Patterns and Indications for Orthopaedic Implant Removal: A Retrospective Analysis

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ABSTRACT

In different health care settings, orthopaedic implant removal varies significantly after fracture healing, with limited data from private tertiary care hospitals in South India. The study included patients having fracture fixation after undergoing removal of orthopaedic implants. 285 patients were included (198 males; 87 females). Mean (SD) age was 34.8 (14.2) years. The most common location was tibia and most frequently removed implants were plates and screws. The median time from insertion to removal was 15.8 months. Complications occurred in 28 patients (9.8%).The study revealed contemporary data on implant removal patterns in a private tertiary care setting, highlighting patient preference as the predominant indication. The findings emphasize the need for evidence-based preoperative counselling and individualized decision-making regarding implant retention versus removal.

Keywords: fracture, Implant removal, implant type, fracture fixation

INTRODUCTION

The use of metallic implants for internal fixation has revolutionized fracture management, enabling early mobilization and improved functional outcomes[1]. However, the necessity of removing implant after fracture union remains controversial in orthopaedic practice[2,3]. While implants serve their primary function during bone healing, questions persist regarding their long-term retention, including concerns about stress shielding, hardware prominence, metal sensitivity, and potential complications[4,5].

International practices vary considerably, with European centres reporting routine removal rates of 60% to 80%, while North American surgeons favour selective removal in 30% to 40% of cases[6,7]. These variations reflect differences in healthcare systems, medico legal environments, patient expectations, and cultural attitudes toward retained hardware[8]. In the Indian context, limited data exist regarding implant removal patterns, particularly from private tertiary care institutions where patient autonomy and informed decision-making may influence clinical practice[9].

Instead of following routine removal protocol, recent literature has emphasized the importance of individualized decision-making based on patient age, anatomical location, implant type, and clinical indications[10,11]. However, patient preferences often drive removal decisions despite the absence of compelling medical indications, reflecting anxiety about long-term hardware retention[12].

The following study evaluated the indications, timing, and patterns of orthopaedic implant removal at a private tertiary care academic medical centre over a 3-year period, providing insights into current practice patterns in South India.

METHODS

Study Design and Setting

This retrospective cohort study was conducted at the Department of Orthopaedics, Chettinad Hospital and Research Institute (CHRI), Chennai, Tamil Nadu, India, a 1000-bed private tertiary care teaching hospital. The Institutional Human Ethics Committee approved the study with Ref No: IHEC-I/115/11/2025, and since the study was retrospective in nature, informed consent was not required.

Study Period and Participants

All implant removal procedures performed between January 1, 2022, and December 31, 2024, were reviewed. Patients aged 1 year or older who underwent removal of orthopaedic implants placed for fracture fixation with complete medical records and minimum 3-month follow-up were included. Patients with implant removal for non-fracture indications, incomplete records, or same-day temporary fixator removal were excluded.

Data Collection

Electronic medical records, operation theatre registers, and outpatient clinic records were used to obtain data using a standardized data collection form. Variables included patient demographics, fracture location; implant type, dates of insertion and removal, indication for removal, operative details, and complications.

Statistical Analysis

Descriptive statistics were calculated for all variables. Mean (SD) for normally distributed data and median (IQR) for non-normally distributed data were used as continuous variables. Frequencies and percentages represent categorical variables. Subgroup comparisons were performed using χ^2 test for categorical variables and t test or Mann-Whitney U test for continuous variables. $P < .05$ was used as a statistically significant value. SPSS version 28.0 (IBM Corp) was used to perform data analysis.

RESULTS

Patient Demographics

During the 3-year study period, 285 patients underwent orthopaedic implant removal and met inclusion criteria. The cohort comprised 198 males (69.5%) and 87 females (30.5%), with a male-to-female ratio of 2.28:1. Mean (SD) age was 34.8 (14.2) years (range, 7-68 years). The participants mainly belong to age 16-30 years (118 patients [41.4%]), followed by 31-45 years (89 patients [31.2%]). Paediatric patients (age <16 years) accounted for 19 cases (6.7%). Most of the patients were working in private sector (142 patients [49.8%]), followed by students (67 patients [23.5%]). Insurance coverage included private insurance in 156 patients (54.7%), government insurance schemes in 78 patients (27.4%), and self-payment in 51 patients (17.9%) (Table1).

