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Exodontia: Tips and Pearls

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Abstract

Exodontia or tooth extraction refers to the procedure by which teeth are removed from their sockets. It is done as the last resort of treatment for painful non restorable and infected teeth. Proper evaluation before the procedure is essential in order to have a smooth procedure with no unexpected results. Subsequent implant placement requires healthy tissues with adequate dimensions. This led to the concept of minimally traumatic extraction procedure.

Keywords: *Exodontia; oral surgery; dental implants; atraumatic extraction; dental extraction*

1. Introduction

Exodontia or tooth extraction refers to the procedure by which teeth are removed from their sockets. It is done as the last resort of treatment for painful non restorable and infected teeth. Extraction of sound teeth (most commonly the premolars) may be part of orthodontic treatment plan. Other reasons include severe periodontal disease and certain teeth involved in dentoalveolar fractures.

Historical documentation of exodontia dates back to the first century (Celsus). It was also described by Hippocrates (6^{th} century). Rhazes or Abu BekrRhazi (9^{th} century) suggested extraction of teeth as the last resort after exhausting any possible means of treating it [1].

The modern forceps became popular in the early 20th century. Tissue loss in association with the procedure itself was not of major concern. Although, no much technological advancement has been observed in relation to the technique and instrument used in exodontia, the development of dental implant as a prosthetic option created a new aim besides removing the tooth. The current standard of care includes preservation of soft and hard tissues as much as possible for better implant prosthetic replacement.

The aim of this article is to review basic extraction techniques with emphasis on atraumatic procedures. Extraction is an everyday procedure and should be performed by all dentists.

2. Evaluation

As in any procedure, exodontia should be preceded by thorough evaluation which includes taking medical history and performing appropriate medical and dental examinations. Radiographs such as orthopantomograms (OPG) is considered as routine and basic radiographic evaluation. However, better detailed image could be obtained by a periapical intraoral radiograph. CT or CBCT may sometimes be needed for evaluation of vital structures.

In case the patient is referred from another facility, the data obtained from evaluation is compared with the referral form. To prevent any source of miscommunication, ensure correct patient name, file number, diagnosis and investigations. These all should match and any uncertainty should elicit revising the diagnosis with the referring dentist and the patient [2]. In addition, evaluation allows for determining the difficulty of the procedure and the need for certain instruments or situations for example sedation or general anesthesia. In addition, the need for any precautions before the procedure like consultations, lab tests or prophylactic antibiotics is determined during this step.

2.1. Evaluate the Reason for Extraction

In brief, determining the restorability is based on the remaining coronal structure, condition of the periodontium and the root canal system [3]. Unrestorable teeth usually have poor structural integrity of the remaining coronal structure. Crowning of teeth that haveless than 1mm

Ferule are of questionable prognosis [4]. Therefore, teeth with subgingival caries and inadequate ferrule are considered non-restorable (figure 1). If crown lengthening is to be considered, the esthetics and periodontal support of adjacent teeth should not be jeopardized.

Periodontalconditions with severe bone loss and those progressing despite periodontal surgeries are indicated for extraction. However, isolated bone defects associated with pulp involvement may benefit from combined endo-perio treatment.

Favorable endodontic conditions include well-performed root canal filling that is well compacted and terminates within 2 mm of the root apex. Difficult or complex root canal conditions contribute tounpredictable endodontic treatment results. Examples include root canal sclerosis, canal curvature more than 30°, aberrant root canal system, irretrievable broken instruments. These conditions favor extraction over questionable attempts of endodontic treatment. In addition, root resorption either external or internal, if significantly large or inaccessible is considered as indication for exodontia.

Figure1. *Badly decayed lower right first molar at the evaluation visit. Poor structural integrity of the crown is visible clinically. Radiographic evaluation also reveals subgingival caries. This would make the extraction process more difficult.*

2.2. Determine Difficulty of Extraction

Exodontia, although minor oral surgical procedure, it may be unpredictable due to many factors involved during the procedure. Visibility is one important factor during extraction. Maintain constant clear vision through good light source, frequent suctioning, and adequate retraction. Another important key is to properly use correct instrument. In general, factors that affect visibility and instrument use increase difficulty of the procedure [5]. Limited mouth opening greatly affects the difficulty procedure. Access may also be hampered by the presence of crowding or malalignment. In these cases, adjacent teeth may be at risk of luxation during the procedure. Also consider the path of removal needed for the tooth to completely exit the socket. Root curvature affects the path of removal greatly and in case of limited space, consideration to multiple tooth sectioning should be taken to prevent damage to adjacent structures. Other considerations that affect access includes large tongue, thick cheeks, broad shoulders which are commonly seen in obese patients. Special attentions should also be paid to the quadrants away from the operator.

