacted canine and the incisor (Figure 7).

#### Vertical level of impaction

The radiographic position of the impacted canine might influence the decision on selecting the exposure method; however, this factor has not been studied before. Experienced oral surgeons and orthodontists believe that the more severely the canine is vertically positioned, the greater the surgical complexity, in the sense of more bone will need to be removed, therefore open exposure is better avoided as this method leaves the canine exposed high in the palate, which might not be comfortable for the patient. Taking the 'rule of thirds' into account,[16] closed exposure method is recommended for deeply impacted canines in vertical level III for the above-mentioned reason (Figure 8). For canines positioned in level I or II, open exposure method can be selected if the other three factors favour this method.

## What are the advantages and disadvantages of each technique?

Advocates of the closed exposure approach note the multiple benefits, such as patient comfort during the healing process and better periodontal outcome. On the other hand, the advocates of the open exposure technique and spontaneous eruption of the canine claim several potential advantages, such as the ability to observe the impacted tooth movement during treatment, no need of attachment bonding at the time of surgery and fewer failures and less need to re-expose the impacted canine. However, the latest Cochrane review concluded that there is lack of high quality evidence in this area, and further studies are needed in order to compare the outcomes of the two techniques.[17]

It is essential to be aware of the main advantages and disadvantages associated with both surgical exposure techniques in order to comprehend the surgical procedure fully before obtaining informed consent (Table 1). It seems apparent that the evidence is equivocal and these factors are less likely to influence the decision when selecting one exposure method over the other.

## Patients' comfort and perceptions of recovery

The latest Cochrane review found a lack of high quality evidence to support one technique over the other in terms of patient reported outcomes.[17] Gharaibeh and Al-Nimri carried out a randomized prospective trial to compare patients' perceptions of pain one week after having open exposure and closed exposure. It was found that clinically and statistically there was no significant difference between the two methods. However, post-operative recovery seemed to be faster in the closed exposure group.[19] A more recent multicentre randomized controlled trial reinforced

