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Review Article

Hemodynamic Responses to Different Tooth Extraction Techniques

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Abstract: ***Background:*** Exodontia, or the removal of teeth, is not only a routine dental procedure but also a significant event that interacts with the cardiovascular system. Stress, anxiety, and pain associated with tooth extraction can lead to fluctuations in blood pressure and heart rate, especially in patients with pre-existing conditions. The role of local anesthesia, the psychological state of the patient, and procedural factors are all critical in understanding these physiological changes. Research indicates a transient elevation in blood pressure and heart rate during exodontia, predominantly due to stress-induced activation of the sympathetic nervous system. This review aims to analyze the existing literature on the interplay between dental procedures and cardiovascular responses, highlighting factors that exacerbate or mitigate these effects. ***Conclusions:*** Effective management strategies for anxiety and pain, such as pharmacological interventions and patient preparation, are essential for minimizing risks during such procedures. Understanding these dynamics is vital for ensuring patient safety and improving outcomes in dental practice.

Keywords: Exodontia, Cardiovascular Response, Anxiety, Stress, Blood Pressure, Heart Rate.

1. INTRODUCTION

One of the fundamental oral surgical techniques is tooth extraction, which is frequently carried out when the teeth are irreparable. Tooth extraction is the most common procedure in oral surgery and can be done for a number of reasons, such as periodontitis, dental caries, excess or misaligned teeth, orthodontic treatment, non-restorable teeth, and more. The goal is to extract the tooth or its roots from its socket as completely as possible while minimizing discomfort and harm to the surrounding soft tissues [1]. In addition to being one of the most popular surgical procedures in the world, tooth extractions may also be the most straightforward and technically complex. Additionally, it has a major impact on oral health, frequently necessitating restorative procedures to replace the lost tooth. A tooth extraction is a dental procedure when the tooth is completely removed from its socket. This is commonly referred to as "Extraction" a tooth [2].

The first documented mention of tooth extraction techniques can be found in the 47 AD book De Medicina, written by the Romanian encyclopedist Antonius Cornelius Celsus. Safety precautions are necessary because tooth extraction is one of the most frequent and delicate dental procedures. Consequently, wrong-site tooth extraction (WSTE) is the most common serious patient safety occurrence in the National Health Service (NHS). The safety checklist is a useful tool for improving patient safety and lowering the risk of WSTE. These checklists help people remember crucial information and simplify record-keeping procedures. But for checklists to be useful, they must be utilized properly [3].

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Before choosing to extract a tooth, a comprehensive examination of the teeth is essential because it enables a precise diagnosis and the creation of an effective treatment strategy. For example, in orthodontics, it is critical to evaluate the patient's skeletal, facial, and dental features in order to guarantee an accurate diagnosis and a successful course of treatment. Following extraction, there is a defect in the bone tissue that causes remodeling and a decrease in volume in different directions [3].

1.1 Tooth extraction techniques

The tooth or remaining root should be completely extracted with the least amount of discomfort and tissue damage possible. Numerous anatomical and clinical aspects, including as the tooth's shape and condition, the thickness of the bone cortex in relation to the lower tooth canal, the degree of impaction, and the need for an osteotomy or flap, all affect how complicated the surgery is. Finding the safest and most efficient extraction technique is a major challenge for dentists. The results of the procedure are directly impacted by the tools and methods used. A simple extraction might become complicated due to poor method or tool selection, raising the possibility of complications [4].
Tooth extraction techniques include basically 2 types:

1-Simple tooth extraction:

A. Indications: The bone socket needs to be gradually enlarged in order to provide enough mobility for the tooth to be extracted from the jaw without the need for surgery. This technique is frequently applied to teeth that have received endodontic therapy, which makes them more difficult to extract, as well as teeth that are significantly damaged or substantially carious. Simple extraction is also suggested in cases of advanced marginal periodontitis, particularly for teeth with considerable movement or exposed furcation. In cases of dental crowding, hyperdontia, and when a tooth cannot be preserved because of damage, like a longitudinal fracture, it is also done for orthodontic purposes [5].