Table 1- Patient Demographics and Clinical Characteristics (N = 285)

Characteristic	**Value**
Age, mean (SD), y	34.8 (14.2)
Age range, y	7-68
Age distribution, No. (%)	
<16 y (pediatric)	19 (6.7)
16-30 y	118 (41.4)
31-45 y	89 (31.2)
46-60 y	48 (16.8)

>60 y	11 (3.9)
Sex, No. (%)	
Male	198 (69.5)
Female	87 (30.5)
Male-to-female ratio	2.28:1
Occupation, No. (%)	
Private sector employee/self-employed	142 (49.8)
Student	67 (23.5)
Homemaker	48 (16.8)
Government employee	18 (6.3)
Retired	10 (3.5)
Insurance status, No. (%)	
Private insurance	156 (54.7)
Government insurance schemes	78 (27.4)
Self-pay	51 (17.9)
Extremity involved, No. (%)	
Lower extremity	189 (66.3)
Upper extremity	96 (33.7)

Anatomical Distribution

The lower extremity accounted for 189 cases (66.3%), and the upper extremity for 96 cases (33.7%). The tibia was the most frequently involved bone (92 cases [32.3%]), followed by the femur (68 cases [23.9%]), radius and ulna (54 cases [18.9%]), humerus (38 cases [13.3%]), and fibula (21 cases [7.4%]). When analyzed by specific anatomical region, the distal tibia/ankle was the most common location (48 cases [16.8%]), followed by the femoral shaft (36 cases [12.6%]) and forearm (32 cases [11.2%]) (Table 2)

Table 2- Anatomical Distribution of Implant Removal (N = 285)

Anatomical Location	**No. (%)**
By bone	
Tibia	92 (32.3)
Femur	68 (23.9)
Radius and ulna	54 (18.9)
Humerus	38 (13.3)
Fibula	21 (7.4)
Other (clavicle, hand, foot, pelvis)	12 (4.2)
By specific region	
Distal tibia/ankle	48 (16.8)
Femoral shaft	36 (12.6)
Forearm (both bones)	32 (11.2)
Tibial shaft	28 (9.8)
Distal radius	26 (9.1)
Proximal femur	24 (8.4)
Distal femur	18 (6.3)
Humeral shaft	16 (5.6)
Proximal tibia	14 (4.9)
Proximal humerus	12 (4.2)
Clavicle	8 (2.8)
Other	23 (8.1)

Implant Types

Most removed implants belong to plates and screws (124 patients [43.5%]), intramedullary nails (78 patients [27.4%]), isolated screws (48 patients [16.8%]), Kirschner wires (22 patients [7.7%]), tension band wiring (9 patients [3.2%]), and external fixators (4 patients [1.4%]). Among plate constructs, locking compression plates were most common (87 cases [70.2% of plates]), followed by dynamic compression plates (24 cases [19.4%]) and anatomically contoured plates (13 cases [10.5%]).

Indications for Removal

Most commonly removed implants were on patients request (96 patients [33.7%]), followed by prominent/symptomatic hardware (78 patients [27.4%]), surgeon recommendation (62 patients [21.8%]), infection (38 patients [13.3%]), and implant failure (11 patients [3.9%]). Among patient-requested removals, concerns about long-term implant retention accounted for 42 cases (43.8%), discomfort with retained hardware for 28 cases (29.2%), cultural or religious reasons for 14 cases (14.6%), and travel-related concerns for 12 cases (12.5%). Prominent hardware cases included soft tissue irritation (38 cases [48.7%]), pain with activity (26 cases [33.3%]), limitation of motion (10 cases [12.8%]), and cosmetic concerns (4 cases [5.1%]). Surgeon recommendation was most common in young active adults (32 cases [51.6%]), pediatric patients (15 cases [24.2%]), and prophylactic removal in high-risk sites (15 cases [24.2%]) (Table 3).

