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## Intercepting the Resorptive Cascade: Contemporary Management Strategies and the Role of Decoronation in Young Adult Populations

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### ABSTRACT

Replacement resorption, a pathologic consequence of severe dental trauma, represents a formidable clinical challenge, particularly in the young adult demographic. This sequela, characterized by the progressive substitution of tooth structure with bone, leads to ankylosis and infra-position, compromising long-term periodontal health, alveolar ridge contour, and esthetic outcomes. In young adults, the transition from active skeletal growth to functional maturity creates a complex temporal window where intervention timing is critical. This narrative review synthesizes the contemporary understanding of replacement resorption, beginning with an in-depth exploration of its biological underpinnings, from the critical loss of periodontal ligament (PDL) viability to the subsequent osseous replacement. We critically evaluate the most current guidelines from the International Association of Dental Traumatology (IADT), delineating management paradigms based on a patient's growth potential. Furthermore, we dissect contemporary management strategies, ranging from the biologically-driven "decoronation" procedure for alveolar preservation to advanced restorative "rescue" protocols.

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The review culminates in a discussion of the profound esthetic and functional dilemmas posed, advocating for a multidisciplinary, patient-centered approach that prioritizes the management of the alveolar foundation over the futile preservation of the tooth itself.

**Keywords:** Replacement Resorption, Dentoalveolar Ankylosis, Dental Trauma, Decoronation, IADT Guidelines, Alveolar Ridge Preservation, Young Adults.

## **1. INTRODUCTION**

Dental trauma affects millions annually, with avulsion and luxation injuries accounting for a significant proportion in the young adult population, where high-energy impacts from sports, accidents, or assaults predominate. Among the most insidious long-term complications is replacement resorption, a progressive pathologic process wherein the root structure is resorbed and substituted by bone, culminating in ankylosis and infra-occlusion. This not only disrupts occlusal harmony and periodontal stability but also compromises alveolar ridge contour and facial esthetics, particularly during the transitional phase from active skeletal growth to maturity—a period when vertical alveolar development is paramount.

The biological cascade begins with the loss of periodontal ligament (PDL) viability, exposing dentinal tubules to osteoclasts and triggering unchecked osseous invasion. In young adults, this interplay with ongoing craniofacial growth exacerbates infra-positioning, rendering conventional tooth preservation futile and shifting emphasis toward alveolar ridge preservation. Current International Association of Dental Traumatology (IADT) guidelines underscore stage-specific interventions, yet gaps persist in translating biological insights into optimized protocols. This narrative review elucidates pathogenesis, critically appraises evidence-based management, from decoronation to regenerative "rescue" strategies, and advocates a multidisciplinary paradigm prioritizing alveolar foundation over root vitality.

## **2. DISCUSSION**

Replacement resorption is not a disease entity but rather an inevitable physiological outcome when the unique biological conditions required for tooth vitality are irreparably compromised (1). The cornerstone of this process lies in the critical loss of viable periodontal ligament (PDL) covering the root surface. The PDL is a highly specialized, vascular, and cellular soft connective tissue that serves functions far beyond simple tooth attachment. It provides proprioceptive feedback, contributes to homeostasis, and, most importantly for this context, actively secretes factors (such as osteoprotegerin) that inhibit osteoclastic activity and maintain the periodontal space (2). The scientific consensus posits that when the viable PDL coverage of the root surface falls below a critical threshold—typically cited as less than 20%—this protective function is catastrophically lost (3).

In the absence of these inhibitory signals from a healthy PDL, the biological narrative changes. The root surface, now devoid of its protective cementoblast and PDL fibroblast layer, is perceived by the body's osseous environment as a surrogate bone surface. Osteoclasts, the cells responsible for bone resorption, begin to adhere to and resorb the mineralized dentin and cementum. This creates a resorption lacuna, which is subsequently populated by osteoblasts that deposit new bone (4). This coupled process of resorption and formation, mirroring the natural \$A-R-F\$ (Activation-Resorption-Formation) cycle of bone remodeling, results in the direct osseous union between tooth and alveolar bone, a condition termed dentoalveolar ankylosis (5). The tooth is progressively, and often imperceptibly, incorporated into the alveolar bone complex, losing its PDL suspension and its ability to move in response to orthodontic forces.