Loss of crown structure affects the feasibility and application of forceps use (figure 1). However, in certain situations, it may be better to remove the crown first during the procedure. In cases of tight contact with adjacent, grinding part of the crown at the mesial and distal contact areas of the crown may facilitate extraction with lesser trauma to the adjacent teeth.

Mobility can be noted during radiographic examination by evaluating the PDL space. Normally, dark line representing the PDL space is seen surrounding the root. As a role, the greater mobility, the easier the tooth extraction will be. Even if during extraction mobility was not significant, progressive microscopic mobility can be advanced to allow uneventful extraction. Ankylosis or absent PDL space is seen in cases of submerged, root canal treated or non-vital lone standing teeth. In these cases, teeth will feel like embedded in concrete and, therefore, surgical technique should be strongly considered.

Root number, size, length and curvature have strong effect on the difficulty of extraction. Attempting to extract a 3-rooted tooth requires greater force than single rooted teeth. In the author's opinion, roots should be separated and removed individually. The presence of curvature at the apex of the root should not be underestimated as it will add much to the difficulty of extraction. Large root resorption may make extraction very difficult. Vertical

intra-root division converts large ellipsoid root into two smaller divisions that can be taken with less force.

Sclerotic bone is present mainly in around isolated lone standing teeth. Bone that doesn't expand during the procedure increases the chances of root fracture. Younger patients usually have soft and elastic bone making the procedure easier than in older patients. Rather than increasing the difficulty of the procedure, proximity to vital structures mandates extra care to avoid inadvertent damage.

3. INSTRUMENTS

This should include the basic exam set, topical and local anesthetic set, a periosteal elevator, straight elevator and appropriate extraction forceps (discussed next). Metal suction tip is mandatory. Minnesota retractor is key instrument for retraction especially for upper wisdom teeth. Other instruments include the hand piece and surgical burr.

3.1. Dental Extraction Forceps

Dental extraction forceps are designed to grasp the tooth and expand the socket. Grasping the tooth should be the main use and excessive dilation of the socket should be avoided. Different designs are available to enhance grasping the tooth. Concave beaks fitting the convex tooth surface allows maximum control and force distribution [6]. For teeth with furcation, a tip is designed over the beak to fit between the roots to increase control. The beaks are designed to be aligned along the long axis of the tooth. Failure to achieve grasp parallel this axis would result in unfavorable force application. In general, maxillary forceps have more straight design that allows the beaks to fit on the tooth while the maxillary occlusal plane is at about 60° to the floor. In contrast, the beaks of the mandibular forceps are at right angle to the handles and should be used while the mandibular occlusal plane is parallel to the floor.

The first expanding movement should be directed apically as if trying to push the tooth into the socket. In this way, not only the socket is dilated but also the point of grasp in placed further towards the apex. This would ensure grasping more structurally intact tooth surface and better axis of rotation. The forceps then are used as a lever moving the tooth in buccolingual direction with care taken to move the tooth towards the thinner cortical bone first (mostly buccal, except in the lower posterior teeth).

Other movements include figure of 8, rotational and tractional movements [5]. Figure of 8 movement helps in initial microscopic luxation in resistant cases. Rotational movement may be all needed for straight single rooted teeth like upper central incisors and lower premolars. Curved roots and multirooted teeth will fracture easily with rotational movements. Tractional force may be applied at the conclusion of forceps extraction attempting to severe what is left of PDL with care not to struck opposing teeth. To avoid this, the direction should be occlusally and buccal with finger or gauze protection applied.

The cow horn extraction forceps work differently from the regular forceps. Their pointed beaks are designed to fit between the roots and by squeezing the forceps it luxates the tooth vertically. This design also helps in root separation in some cases.

3.2. Elevators

Elevators are used to luxate the tooth by severing PDL and expanding the socket. Luxation movement should direct the tooth along the path of removal which is taken by the tooth as it exits the socket. The tooth shape and the presence of root curvature strongly affect this path.