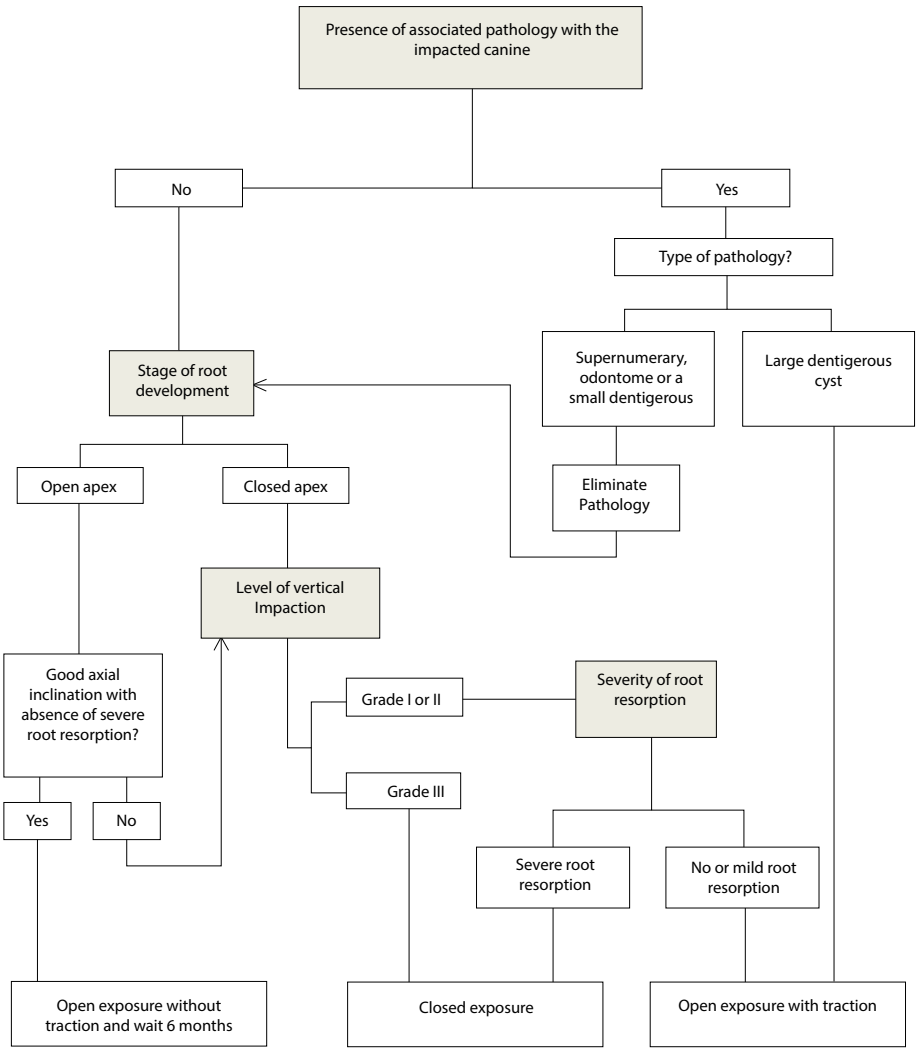


**Figure 5.** Flowchart for the selection of the surgical exposure technique taking into account the determinant factors.

the previous findings in that there was no statistical difference between the two groups.[18] Chaushu *et al* prospectively assessed patient perceptions of immediate post-operative recovery after the surgical exposure of impacted maxillary teeth with open exposure and closed exposure techniques. The comparison revealed that patients receiving an open exposure had a slightly longer recovery time.[20] However, no previous qualitative studies exploring patient perception and experiences with both techniques were found. Qualitative research in this field might provide new insight and a different perspective than what is known from previous quantitative research.

## Periodontal health

The periodontal health of exposed PICs with open and closed techniques has been investigated in two studies. Parkin *et al* carried out a multicentre, randomized controlled trial. Periodontal health was assessed three months after removal of fixed appliances. The results showed that there was no difference between canines exposed with open and closed surgical techniques.[21] The other trial involved palatally impacted canines exposed using open exposure without traction and closed exposure.[22] The results were in agreement with the study by Parkin *et al*. Therefore, it can be concluded that there is no proven relationship between exposure method and periodontal health, assuming that the correct surgical procedure is done with minimal bone removal and avoidance of exposure of the cemento-enamel junction.

## Surgical treatment time

Gharaibeh and Al-Nimri and Pearson *et al* compared the operating times required to expose PICs surgically by the closed exposure method with the operating times required for the open exposure method. They reported that the closed exposure technique took longer to complete than the open exposure method.[19,23] However, Parkin *et al* found the differences between the operating times not to be statistically significant. It is important to note that secondary variables might have a direct impact on the surgical treatment time, eg experience of the surgeon, level of impaction, amount of bone removal needed, type of attachment bonded, presence of orthodontist at time of surgery for bonding attachment (in cases of closed exposure) and the anaesthetic technique (local anaesthetic, sedation or general anaesthetic).

## Ankylosis-related root resorption

Three main factors can cause trauma to the periodontal ligament or the cementum of the root of the impacted tooth and lead to ankylosis-related resorption:

1. The low-speed bur during exposure (both open and closed);
2. Chemical trauma to the periodontal ligament from the 35% phosphoric acid (this applies to open exposure as well as closed exposure); and
3. Trauma to the periodontal ligament in the cervical region because of the direction or magnitude of the orthodontic force.

Thus, cervical root resorption can be a possible complication associated with both exposure techniques, especially if extensive bone removal is carried out beyond the cemento-enamel junction of the PIC.[24]

## Orthodontic treatment time

Two retrospective studies found that the duration of orthodontic treatment of impacted canines treated by the open exposure method or by the closed exposure technique was not significantly different between the groups.[25,26] Therefore, it seems that the method of surgical exposure does not clearly have a direct effect on the overall treatment duration.

## Aesthetics

Parkin *et al* recently carried out a multicentre randomized clinical trial to compare the aesthetic judgements of orthodontists and laypeople regarding the appearance of PICs three months after treatment with either a closed or an open surgical exposure and orthodontic alignment.[27] The results showed that there were no differences between the closed and

**Figure 6**. Cystic changes can be seen around the crown of UL3. Clinically, there was slight swelling of soft consistency on the palatal gingiva consistent with clinical features of a cyst. Therefore, open exposure was carried out to allow for decompression.