Table 3- Indications for Implant Removal and Subcategories (N = 285)

Indication	**No. (%)**	**Subcategory Details**	**No. (%)**
Patient request	**96 (33.7)**	Concerns about long-term retention	42 (43.8)
		Discomfort with retained hardware	28 (29.2)
		Cultural/religious reasons	14 (14.6)

		Travel/airport security concerns	12 (12.5)
Prominent/symptomatic hardware	**78 (27.4)**	Soft tissue irritation	38 (48.7)
		Pain with activity	26 (33.3)
		Limitation of motion	10 (12.8)
		Cosmetic concerns	4 (5.1)
Surgeon recommendation	**62 (21.8)**	Young active adults	32 (51.6)
		Pediatric/adolescent patients	15 (24.2)
		Prophylactic removal	15 (24.2)
Infection	**38 (13.3)**	Acute postoperative (≤3 mo)	14 (36.8)
		Chronic (>3 mo)	18 (47.4)
		Late-onset (>12 mo)	6 (15.8)
Implant failure	**11 (3.9)**	Screw breakage	5 (45.5)
		Plate fracture	3 (27.3)
		Implant loosening	2 (18.2)
		Nail migration	1 (9.1)

Anatomical Location and Indication Correlation

Prominent hardware was significantly more common in superficial locations such as the distal tibia/ankle (45.8%), clavicle (58.3%), and distal radius (38.5%) compared with deeper locations such as the femoral shaft (8.3%) ($P < .001$). Patient request was more common in upper extremity removals (42.7%) compared with lower extremity removals (29.1%) ($P = .021$).

Timing of Removal

The median time from implant insertion to removal was 15.8 months (IQR, 11.2-24.6 months; range, 2.5-62.3 months). Early removal (less than 12 months) occurred in 110 patients (38.6%). The distribution included 42 patients (14.7%) within 6 months, 68 patients (23.9%) between 6-12 months, 132 patients (46.3%) between 12-24 months, and 43 patients (15.1%) after 24 months. Early removal was significantly more common in cases of infection (32 of 38 cases [84.2%]) and implant failure (9 of 11 cases [81.8%]) compared with elective removals (69 of 236 cases [29.2%]) ($P < .001$). The mean time to removal varied significantly by indication: infection (6.8 ± 4.2 months), implant failure (8.2 ± 5.6 months), prominent hardware (14.6 ± 7.8 months), surgeon recommendation (16.2 ± 6.4 months), and patient request (18.4 ± 9.2 months) ($P < .001$). Pediatric patients implants were removed earlier (median, 13.2 months) when compared with adult patients (median, 16.4 months) ($P = .028$).

Operative Details

Mean (SD) operative time for implant removal was 52.4 (22.8) minutes (range, 15-145 minutes). Operative time varied significantly by implant type: plates and screws (64.2 ± 24.6 minutes), intramedullary nails (58.8 ± 26.4 minutes), isolated screws (32.4 ± 14.2 minutes), and Kirschner wires or tension bands (24.6 ± 10.8 minutes) ($P < .001$). The majority of procedures (218 cases [76.5%]) were carried out using regional anesthesia, while 67 cases (23.5%) required general anesthesia.

Complications

Perioperative and postoperative complications occurred in 28 patients (9.8%). Intraoperative complications (14 cases [4.9%]) included difficulty in screw extraction (7 cases [2.5%]), stripped screw heads requiring drilling (4 cases [1.4%]), iatrogenic cortical perforation (2 cases [0.7%]), and excessive bleeding (1 case [0.4%]). Postoperative complications (18 cases [6.3%]) included surgical site infection (9 cases [3.2%]), with 6 superficial and 3 deep infections, re-fracture (4 cases [1.4%]), transient nerve injury (3 cases [1.1%]), wound dehiscence (1 case [0.4%]), and hematoma requiring drainage (1 case [0.4%]). All complications were managed successfully. Antibiotics or surgical debridement were used to treat infection at surgical site. Re-fractures were managed with re-fixation in 3 cases and conservative treatment in 1 case. Within 6 months, nerve injuries resolve automatically (Table 4).