Elevators are useful to start the extraction procedure facilitating forceps. They are designed to be placed at the interface between the root and adjacent alveolar bone. This is a very important concept and needs good vision and appropriate elevator tip size. Failing to do so will either unnecessarily damage adjacent alveolar bone or push the root in unfavorable direction. Depending on the situation, possible movements include levering, wedging and wheel-axel type. Wedging movement is a starter move and is the ideal in terms of reducing trauma. Other movements relay on adjacent bone as a fulcrum which may cause compression-induced necrosis. Movements should be delicate and just enough to move the root and progressively increased once the direction of movement is ensured to be along the path of removal. Excessive or uncontrolled force application is the most common source of complications (eg. root fracture or displacement, alveolar bone fracture). Elevator positioning may sometimes be difficult or not possible. In general, smaller sized elevators should prepare the place for larger ones. Drilling into bone or tooth may help in creating a good point for elevator application [7].

4. CLOSED TECHNIQUE

Closed extraction or non-surgical technique doesn't involve flap reflection or tooth separation. To reemphasize, keys to successful procedure include good access, visibility and controlled forces. Right-handed operators should stand in the zone from 7 to 11 o'clock positions, while left-handed should be in the 1 to 5 O'clock position. The level of the patient's mouth should be just below the elbow. The nondominant hand should be used to retract soft tissues, provide some tactile sense and in mandibular extractions, to support the TMJ by counteracting apical movements. General steps are as follow [6]:

After evaluating the effectiveness of administered local anesthetics, a drape of gauze is placed at the back of the mouth to help prevent any tooth or foreign body aspiration or swallowing. Next soft tissue around the tooth is loosened with a no 9 or other appropriate periosteal elevator to allow access to more apical surface. With suitable type and size of elevators, the tooth is progressively luxated. Small straight elevator is wedged between the root and alveolar bone and progressively moved apically may be all what is need to extract the tooth. The use of small elevators in the interface between bone and root loosens the tooth by cutting PDL attachment. Minimally traumatic extraction techniques relay on this principle. The size of elevator may be increased as the mobility of the tooth increases. Wedging forces may be augmented by levering actions with the elevator rotated at right angle to the tooth. Care should be practiced during use of elevators to avoid excessive and uncontrolled forces. After adequate luxation of the tooth, appropriate forceps are selected and adapted to tooth by placing the beaks as parallel to the long axis of the tooth as possible. The tooth is grasped best at the root cementum. Due to varied anatomy, each tooth should be evaluated and approached independently. Table 1 describes specific considerations to each tooth.

Table1. *Specific considerations in extraction of each tooth type*

Tooth type	Specific consideration
Maxillary central incisors	Special care should be practiced to prevent bone loss caused by excusive force or any bone removal. These teeth are the most esthetically demanding. The best approach is to perform atraumatic extraction with either immediate implant placement or socket preservation.
Maxillary lateral incisors	May have palatally curved root and forceps movement may better start towards the palatal. However, atraumatic procedure should be considered as described in centra incisor extraction.
Maxillary canines	They have large ovoid cross-section and covered with thickened bone (canine eminence). Therefore, large force application may fracture the buccal plate overlaying this tooth. In this situation, intra-root sectioning is advised and the root may better be removed in 4 portions.
Maxillary premolars	The first premolar root often bifurcates in buccopalatal direction (more than 50%). Main buccal movement of the forceps help preventing palatal root fracture which is more difficult to remove due to thick palatal bone. The second premolar is often single-rooted and rotational movement may all be what is needed to remove it.
Maxillary first/second molars	They have three roots two buccal and one palatal. Because of thin buccal plate, the expansion movement should be directed more to the buccal direction. This may help reducing the chance of palatal root fracture which is more difficult to remove if it fractures. However, in case of severe root divergence, root separation is indicated to prevent concomitant fracture of buccal plate, root tip or sinus floor.
Maxillary third molars	They tend to have fused roots and due to absence of distal contact, elevators alone may suffice their extraction. The elevator action is aimed to displace the tooth mainly distally. Teeth with severe root bends and unusual morphology may be more difficult to luxate. With patience and progressive luxation movement the tooth can be removed, otherwise, surgical extraction may be the best means to avoid tuberosity or root fracture. In some situations, the tooth has a path of removal which is totally horizontal and the tooth impinge on the inner aspect of the ramus. Asking the patient to close the mouth helps clears the path for the tooth to come out with lesser impingement on the ramus.
Mandibular anterior and premolars	These are single-rooted and have small crowns. In crowded cases, the application of forceps may be difficult. Care should be practiced to avoid injury to adjacent teeth. Due to round cross-section of their roots, premolars may be extracted with rotational movement only.
Mandibular molars	These may be the most difficult teeth to extract as they are multirooted and surrounded with dense bone buccally. Lingual force of extraction helps to avoid the thicker buccal bone. Sectioning the tooth into two teeth simplifies the procedure. The two parts may be extracted with elevators or with premolar forceps.