B. Contraindications: The risk of complications during tooth extraction is increased by certain systemic conditions. Adverse events are more likely to occur in patients with cardiovascular diseases, blood clotting disorders, or neurological impairments. Similarly, individuals with liver diseases, such as cirrhosis, have an increased risk of hemorrhage [5]. Local contraindications also exist, particularly when a malignant tumor is associated with a tooth. In such cases, extraction is usually necessary due to periodontal tissue deterioration, which causes tooth mobility. However, extraction should be avoided unless performed under strict supervision, as it may facilitate the spread of cancerous cells into the capillaries, potentially accelerating tumor progression. Therefore, extractions in these cases should only be performed while the underlying pathology is controlled [5].

C. Procedure: The extraction process begins with loosening the periodontal fibers using an elevator. The tooth is then mobilized within the alveolus by applying larger elevators. Once the elevator contacts the alveolar limbus, it should be rotated with mild, controlled force. If forceps are needed, they are selected based on the tooth's root anatomy and applied along its longitudinal axis. The forceps are positioned as low as possible beneath the cementoenamel junction, followed by controlled tilting and rotational movements to sever the periodontal fibers and expand the alveolus as seen in figure 1. Atraumatic extraction is achieved by initially loosening the tooth with rotational movements, then tilting it lingually and buccally before complete removal [6].

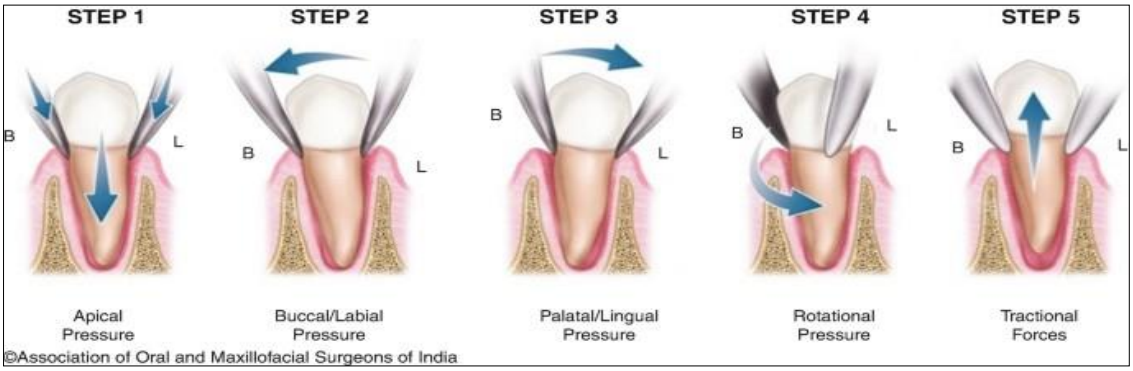

Figure 1: Sequential motions performed using forceps [7]

2. Surgical tooth extraction

A. Indications: A surgical extraction is necessary when a tooth cannot be removed using forceps or elevators, often due to impaction, misalignment, or both. These cases frequently involve persistent residual roots or ankylosed roots that fracture upon crown removal. Additionally, multi-rooted teeth with diverging roots, particularly in the upper first molar region, may require surgical intervention [8].

B. Contraindications: Absolute contraindications stem primarily from the patient's medical history, such as chemotherapy or severe systemic conditions that impair cooperation. Temporary contraindications include short-term

triple anticoagulant therapy, which may later transition to dual or monotherapy. Acute infections, such as pericoronal infections, also present a temporary contraindication. In such cases, initial management with drainage, mechanical cleaning, or disinfectant rinses is recommended to control inflammation before proceeding with surgical extraction [7].

C. Procedure: The surgical extraction of single-rooted teeth has traditionally involved cutting the buccal bone wall and performing a vestibular mucoperiosteal flap as seen in figure 2. However, due to the susceptibility of the buccal wall to resorption, modern approaches aim to preserve it by avoiding mucoperiosteal flap formation whenever possible. Instead, targeted root separation and minimal alveolar bone incision are performed to facilitate elevator access. The procedure begins with crown removal at the gingival level, often using a diamond bur, followed by root division and elevation for extraction [9]. For multi-rooted teeth, forceps should not be applied without first separating the roots to prevent severe bone abnormalities. Similar to single-rooted teeth, the crown is initially removed using a diamond bur, and roots are individually identified based on their orientation and number. Each root is then mobilized separately with an elevator, prioritizing the preservation of the buccal wall. The first root should be extracted to create space for mobilizing the remaining root(s). For impacted teeth, a mucoperiosteal flap is often unavoidable. The choice of incision should allow for adequate flap expansion while minimizing trauma. Flapless extraction techniques are preferred whenever possible, as they result in less crestal bone loss compared to open flap techniques. Additionally, flapless procedures reduce the risk of periosteal injury and help maintain blood supply to the buccal plate, contributing to better post-extraction healing [9].

