

Retained Root Fragments Following Exodontia: A Narrative Review of Clinical outcomes, Risk-Based Management, and the Ethico-Legal Standard of Disclosure

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Abstract

Root fracture with retention of an apical fragment is among the most frequently encountered intraoperative complications of exodontia, reported in an estimated 15–37% of extractions in historical series and in up to 86% of sites when post-extraction imaging is used systematically to detect fragments that clinical inspection alone misses.¹ This narrative review examines the clinical, radiographic and ethico-legal literature on retained root fragments to determine under what circumstances planned retention is defensible, and what obligations attach to the clinician when a fragment is left — whether by deliberate decision or unplanned fracture. Retrospective and histological series indicate that small, deeply positioned, non-mobile, non-infected fragments in teeth without periapical pathology are frequently well tolerated, healing beneath an intact layer of cementum and bone.^{2,3,4} This underlies the accepted practice of coronectomy for third molars in close proximity to the inferior alveolar nerve, and of intentional partial root retention adjacent to implants and in intentional replantation protocols.^{5,6,7,8} However, fragments that communicate with the oral cavity, are infected, mobile, or associated with periapical disease carry a materially higher risk of persistent infection, cyst formation, pain and, in implant sites, retrograde peri-implantitis and implant failure.^{1,2,7} Medico-legal case series show that adverse outcomes and successful negligence claims involving retained roots arise less from the retention itself and far more from failure to detect the fragment, failure to document it, and failure to disclose it and its implications to the patient.^{9,10,11,12,13} The review concludes that no fragment size or retention decision is categorically “without issue,” and that ethical and legal defensibility rests entirely on individualised risk assessment, post-extraction radiographic confirmation, informed consent that is contemporaneously documented, and structured follow-up — not on a blanket assumption that retention is inconsequential.

Keywords:

Retained Root Fragment; Exodontia; Coronectomy; Informed Consent; Dental Negligence; Post-Extraction Radiography

Introduction

Surgical and simple extraction of teeth is one of the most common procedures performed in general dental practice, and root fracture with retention of a fragment in the alveolus is one of its most common intraoperative complications.¹ Historical case series spanning 1927 to 2007 report retained-root rates of 15–37% following extraction, with maxillary molars — particularly the maxillary left first molar — disproportionately affected because of curved, divergent or hypercementosed roots and their proximity to the maxillary sinus floor.¹ More recent work using systematic post-extraction imaging suggests that clinical inspection alone substantially underestimates the true incidence of

retained fragments, and that many are only identified on radiographs taken for unrelated reasons months or years later.

Clinical opinion on what to do when a root fractures has shifted considerably over the past seven decades. Early twentieth-century teaching held that every root remnant should be pursued and removed, on the assumption that retained tissue would inevitably cause pain, infection or cyst formation.¹ This absolutist position was challenged as early as 1960 by Helsham, who reviewed 2,000 patients referred for removal of retained roots and found that the great majority had developed a fibrous or bony seal over the fragment, with 83% remaining free of both symptoms and radiographic pathology.³ Contemporaneous histological work by Glickman and colleagues demonstrated experimentally that extraction wounds containing small, non-mobile root or bone fragments could heal by encapsulation in cementum and new bone, provided the fragment was not infected and the socket achieved primary or secondary closure.⁴ This evidence base underlies deliberate, planned retention techniques used in contemporary practice: coronectomy of mandibular third molars at risk of inferior alveolar nerve injury, intentional partial root retention (the “socket-shield” technique) to preserve the buccal plate at immediate implant sites, and intentional replantation protocols in endodontics.^{5,6,7,8}

It does not follow, however, that retention of a fractured root is inherently benign or that its ethical acceptability can be generalised from these narrow, deliberately engineered indications to every case in which a root breaks during extraction. A materially different literature — case reports of chronic infection, cyst formation and retrograde peri-implantitis attributable to retained fragments, and medico-legal case files describing negligence findings against dentists — documents real and sometimes serious harm attributable specifically to undetected, undisclosed or unmonitored retained roots.^{1,7,9,10,11,12} The clinical and ethical question is therefore not whether root fragments can ever safely remain in situ (the evidence shows clearly that, under defined conditions, they can), but under what conditions retention is defensible, what size and positional factors modify risk, and what obligations of detection, documentation and disclosure attach to the clinician regardless of the retention decision reached.