Table 4- Complications Following Implant Removal (N = 285)

Complication	**No.(%)**	**Management**	**Outcome**
Intraoperative complications	**14 (4.9)**		
Difficulty in screw extraction	7 (2.5)	Specialized extraction techniques	Successful removal
Stripped screw heads	4 (1.4)	Drilling technique	Successful removal
Iatrogenic cortical perforation	2 (0.7)	Bone grafting, protected weight-bearing	Healed uneventfully
Excessive bleeding	1 (0.4)	Hemostasis, transfusion	No sequelae
Postoperative complications	**18 (6.3)**		
Surgical site infection	9 (3.2)		
- Superficial	6 (2.1)	Oral antibiotics	Complete resolution
- Deep	3 (1.1)	Surgical debridement, antibiotics	Complete resolution
Re-fracture	4 (1.4)		
- Re-fixation	3 (1.1)	Open reduction internal fixation	Healed successfully
- Conservative	1 (0.4)	Cast immobilization	Healed successfully
Transient nerve injury	3 (1.1)	Observation, physiotherapy	Complete recovery

Wound dehiscence	1 (0.4)	Wound care, delayed closure	Healed successfully
Hematoma	1 (0.4)	Surgical drainage	No sequelae
Total complications	**28(9.8)**[a]		

[a]Four patients experienced both intraoperative and postoperative complications; therefore, the total is less than the sum of individual categories.

Hospital Stay and Recovery

Mean (SD) hospital stay after implant removal was 1.8 (1.2) days (range, 0-7 days). Day-care procedures (discharge within 24 hours) were performed in 178 cases (62.5%). Return to full activities occurred at a median of 6 weeks (IQR, 4-10 weeks), and return to work or school occurred at a median of 2.5 weeks (IQR, 1.5-4.0 weeks).

Subgroup Analyses

Pediatric patients (n = 19) showed significantly higher rates of surgeon recommendation (36.8% vs 20.7%, P = .042), earlier removal (median 13.2 months vs 16.4 months, P = .028), and lower complication rates (5.3% vs 10.2%, P = .038) compared with adults (n = 266). Upper extremity removals (n = 96) demonstrated higher patient-requested removal rates (42.7% vs 29.1%, P = .021), earlier removal (median 14.2 months vs 16.8 months, P = .034), and higher day-care procedure rates (78.1% vs 54.5%, P < .001) compared with lower extremity removals (n = 189). Elective removals (patient request, surgeon recommendation, prominent hardware; n = 236) occurred significantly later (median 17.2 months vs 7.2 months, P < .001) and had lower complication rates (7.6% vs 20.4%, P = .008) compared with mandatory removals (infection, failure; n = 49).

DISCUSSION

The retrospective study of 285 implant removal procedures provides contemporary insights into practice patterns at a private tertiary care academic medical centre in South India. In orthopaedic practice, there is predominance of patient request (33.7%) for removing implants. This was similar with studies from similar healthcare settings, where patient preferences significantly influence implant removal decisions despite the absence of mandatory medical indications[13,14].

The significant proportion of patient-requested removals reflects increasing health awareness and access to medical information through digital platforms[15]. Previous literature (2023)[16] stated that up to 40% of patients request implant removal despite being asymptomatic, primarily driven by anxiety about retained. While modern titanium implants demonstrate excellent biocompatibility and minimal systemic effects[17], these concerns significantly influence patient preferences and warrant comprehensive preoperative counselling.

Educating individuals about implant retention misconception may reduce unnecessary removal procedures[18]. After comprehensive counselling regarding risks and benefits, patients willing for implant removal should be considered. Compared to other indications, patient-requested implant removal procedures (18.4 months) were longer, indicating deliberate and careful decision-making.

Prominent or symptomatic hardware accounted for more than one-quarter of removals (27.4%), demonstrating strong anatomical predilection. Superficial locations such as the distal tibia/ankle (45.8%), clavicle (58.3%), and distal radius (38.5%) were significantly higher in comparison to deeper locations like the femoral shaft (8.3%). These findings align with biomechanical studies stating that surfaces with minimal soft tissue coverage are prone to hardware prominence and irritation of soft tissue[19].

Recent advances in implant design, including low-profile locking plates and anatomically contoured constructs, reduced symptomatic hardware but do not completely eliminate them[20]. Similar study stated that, 70.2% of removed plates were conventional-profile locking compression plates.