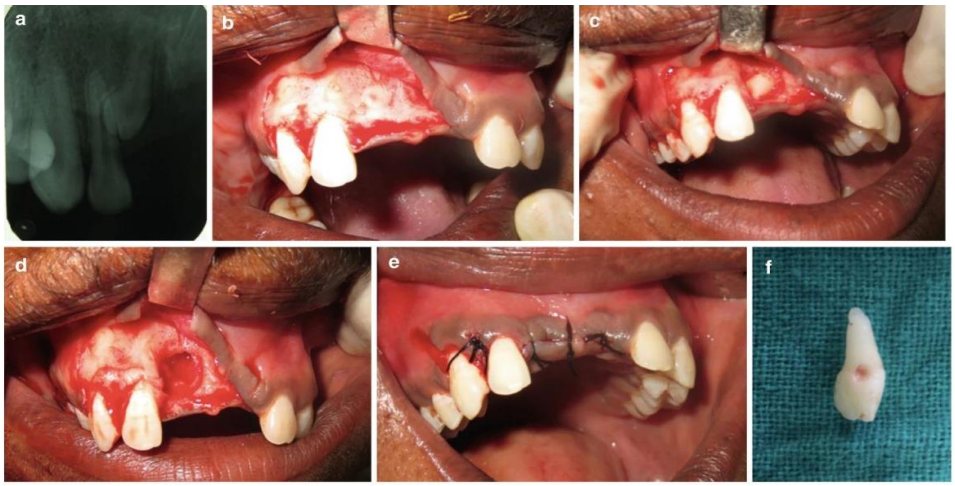

Figure 2: Transalveolar extraction of impacted tooth: (a) A raidograph showing impacted tooth, (b) Incision and flap reflection (Triangular flap), (c) Bone removal, (d) Extraction socket (e) Closure, (f) Extracted tooth. [7].

3. Minimally invasive extraction system

Atraumatic extraction can still be performed using traditional methods such as elevators and forceps; however, these techniques often lead to sudden complications during the procedure. The Benex extraction system provides an alternative by enabling tooth removal in a vertical direction, where resistance is minimal. This approach helps preserve the alveolar bone and surrounding soft tissues, minimizing trauma [10].

By reducing osteoblast cell loss and preventing sudden injuries or lacerations, the Benex system enhances bone preservation. This ensures that an adequate amount of tissue remains for initiating the healing process, allowing for an uninterrupted and complete natural healing response with long-term stability as seen in figure 3[11].