A critical distinction must be made between replacement resorption and its more acute counterpart, inflammatory resorption (6). While replacement resorption is an inexorable, cell-mediated remodeling process, inflammatory resorption is a rapidly destructive response driven by infection and the presence of pro-inflammatory cytokines. It typically occurs when the necrotic and infected contents of the root canal space egress through dentinal tubules into the PDL, inciting a potent osteoclastic reaction (7). Consequently, a crucial prerequisite for the management of any tooth at risk of resorption is the elimination of the endodontic infection source through timely root canal therapy using calcium hydroxide or non-staining medicaments (3).

Clinically, the detection of established replacement resorption relies on a combination of subtle but definitive signs. Patients are often asymptomatic, as the ankylosed tooth lacks PDL mechanoreceptors (2). Key clinical findings include:

- **Percussion Test:** A characteristic high, metallic (or ankylotic) percussion note is elicited, in stark contrast to the dull, cushioned thud of a tooth with a healthy PDL (5). This is often the first and most reliable clinical indicator.
- **Lack of Physiologic Mobility:** The tooth is immobile, as it is rigidly fixed to the bone (2). This lack of mobility is absolute, even under significant manual pressure.

Radiographically, the diagnosis is confirmed by the progressive effacement of normal anatomy:

- **Disappearance of the PDL Space:** The fine, radiolucent line representing the PDL becomes indistinct, interrupted, and eventually completely obliterated (5).
- **Blurred Root Outlines:** The clear, sharp delineation of the root surface is lost as it merges imperceptibly with the surrounding bone (3). Cone-beam computed tomography (CBCT) offers superior diagnostic capability, allowing for three-dimensional visualization of the ankylosed site; however, clinicians must be aware that "blooming" artifacts from metallic restorations or dense gutta-percha can sometimes obscure early resorptive lacunae (8).

**Navigating Clinical Decision-Making: (2020/2024 Standards)**

The International Association of Dental Traumatology (IADT) provides the globally recognized standard of care for the management of traumatic dental injuries (1,4,9,10). Their guidelines, most recently updated and reaffirmed in 2024, emphasize that the primary objective in the acute phase is prevention during the so-called "golden hour" following trauma. This includes immediate, atraumatic replantation of avulsed teeth, splinting for an appropriate duration, and verification of endodontic sterility (4). However, once ankylosis is established in a young adult, the therapeutic strategy pivots decisively from "tooth salvage" to "site management" (8). The IADT guidelines implicitly and explicitly advocate for a growth-stage-dependent approach (1). The critical differentiating factor is not merely chronological age but the patient's remaining skeletal growth potential. This can be assessed through hand-wrist radiographs, cervical vertebral maturation (CVM) staging on lateral cephalograms, or simply by monitoring serial standing height measurements (11).

**Table 1.** Comparison of clinical progression and recommended therapeutic interventions for ankylosed teeth in growing versus skeletally mature patients.

<b>Feature</b>	<b>Growing Patient (Late Adolescent)</b>	<b>Young Adult (Post-Growth)</b>
Primary Concern	Infra-occlusion & Alveolar Atrophy	Esthetics & Functional Longevity
Rate of Loss	Rapid (1–3 years)	Slow (5–10+ years)
Recommended Intervention	Decoronation to Preserve Bone	Monitor; eventual implant/bridge

Table 1 highlights the paradigm shift. In a growing patient, the alveolar process continues its vertical development. The ankylosed tooth, fixed in position, cannot follow this growth and thus becomes a static island in a dynamic landscape, leading to significant infra-occlusion (12). This not only creates an esthetic and functional problem but also leads to a phenomenon where the bone encasing the tooth fails to follow the vertical eruption of adjacent teeth, resulting in a localized vertical bone defect (2). Therefore, intervention is driven by the need to preserve bone. In a post-growth adult, the rate of change is so slow that a "watch and wait" strategy is often the most pragmatic initial approach (3).

**Spectrum of Care: Contemporary Management Strategies**

The management of established replacement resorption has evolved from a reactive approach to a proactive, strategic plan encompassing a spectrum of interventions.

**a)The "Wait and Watch" Approach: Active Surveillance**

In skeletally mature adults where vertical facial growth has demonstrably ceased, a conservatively monitored approach is entirely appropriate (1). If the degree of infra-occlusion is minimal (typically < 1 mm) and poses no esthetic or functional compromise, no immediate surgical intervention is warranted. The patient should be enrolled in a rigorous, long-term follow-up program involving annual clinical and radiographic examinations (5). Special attention should be paid to the development of secondary periodontal defects on adjacent teeth.