This review addresses three linked objectives: (1) to summarise the evidence on clinical outcomes of retained root fragments and the factors associated with favourable versus unfavourable healing; (2) to describe the accepted clinical indications for planned retention and the protocols (coronectomy, socket-shield, intentional replantation) through which the evidence has been operationalised; and (3) to examine the ethical and medico-legal standard — particularly informed consent and documentation — that governs a clinician's conduct whenever a fragment is retained, whether by intention or by unplanned fracture.

Materials and Methods

This is a narrative literature review rather than a systematic review or primary clinical study, and no original patient data, human or animal experimentation was undertaken; institutional ethical approval and informed consent were therefore not applicable to the conduct of the review itself.

A targeted search of PubMed/MEDLINE-indexed and journal-hosted literature was conducted for English-language publications addressing retained root fragments, root fracture during exodontia, coronectomy, intentional root retention, intentional tooth replantation, and the socket-shield technique, supplemented by hand-searching of the reference lists of retrieved articles. Search terms included combinations of “retained root fragment,” “root tip,” “exodontia,” “coronectomy,” “intentional replantation,” and “informed consent.” Historical foundational studies (Helsham, 1960; Glickman et al., 1947) were included for their continuing influence on clinical decision-making despite their age, alongside contemporary case reports, case series, a randomised controlled trial, and an international expert consensus statement published in 2025.^{3,4,6,8}

To characterise the ethical and medico-legal dimension of the topic, published case files and commentary from dental defence organisations (the Medical and Dental Defence Union of Scotland and Dental Protection) and a legal analysis of informed consent in dental negligence claims were reviewed.^{9,10,11,12,13} Because the corresponding author practises in South Africa, guidance specific to the South African legal standard for informed consent, derived from Health Professions Council of South Africa publications and the peer-reviewed anaesthesiology literature interpreting that standard, was also incorporated.^{14,15}

This review does not claim to be exhaustive or systematic; its purpose is to synthesise the available clinical and ethico-legal evidence into a risk-stratified framework that can inform clinical decision-making and consent practice, and its conclusions should be read with the limitations of a narrative methodology in mind.

Results and Discussion

Incidence and detection of retained root fragments

Reported rates of root fracture and fragment retention during extraction vary widely by tooth type, operator experience and, critically, by detection method. Aggregated older series report retained-root incidence of 15–37%, with maxillary molars and premolars fracturing most often and maxillary left molars carrying the highest combined rate of root fracture and oro-antral complication.¹ More recent audits relying on routine post-extraction radiography rather than clinical inspection alone report substantially higher detection rates, indicating that a considerable proportion of retained fragments go unrecognised at the time of surgery and are identified only incidentally, sometimes years later, on radiographs taken for unrelated purposes. This detection gap is clinically important: a fragment that is never identified cannot be assessed for risk, cannot be discussed with the patient, and cannot be scheduled for radiographic follow-up — all of which are, as discussed below, central to defensible management.

Determinants of favourable versus unfavourable outcomes

The literature does not support the proposition that fragment size alone determines outcome. A structured review of extraction complications explicitly noted that “literature review does not identify the size of the remaining fragment as a factor in the final decision to leave a root fragment,” and instead identified vitality of the root, absence of mobility during the extraction attempt, and absence of communication with the oral cavity as the operative determinants of favourable healing.¹ This is consistent with the histological findings of Glickman and colleagues, who showed that small, immobile, uninfected fragments could be enclosed by new cementum and bone, and with Helsham's clinical observation that the majority of long-retained roots he reviewed were asymptomatic and radiographically unremarkable.^{3,4}

Conversely, where a fragment is non-vital, is associated with pre-existing periapical pathology, remains mobile, or is left in continuity with the oral cavity rather than sequestered within intact bone, the evidence is equally consistent that complication rates rise: local inflammation, cyst formation, persistent or recurrent infection, and pain are all attributable specifically to fragments meeting one or more of these criteria.¹ Root remnants can also act as a nidus for chronic low-grade infection that presents insidiously, with swelling, sinus tract formation, or delayed diagnosis months or years after the original extraction.