**Figure 7**. Palatally impacted UR3 causing root resorption of the adjacent lateral incisor. Closed exposure was carried out in this case given that open exposure might endanger the vitality and long-term prognosis of the UR2.

open groups. The authors concluded that there is an aesthetic impact to aligning a PIC, but it is mostly minor and unlikely to be detectable by laypeople. Therefore, the aesthetic outcome is unlikely to affect the selection process of exposure method.

## Re-exposure

Concerns exist about the frequency of repeat surgery with both the open and closed exposure techniques. If the closed method is used, failure of the bonded attachment usually means that repeat surgery is required to uncover the impacted canine so that a new bonded attachment can be placed. When the open exposure technique is used, overgrowth of the healing wound margins surrounding the surgical defect can necessitate further surgery to provide adequate access to the impacted canine. Pearson *et al* compared 52 consecutive cases treated by the open exposure technique with 52 patients treated by the closed exposure method.[23] This study found that 8 of the patients (15%) treated by open exposure required repeat surgery as a result of gingival overgrowth or failure to erupt. However, nearly one third (31%) of the 52 patients treated by the closed exposure method required a second operative procedure. Six patients (12%) needed repeat surgery as the result of the failure to erupt; bond failure occurred in 3 patients (6%), and in 7 patients (13%) the wire ligature attached to the orthodontic bracket fractured.

Although repeat surgery (re-exposure) can be required with both the open and closed exposure methods, the published evidence appears to indicate that this problem is more often associated with the closed eruption method.[18]

## Conclusion

The choice of surgical exposure technique of PIC was reviewed in this article in terms of patient factors, orthodontic/surgical and radiographic factors. Taking all possible 'determinant' factors into account (presence of pathology, age, resorption of adjacent incisors and vertical level of impaction), a flowchart for the selection of the surgical exposure technique was constructed accordingly and presented in this paper after carrying out an extensive search of the literature. Other factors were also reviewed and grouped in a table as pros and cons of the two techniques that are less likely to affect the selection process.

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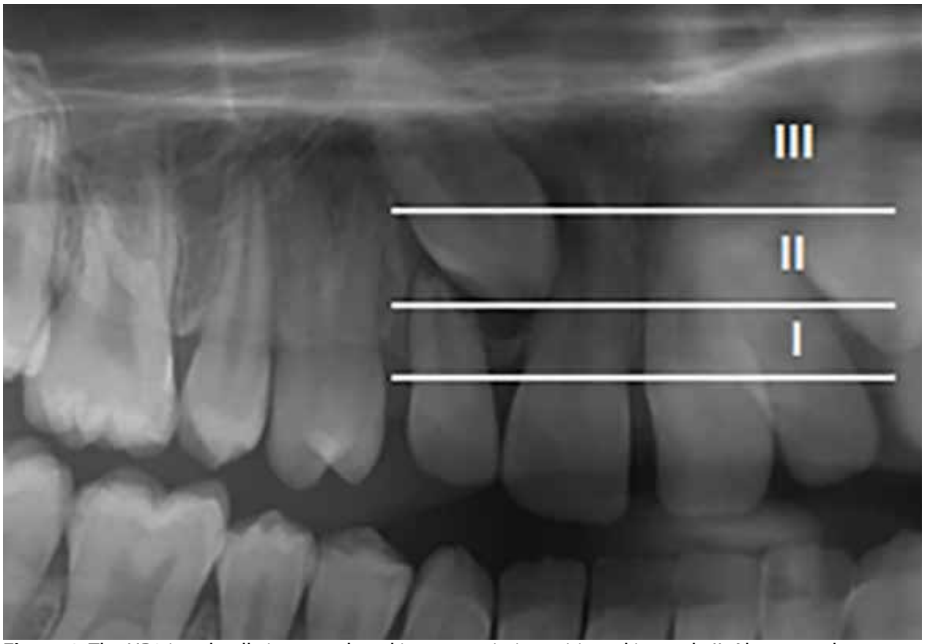


**Figure 8**. The UR3 is palatally impacted, and its crown tip is positioned in grade II. Also, note the associated root resorption of adjacent incisors. Therefore, closed exposure was carried out in this case.

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