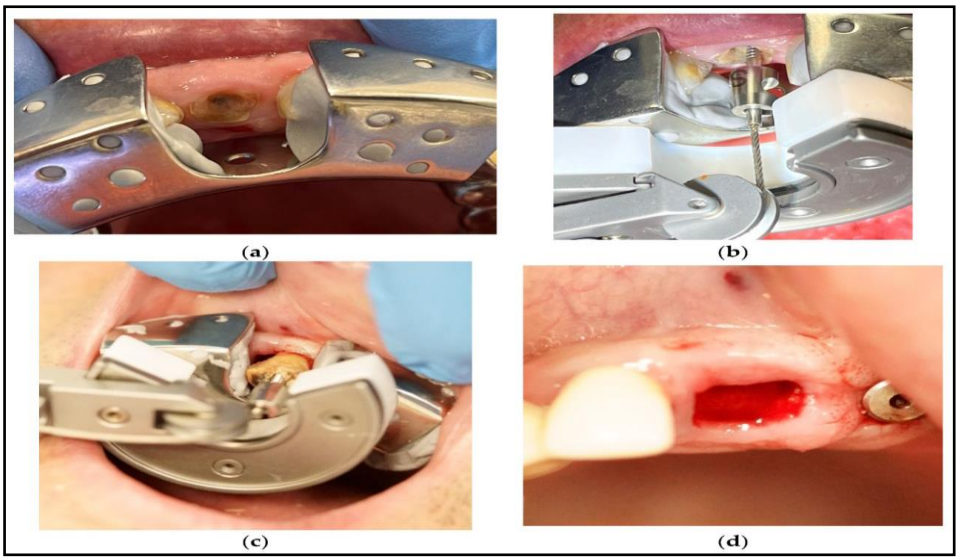

Figure 3: Benex tooth extraction: (a) Impression and positioning of the impression tray, (b) Assembled Benex extractor, (c) Tooth extraction process, (d) Final socket extraction wound [12]

1.2 Tooth extraction complications

Tooth extractions are generally considered safe procedures; however, several post-extraction complications may arise due to factors related to the patient, the tooth, or the practitioner [13].

1-Infection

One of the most common complications, post-extraction infection, is influenced by oral bacteria, surgical manipulation, and inadequate postoperative care. Symptoms include fever, pus, redness, bad breath, swelling, and persistent pain. Severe cases may lead to systemic infections requiring antibiotics, abscess drainage, local cleansing, or further surgical intervention [13].

2-Healing Problems

Delayed healing can be life-threatening and is influenced by systemic conditions like diabetes, immune deficiencies, infections, trauma during extraction, smoking, and poor oral hygiene. Such factors hinder blood clot formation, which is crucial for healing. Management includes prescribed medications to prevent infections and strict postoperative care instructions emphasizing oral hygiene and avoiding harmful habits like smoking [13].

3-Excessive Hemorrhage

While mild bleeding is normal, excessive bleeding can indicate complications. Research by Herrera Barraza et al. reported a 0.1% bleeding rate in healthy individuals compared to 21.8% in patients on anticoagulants. This highlights the need for close coordination between the dentist and the patient's physician to minimize risks [13].

4-Paresthesia

This condition, characterized by tingling, numbness, or partial loss of sensation, occurs due to sensory nerve damage during extraction. The risk depends on surgical technique, patient anatomy, and tooth position. Despite careful precautions, paresthesia can still occur in some cases [13].

5-Dry Alveolitis (Dry Socket)

This occurs when the bone within the socket remains exposed due to inadequate tissue coverage or loss of the initial blood clot. Management includes socket irrigation with saline or chlorhexidine gluconate to remove debris and applying medicated dressings to promote healing [14].

6-Swelling

Common after extractions and periodontal surgeries, swelling can be minimized with ice therapy during the first 18 hours. If swelling persists beyond three days or worsens, it may indicate an infection requiring dental evaluation [14].

7-Bone Fracture

Alveolar bone fractures can occur post-extraction, typically affecting the vestibular side. This may result from pathological bone changes, root alignment, alveolar morphology, or improper forceps use. Treatment options include autogenous bone grafts, alveolar osteogenic distraction, and motor drill adjustments for sharp bone edges [14].

8-Bone Necrosis

A severe complication involving bone tissue loss due to surgical trauma or poor blood supply. Risk factors include osteomyelitis, osteonecrosis, and radiation therapy. Treatment involves necrotic tissue removal, antibiotic therapy, and bone grafting to promote regeneration [15].

9-Occlusion Problems

Tooth loss can lead to shifting of adjacent teeth, misalignment, and altered bite mechanics, potentially damaging remaining teeth. Severe cases may result in vertical dimension loss, affecting jaw position and leading to symptoms such as dry, chapped lips. Preventative measures include prosthetic replacements to maintain occlusal stability [15].

10-Trismus

Defined as restricted mouth opening, often due to muscular spasms, trismus can occur following oral surgery, especially lower molar extractions. Causes include direct trauma to the temporomandibular joint and inflammation of the masticatory muscles [15].