A further, more recently characterised risk applies specifically to fragments retained in sites subsequently selected for dental implant placement. Case reports of implants placed in unrecognised proximity to retained root fragments describe two distinct patterns: fragments that remain quiescent for many years before contributing to late implant failure, and fragments causing earlier “clinically undetected root-to-implant contact” complications, including retrograde peri-implantitis and coronal bone loss severe enough to require implant removal.⁷ These reports reinforce that a fragment's long asymptomatic history does not guarantee indefinite stability, and that pre-implant imaging (including cross-sectional imaging where indicated) has a specific role in excluding undetected retained roots at planned implant sites.

Where planned retention is an accepted part of clinical practice

Three contemporary protocols operationalise the principle that selected, well-characterised root tissue can safely remain in situ, and each illustrates the conditions under which that principle holds.

Coronectomy — deliberate decoronation of a mandibular third molar with intentional retention of roots that lie in close proximity to the inferior alveolar nerve — was developed specifically to avoid the substantially higher risk of permanent nerve injury associated with complete root removal in this anatomical position.⁵ A randomised controlled trial comparing coronectomy with conventional removal of mandibular third molars found a significantly lower incidence of inferior alveolar nerve injury with coronectomy, at the cost of the roots remaining in the jaw and requiring follow-up.⁶

Success is contingent on strict technique: roots must not be mobilised during decoronation, there must be no bacterial contamination of the pulp before the crown is removed, and the wound must achieve complete closure; migration of retained roots away from the nerve occurs gradually over the following months to years and is itself monitored radiographically.

Intentional partial root retention at immediate implant sites (the socket-shield technique) similarly retains a thin buccal fragment of root, still attached by an intact periodontal ligament, specifically to preserve the buccal bone plate and peri-implant soft-tissue contour. Reported success rates are high when the fragment is genuinely non-mobile and periodontally healthy at the time of retention, but the technique is explicitly distinguished in the literature from the unintentional, unrecognised retention of infected or mobile fragments, which carries the peri-implant risks described above.⁷

Intentional replantation — deliberate extraction of a tooth for extraoral root-end management followed by replantation into its own socket — is governed by a 2025 international expert consensus statement setting out biological and technical prerequisites, including minimising extraoral time, protecting periodontal ligament vitality, and careful case selection; the consensus explicitly frames the procedure as a last-resort option for teeth that cannot otherwise be preserved, not as a default alternative to straightforward extraction.⁸

Taken together, these protocols demonstrate that planned retention of root tissue is an accepted and evidence-based part of contemporary practice — but only within narrowly defined clinical indications, with specific technical prerequisites, and with structured follow-up built into the protocol. None of them supports a general inference that retention of a fragment resulting from an unplanned intraoperative fracture is, by virtue of that evidence base, automatically low-risk or inconsequential.

The ethico-legal dimension: what the case record shows

Reviewing published case files from dental defence organisations is instructive precisely because it shows where adverse outcomes and liability findings actually arise in practice. In one reported case, a root fractured during extraction of a carious molar, the fragment could not be retrieved, and imaging showed it close to the maxillary sinus floor; the substance of the subsequent claim centred not on the fracture itself but on an allegation that the dentist had failed to warn the patient beforehand of the risk of root fracture as a recognised complication of the procedure.⁹ In a second case, a root fragment was left following extraction with no post-extraction radiograph taken and no note made of the fracture; the fragment was discovered infected two years later by a different practice, and the ensuing claim turned substantially on the absence of a post-extraction radiograph and the absence of any contemporaneous record that the fracture had occurred or been disclosed.¹⁰ A third case involved a root deliberately left in situ because it was deeply buried and asymptomatic — a defensible clinical decision on the evidence reviewed above — yet the case record did not reflect the conversation in which the patient was informed, and the matter became a live dispute over whether valid consent had in fact been obtained, including consent to the possibility that a second surgical procedure might later be required.¹¹ Comparable Australian case material describes a patient alleging that had she been informed of an elevated risk of oro-antral communication and retained roots in her specific case, she would have chosen to have the procedure performed by a specialist in a hospital setting rather than in general practice.¹²