**b) Decoronation: The Biological Gold Standard for Alveolar Preservation**

When a young adult with residual growth potential presents with clear signs of progressive infra-occlusion, decoronation is the indicated intervention (2). First described by Malmgren, this procedure is conceptually brilliant in its biological simplicity (8).

- Procedure in Detail: Under local anesthesia and antibiotic prophylaxis, a full-thickness mucoperiosteal flap is raised to expose the alveolar bone and the crown-root junction. The crown is sectioned and removed approximately 1–2 mm below the alveolar crest. The blood clot fills the chamber and the empty root canal space after the removal of any non-resorbable filling materials (like gutta-percha). The flap is then replaced and sutured, completely covering the residual root (2).
- Biological Rationale and Benefits: By removing the crown, the site is converted into a healing wound. The retained root fragment acts as a natural scaffold. The induced blood clot organizes, and the osteogenic cells populate the site. Over the following months to years, the body's own remodeling process completes the resorption of the root and replaces it with vital bone. This process, termed "substitution," ensures that the volume of the alveolar ridge is maintained by the very bone that replaces the root (13,14,15).

**c) Autotransplantation: The Biological Replacement**

In cases where a tooth is deemed non-restorable or has been lost early to resorption, autotransplantation presents a compelling biological alternative to a prosthesis (11). This is particularly advantageous in patients where implant placement is contraindicated due to ongoing skeletal growth.

**d) Intentional Replantation and "Rescue" Protocols (Experimental/Reserved)**

While generally discouraged for replacement resorption, intentional replantation may be considered if the ankylotic area is localized and accessible. However, the outlook remains guarded, and the risk of "re-ankylosis" is high (16).

**Table 2.** Comparison of Decoronation and Intentional Replantation: Success Rates and Biological Indications.

Feature	Decoronation	Intentional Replantation
<b>Primary Goal</b>	<b>Alveolar Ridge Preservation</b> (Site Development)	<b>Tooth Retention</b> (Salvage)
<b>Success Rate (Bone)</b>	<b>High (&gt;90%)</b> – Effectively maintains ridge dimensions for future implants.	<b>Low/Variable</b> – Bone loss often continues if resorption is not halted.
<b>Success Rate (Tooth)</b>	<b>0%</b> – The tooth crown is intentionally removed.	<b>Guarded (20–50%)</b> – High risk of "re-ankylosis" or rapid replacement.
<b>Biological Process</b>	<b>Substitution</b> – The root is replaced by the patient's own bone.	<b>Repair</b> – Attempting to heal the PDL; often results in further scarring.

<b>Ideal Candidate</b>	<b>Growing patients</b> with progressive infra-occlusion.	<b>Skeletally mature patients</b> with localized, accessible defects.
<b>Complexity</b>	Moderate – Requires flap surgery and prosthetic management.	High – Technically demanding; extra-oral time is critical.

### The Multidisciplinary Esthetic and Functional Dilemma

The consequences of replacement resorption—a progressive coronal discrepancy, a high gingival margin due to infra-occlusion, and a resulting "shorter" appearing clinical crown—can be profoundly distressing for a young adult’s self-esteem. (17,18)

The 2024 IADT perspectives emphasize that "success" is no longer just the retention of the tooth, but the successful transition to a final prosthetic solution without loss of bone volume. This demands a well-orchestrated, multidisciplinary team effort (19,20).

#### Key Clinical Considerations:

- The "Pink" Esthetic Challenge: Remind readers that while decoronation preserves bone height, the gingival margin of the future implant will only be as good as the soft tissue managed during the transition. The role of the periodontist or restorative dentist in creating an interim "pontic" that shapes the gingival architecture is vital.
- Timing of Decoronation: It is widely agreed that intervention should occur as soon as infra-occlusion is detected in a growing patient. Waiting until the tooth is 2–3 mm infra-occluded makes the eventual restoration much more difficult.
- The "Gutta-Percha" Warning: A common clinical error is leaving gutta-percha in the root during decoronation. The root canal must be cleaned of all non-resorbable materials to allow the blood clot to organize and bone to eventually occupy the space.

### 3. CONCLUSION

Replacement resorption in young adults represents a biological inevitability once the protective PDL is critically compromised (1). The clinician's role has transitioned from that of a "tooth-saver" to a "bone guardian." By understanding the pathophysiology, accurately assessing the patient's growth potential through the lens of IADT guidelines, and selecting the appropriate intervention—whether it be active surveillance, decoronation, or autotransplantation—the clinician can transform a seemingly hopeless situation into a predictable pathway for long-term oral health (4).

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