Surgeon recommendation accounted for 21.8% of cases, among those, young active adults comprised the largest proportion (51.6%), followed by pediatric patients (24.2%). In pediatric patients, surgeon recommendation rate (36.8%) was significantly higher than in adults (20.7%), reflecting established concerns about implant interference with skeletal growth and bone remodeling[21]. Current evidence supports routine removal in skeletally immature patients once fracture healing is confirmed[22]. The median removal time in pediatric patients (13.2 months), balances adequate healing with minimizing retention period, aligning with international recommendations for removal between 12-18 months[23].

Implant-associated infection necessitating removal occurred in 13.3% of cases, comparable to recent literature rates[24]. Temporal distribution showed 36.8% acute postoperative infections, 47.4% chronic infections, and 15.8% late-onset infections, reflecting distinct pathophysiologic mechanisms. Early infections typically result from perioperative contamination, while late infections arise from hematogenous seeding or persistent biofilm infection[25] which can be removed (6.8 months) with antibiotics and debridement before definitive hardware removal, consistent with contemporary management protocols[26].

Implant failure requiring removal occurred in only 3.9% of cases; significantly lower than historical rates with older-generation implants[27]. Common failure modes included screw breakage (45.5%), plate fracture (27.3%), and implant loosening (18.2%). Modern locking plate technology distributes stress more evenly across constructs, reducing catastrophic failure rates[28].

The median removal time (15.8 months) falls within the recommended window of 12-18 months for elective removals[29,30]. However, 38.6% of removals occurred before 12 months. Among early removals, mandatory indications (infection and failure) accounted for 37.3%, which is clinically appropriate. The remaining 62.7% were elective removals, raising questions about optimal timing.

According to the study, re-fracture rate (1.4%) compares favorably with literature rates of 2-8%[31]. Importantly, 50% of re-fractures occurred after removal before 12 months, while only 1.1% of removals after 12 months resulted in re-fracture. This supports recent meta-analyses showing higher re-fracture risk with early removal[32]. The pathophysiology involves incomplete bone remodeling and persistent stress concentration at former screw holes[33].

Upper extremity removals demonstrated higher patient-request rates (42.7% vs 29.1%), earlier removal timing (14.2 vs 16.8 months), higher day-care procedure rates (78.1% vs 54.5%), and shorter operative times in comparison to lower extremity removals reflecting faster healing in upper extremity fractures.

The overall complication rate (9.8%) falls within the reported range for implant removal surgery[34]. Intraoperative complications (4.9%) were all managed successfully without long-term sequelae. Postoperative complications (6.3%) included surgical site infection (3.2%), re-fracture (1.4%), and transient nerve injury (1.1%). Oral antibiotics were used for treating superficial infections, while deep infections required surgical debridement.

The complication rate for elective removals (7.6%) was significantly lower than mandatory removals (20.4%). Diabetes mellitus, smoking, and previous infection were included as the risk factors for causing complications at treated site. Hence, patient selection, surgical technique used, and postoperative management are important to rule out infection.

Comparing the study findings with a recent study from a government tertiary care hospital in Karnataka[9], we observed similar rates of patient-requested removal (33.7% vs 31.7%) but surgeon-recommended removal were proportionally different (21.8% vs 25.8%) and prominent hardware (27.4% vs 21.6%). These discrepancies could be caused by variances in patient demographics, implant selection procedures, or the time at which implant removal surgery is performed in different healthcare settings.

CONCLUSIONS

In a private tertiary care context, patient request is the most common reason for implant removal, making up one-third of all instances, according to this retrospective review of 285 implant removal procedures. Infection and failure are necessary criteria that need to be removed right away, but symptomatic hardware and surgeon suggestion are also important considerations. The comparatively low complication rate (9.8%) shows that implant removal is a safe surgery when properly suggested and carried out. Developing context-appropriate therapeutic methods requires an understanding of regional and institutional differences in implant removal processes. Evidence-based counseling can assist patients in making well-informed decisions about implant retention versus removal. To reduce the chance of re-fracture, elective removal should be performed between 12 and 18 months. Future studies should concentrate on creating evidence-based recommendations that strike a compromise between clinical indications, patient preferences, safety concerns, and the use of medical resources.

Conflict of Interest Disclosures: None reported.

Funding/Support: None reported.

Role of the Funder/Sponsor: Not applicable.

Data Sharing Statement: De-identified participant data may be made available upon reasonable request to the corresponding author.

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