5. SURGICAL EXTRACTION

Surgical extraction technique involves greater access and visibility than closed or simple technique. Generally, cases with sings of difficulty are candidates for surgical extraction from the start. Alternatively, it may be used to complete failed closed extraction procedure or to retrieve broken roots below the level of alveolar bone.

During this technique, mucoperiosteal flap is needed to access the roots. Envelope flap usually suffices and it should include one tooth mesial and one distal. If greater access is needed, a mesial vertical releasing incision is completed from the free gingival margin either mesial or distal to the interdental papilla till the mucogingival junction. Flap reflection is achieved with the desired periosteal elevator making sure to sweep over bone. One technique that helps preventing flap tear is to support the periosteal elevator with finger during dissection.

To decrease trauma during the procedure, the roots are sectioned with or without bone removal. Sectioning single root, for example the maxillary canine into two or more segments, helps in facilitating the procedure. After extraction steps described in closed technique should also be followed. Soft tissue reflected, should be replaced back and adapted gently by application pressure application for 5 minutes before suturing. This helps in the formation of fibrin layer between the flap and bone and thus reducing dead space.

The advantages of surgical tooth extraction include minimal discomfort during the procedure as the applied force is minimized. Bone loss associated with flap reflection and bone healingis a major disadvantage especially in esthetically demanding zones. When compared to non-surgical technique, flap surgery may be associated with more postoperative pain [8].

5.1. Atraumatic Extraction

Tooth loss is associated with reduction in ridge dimensions and density. Bone loos are a natural process during socket healing and it is associated with surgical trauma. In addition, the less surgical trauma needed to remove the tooth, the less post-operative pain and complications. Reduction of surgical trauma must be practiced during all surgical procedures. The main goal of atraumatic extraction is to overcome the disadvantages of conventional extraction technique. As described in the conventional technique, socket expansion is mainly achieved by deforming thin bone. One year after extraction, alveolar bone width would be reduced by 50% most of which would occur in the first 3 months [9]. Reduced buccal bone thickness is a major factor in predicting subsequent bone loss and socket grafting technique is recommended when the buccal plate is less than 1.5 mm. Every effort should be attempted to prevent iatrogenic bone loss during and after the extraction process. Minimally traumatic techniques aim at reducing the chances of thin bone fracture or resorption. Another proposed advantage includes flap avoidance to minimize post-operative discomfort [8]. This technique is especially important in the esthetic zone if implant replacement is planned. Different techniques have been described. However, techniques that are simple and demand lesser equipment are generally preferred.

5.1.1. *Periodontal Knives: Periotomes and Fine Luxators*

Periotomes are fine tipped elevators with saw like tip that act by cutting the PDL as they wedge between the root and the alveolar bone. They are applied in all around the surfaces of the tooth, except the buccal [10]. Precise initial placement at the bone-root interface is essential for success of this technique. A period of 10 seconds should be allowed while the periotome is inserted to allow for bone deformation to occur. Once in full depth, the periotome may be twisted to act like a lever that wedges the tooth out. Micromovement of the tooth will be noted which progressively increase.

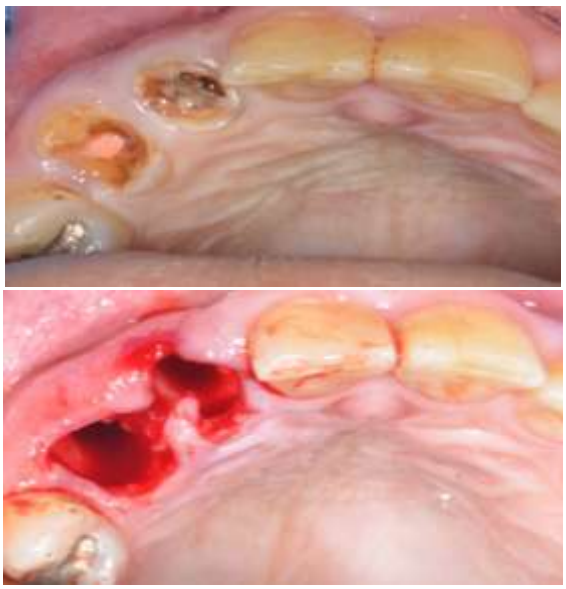

Figure2. *Socket appearance after extraction to upper right canine and first premolar done with periotome technique to lessen the chances of bone loss. Buccal bone was preserved in both sites.*

A fine forceps may be needed to finish the extraction process [figure 2 A, B]. Throughout the procedure, avoid buccopalatal movements. Root separation is required in multi-rooted teeth.