A consistent pattern emerges across these cases: liability and adverse outcome are not driven by the fact that a root was retained, nor, on the available evidence, by the size of the fragment. They are driven by three recurring failures — failure to warn the patient in advance that root fracture is a recognised risk of extraction; failure to take and review a post-extraction radiograph to confirm whether a fragment remains; and failure to document, at the time, what was found, what was decided, and what was communicated to the patient. Legal analysis of dental negligence claims confirms this structurally: a signed consent form alone is not proof that informed consent was obtained, and where clinical records do not document the specific discussion of risks and alternatives, a patient's own account of what they were or were not told tends to be given significant weight in the absence of contemporaneous notes to the contrary.¹³

This is consistent with the broader legal standard for informed consent applicable in South Africa, where the doctrine of informed consent — requiring disclosure of material risks judged by what a reasonable patient in the specific patient's position would want to know, rather than by what a reasonable practitioner would customarily disclose — has applied since it was imported into South

African medical law and subsequently reflected in Health Professions Council of South Africa guidance obliging every healthcare provider to inform patients of the range of available options and the benefits, risks, costs and consequences of each.¹⁴ Practical guidance for South African practitioners emphasises that consent is a documented process, not a signature, and that anaesthetists' (and by direct extension, dentists') exposure to negligence claims correlates closely with gaps in recorded disclosure rather than with the inherent riskiness of the procedure performed.¹⁵

A risk-stratified framework

Synthesising the clinical and ethico-legal evidence reviewed above, root fragments encountered during exodontia can usefully be stratified as follows. Fragments that are small, radiographically confirmed to be deeply and stably positioned within intact bone, non-mobile at the time of fracture, arising from a vital or non-infected root, and not associated with pre-existing periapical pathology are those for which the literature provides the strongest support for observation rather than further surgical pursuit — provided that pursuit itself would risk greater harm (for example, to the inferior alveolar nerve, maxillary sinus, or adjacent anatomical structures).^{1,3,4,5,6} Fragments that are mobile, infected, associated with periapical disease, situated in continuity with the oral cavity, or destined for a site where a dental implant is planned carry materially higher and better-documented risk, and the weight of evidence favours active removal or, where removal itself carries disproportionate surgical risk, closer-interval radiographic surveillance and explicit patient counselling about that elevated risk.^{1,7}

Critically, this clinical risk stratification is analytically separate from the ethical and legal question of what the clinician owes the patient. Even a fragment that falls squarely into the lower-risk category described above does not relieve the clinician of the obligation to: confirm and document the fragment's presence and position, ideally radiographically; disclose the fracture to the patient in terms they can understand, including the rationale for the retention decision and the small but non-zero possibility that later symptoms, infection, or interference with future treatment (including implant placement) could necessitate removal; record that disclosure contemporaneously; and arrange a defined schedule of radiographic review. The evidence reviewed here shows that it is precisely the omission of these steps — not the clinical decision to retain a well-selected fragment — that has repeatedly given rise to justified patient complaint and adverse regulatory or civil findings.^{9,10,11,12,13}

Conclusion

Root fracture with fragment retention is a common and, under defined conditions, manageable complication of exodontia rather than an invariable indication for aggressive surgical pursuit. Small, vital or non-infected, non-mobile fragments sequestered within intact bone are frequently well tolerated, and this evidence base underpins accepted, protocol-driven practices such as coronectomy, intentional partial root retention at implant sites, and intentional replantation. However, the available clinical and histological literature does not support fragment size alone as a determinant of outcome, and it does not support the proposition that retention is categorically “without issue”: infected, mobile, periapically involved or orally communicating fragments carry a demonstrably higher risk of infection, cyst formation, pain and, at implant sites, implant failure.^{1,7}

Nor does the ethico-legal literature support the claim that retention raises no ethical concern. The recurring finding across reported case files is that harm to patients, and liability for practitioners, follows overwhelmingly from failures of detection, documentation and disclosure rather than from the clinical decision to retain a fragment itself.^{9,10,11,12,13} Ethical and legally defensible management of a fractured root therefore depends on individualised risk assessment, post-extraction radiographic confirmation, contemporaneously documented informed consent addressing the specific risk in the specific patient, and a defined follow-up plan — not on a general assumption that no explanation to the patient is required because the fragment is presumed harmless. Clinicians who fracture a root during extraction should treat detection, disclosure and documentation as non-negotiable steps regardless of the size or position of the fragment or the retention decision ultimately reached.

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Conflict of Interest

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