2. Blood pressure and heart rate

Blood pressure (BP) refers to the force exerted by circulating blood against vessel walls, primarily driven by the heart's pumping action. It is represented as systolic blood pressure (SBP) over diastolic blood pressure (DBP) and measured in kilopascals (kPa) or millimeters of mercury (mmHg). Mean arterial pressure represents the average pressure throughout the cardiac cycle, while pulse pressure is the difference between SBP and DBP [15].

The standard resting BP for adults is 120/80 mmHg (~16 kPa/11 kPa), though global averages have remained around 127/79 mmHg in men and 122/77 mmHg in women since 1975 (39). Hypotension is defined as an SBP below 90/60 mmHg, causing symptoms when oxygen delivery to vital organs becomes insufficient. Management involves placing the patient in a supine position with legs elevated, loosening clothing for ventilation, and administering oxygen at 4–6 L/min [15].

Conversely, hypertension affects over 1 billion people worldwide and is classified as SBP >140 mmHg and/or DBP >90 mmHg. It is termed the "silent killer" due to its asymptomatic damage to target organs (kidney, heart, brain, eyes) before clinical signs appear. Primary hypertension accounts for 90–95% of cases with no identifiable organic cause, while secondary hypertension arises from conditions such as renal diseases, endocrine disorders (Cushing's syndrome, primary aldosteronism), neurological disorders, hypercalcemia, or medication use [16].

BP monitoring is essential in pregnant women, diabetic patients, elderly individuals, and those with autonomic dysfunction, as they are prone to orthostatic hypotension. During surgical procedures, uncontrolled hypertension can lead to significant intraoperative bleeding. It is recommended to continue aspirin and antiplatelet therapy (e.g., rivaroxaban, clopidogrel) during minor surgeries, while vasoconstrictors in local anesthesia help control bleeding. A BP reading of 180/110 mmHg is the absolute limit for dental procedures [17].

Heart rate (HR) is another crucial systemic parameter, indicating overall health. It is measured in beats per minute (bpm), and heart rate variability (HRV) is used to assess stress during dental procedures. A resting HR of 60–100 bpm is considered normal, but during dental procedures, BP and HR tend to rise due to stress, pain, and catecholamines in local anesthetics. A preoperative SBP and DBP were significantly higher than postoperative values, highlighting a strong correlation between BP and HR [17].

2.1 Changes in BP and HR in patient undergoing tooth extraction

A comprehensive patient history is essential, including family history of cardiovascular disease, hypertension, medication use, duration of antihypertensive treatment, and severity of the condition. Blood pressure (BP) assessment before dental treatment allows the identification of underlying organ conditions and necessary adjustments to the procedure [18]. Pain, stress, and personal factors such as age, previous traumatic dental experiences, psychological reactions, poor eating habits, a sedentary lifestyle, and tobacco use contribute to BP fluctuations. Many patients undergoing dental procedures experience elevated BP due to stress and anxiety [19]. Local anesthetics, particularly those combined with vasoconstrictors, are a concern in hypertensive patients, as they may further increase BP and pose a risk of hypertensive strokes. Despite their effectiveness in improving pain management, vasoconstrictors should be used cautiously. The safest recommended dose for hypertensive patients is two tubes of 2% lidocaine with epinephrine at 1:100,000, though adherence to maximum dosage guidelines is crucial to ensure patient safety [20]. Anxiety and fear before dental procedures significantly impact BP and heart rate (HR). Studies suggest a strong correlation between anxiety levels and the amount of information provided to patients, indicating that adequate preoperative education can help reduce anxiety. Previous dental experiences were the only personal factor significantly linked to patient anxiety. Additionally, procedure length and complexity influence heart rate variability -measured stress levels. Significant increases in SBP and HR occur following the administration of local anesthetics and tooth extraction, with peak SBP levels much higher during treatment compared

to baseline. Older and middle-aged patients exhibit greater BP elevations post-surgery, highlighting the role of age in stress responses to dental procedures. The physiological effects of anxiety on BP are well-documented, as stress triggers the release of catecholamines (from the sympathetic nervous system and adrenal medulla) and glucocorticoids (from the adrenal cortex). These mediators induce adaptive cellular responses essential for organ protection and survival. The endogenous release of adrenaline stimulates the central nervous system, further elevating BP during local anesthetic administration and contributing to the overall cardiovascular response [21].

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