5.1.2. *Enucleation Technique*

After crown separation, the root is sectioned with fine fissure burr into 2-4 fragments that are removed by inward displacement [11]. Removed tooth substance during sectioning allows for tooth fragments to be displaced within the confines of the socket. Success rate is very high, therefore eliminating the need for flap and bone removal [figure 3 A, B].

Figure3. ***A.*** *case of internal resorption of upper right central incisor. Extraction was difficult with periotome technique and was completed with enucleation technique. Buccal bone was preserved.* ***B:*** *Immediate implant placement.*

5.1.3. *Vertical Extraction Technique*

This technique aims at forcing the tooth out of the socket without any manipulation of the surrounding bone. It depends on a pull rope attached to a screw that is inserted in prepared root canal. The tooth is pulled axially. Successful extraction was noted in 87% of the time. This would avoid flap elevation and bone removal [12, 13]. Teeth with RCT were the most common cause of failure and surgical extraction is needed to continue the procedure. In addition, vertical extraction technique is not recommended for multirooted or severely curved roots.

5.1.4. *Elastic Band Technique*

This technique was developed to avoid traumatic extraction in bisphosphonate treated patients [14]. The risk of osteonecrosis of jaw in bisphosphonate-treated patient is about 80%. In case of unavoidable extraction, minimizing extraction is a prime goal. With the use of orthodontic elastic bands placed serially each week, a gradual exfoliative movement is initiated by the principle of inclined plane as the bands slip from wide to narrow parts of the root. In addition, the presence of elastic band in the crevice of the tooth initiates chronic inflammatory reaction causing granulation tissue to form all around the tooth. This provides a protective layer over bone after the tooth is lost. Mean time needed for this procedure is about 6 weeks.

5.2. Post Extraction Procedures

After the tooth is extracted from the socket, several points should be kept in mind. The socket should be inspected carefully with copious irrigation, light and suction. Foreign bodies, like tooth fragment or piece of calculus, may act as a nidus of infection or delays healing, hence, should be removed. In addition, sinus communication may be identified and addressed immediately. Copious irrigation has also been found to be inversely proportional to the incidence of dry socket [15]. Other than removing foreign bodies, irrigation may help dilute the local fibrinolytic enzymes.

Usually during the evaluation, the presence of periapical cyst or granuloma is identified. Dental extraction is therefore a means of access to such pathology. Failure to address pathology has its consequences which includes the persistent or larger residual cyst or metaplasia to odontogenic keratocyst or ameloblastoma. Ensure removal of these pathologic lesions by curettage. Curettage also removes old PDL and encourages bleeding from surrounding bone. This helps increase blood supply to the socket and enhances healing by regional acceleratory phenomena. Sharp bone edges should be smoothened to prevent future mucosal tenderness and laceration. Achieve hemostasis by applying finger pressure over well-adapted gauze placed on top of the socket. Keep pressure for about 5 minutes. Achieving hemostasis is critical for subsequent healing process [16].

6. POSTOPERATIVE CARE

Postoperative care aim at enhancing the healing process, reducing the chances of complications and reducing chances of pain and discomfort. One important concept of uneventful healing is the formation and maintenance of stable clot. Normal bleeding time is about 5 minutes (range

2-9 minutes) during which primary and secondary hemostasis is achieved. Trapped platelets in the formed clot along with white blood cells contain many cytokines and growth factors that are essential for healing.

Common advice includes biting over a folded gauze for 15 min. The gauze should be wet and the patient should be taught how to apply and remove it correctly. Apply cold pack on the skin overlying the area of extraction. Cold temperature causes vasoconstriction which is needed in the first hours to reduce bleeding and edema. Cold pack should not continue beyond the 48 hr., the time at which postoperative edema peaks. Warm packs help resolve edema after it occurs.

Medications prescribed are usually paracetamol or anti-inflammatory agent. Pain may be worst the evening of the procedure after which it gradually decreases [8]. Antibiotic prescription may be indicated in frankly infected cases and in immunocompromised patients. The procedure of extraction by itself doesn't need antibiotic prophylaxis if strict surgical aseptic techniques are adhered to.

The patient should be informed about the postoperative expectations and what to do in case unexpected events (e.g. dry socket, bleeding) occur. Printed copy of the post extraction instructions should be supplied.

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