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Retrospective Study

Burden of routine orthopedic implant removal a single center retrospective study

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Abstract

BACKGROUND

Open reduction and internal fixation represent prevalent orthopedic procedures, sparking ongoing discourse over whether to retain or remove asymptomatic implants. Achieving consensus on this matter is paramount for orthopedic surgeons. This study aims to quantify the impact of routine implant removal on patients and healthcare facilities. A retrospective analysis of implant removal cases from 2016 to 2022 at King Fahad Hospital of the University (KFHU) was conducted and subjected to statistical scrutiny. Among these cases, 44% necessitated hospitalization exceeding one day, while 56% required only a single day. Adults exhibited a 55% need for extended hospital stays, contrasting with 22.8% among the pediatric cohort. The complication rate was 6%, with all patients experiencing at least one complication. Notably, 34.1% required sick leave and 4.8% exceeded 14 d. General anesthesia was predominant (88%). Routine implant removal introduces unwarranted complications, particularly in adults, potentially prolonging hospitalization. This procedure strains hospital resources, tying up the operating room that could otherwise accommodate critical surgeries. Clearly defined institutional guidelines are imperative to regulate this practice.

AIM

To measure the burden of routine implant removal on the patients and hospital.

METHODS

This is a retrospective analysis study of 167 routine implant removal cases treated

at KFHU, a tertiary hospital in Saudi Arabia. Data were collected in the orthopedic department at KFHU from February 2016 to August 2022, which includes routine asymptomatic implant removal cases across all age categories. Nonroutine indications such as infection, pain, implant failure, malunion, nonunion, restricted range of motion, and prominent hardware were excluded. Patients who had external fixators removed or joints replaced were also excluded.

RESULTS

Between February 2016 and August 2022, 360 implants were retrieved; however, only 167 of those who met the inclusion criteria were included in this study. The remaining implants were rejected due to exclusion criteria. Among the cases, 44% required more than one day in the hospital, whereas 56% required only one day. 55% of adults required more than one day of hospitalization, while 22.8% of pediatric patients required more than one day of inpatient care. The complication rate was 6%, with each patient experiencing at least one complication. Sick leave was required in 34.1% of cases, with 4.8% requiring more than 14 d. The most common type of anesthesia used in the surgeries was general anesthesia (88%), and the mean (SD) surgery duration was 77.1 (54.7) min.

CONCLUSION

Routine implant removal causes unnecessary complications, prolongs hospital stays, depletes resources and monopolizing operating rooms that could serve more critical procedures.

Key Words: Implant removal; Healed fracture; Orthopedic implant; Complications; Healthcare system

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Core Tip: This retrospective study examines the implications of routine asymptomatic implant removal on both patients and healthcare institutions. The study reveals that such practices impose substantial financial and health-related challenges for both individuals and hospitals.

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INTRODUCTION

Elective removal of implants post-fracture union is a prevalent procedure in global orthopedic practice. However, extant literature lacks consensus on the merits and hazards of routine removal in asymptomatic individuals. This procedure demands judicious consideration due to potential operative challenges, encompassing persistent pain, soft tissue infections, and prolonged hospitalization[1]. Moreover, implant removal entails substantial resource utilization, imposing an economic strain on healthcare systems[2,3].

A Finnish retrospective study revealed that routine implant removal constituted nearly 30% of elective surgeries, necessitating further investigation into the efficacy of this orthopedic practice[4]. Notably, studies highlight the impact on productivity, with 11-16 d of missed work or school post-removal, accompanied by a 2.6-d hospital stay[3,5,6]. The mean operating room time for implant removal surgeries was reported as 37 min[7]. While some studies affirm significant functional enhancements and positive outcomes following elective implant removal[8-10], the literature remains contentious.

Despite this, orthopedic surgeons universally concur on the necessity of removing symptomatic implants (e.g., infected, painful, or prominent)[1]. Pediatric patients routinely undergo implant removal due to potential long-term complications, including growth restriction, allergy, implant migration, and carcinosis[11,12]. This study aims to quantify the impact of routine implant removal on patient health, hospital resources, and sick leave duration in both adult and pediatric populations.

MATERIALS AND METHODS

This retrospective analysis examines cases of implant removal treated at King Fahad Hospital of the University (KFHU) in the Eastern Province, Saudi Arabia. Data were gathered from February 2016 to August 2022, encompassing routine asymptomatic implant removal cases across all age groups in the orthopedic department at KFHU. Excluded were cases involving nonroutine indications such as infection, pain, implant failure, malunion, nonunion, limited range of motion, and prominent hardware. Patients who underwent removal of external fixators or replaced joints were also excluded.

Ethical approval was secured from the Institutional Review Board of Imam Abdulrahman bin Faisal University, adhering to the Declaration of Helsinki (IRB number: IRB-UGS-2022-01-396). Informed consent from participants was waived for this retrospective study, as per the Institutional Review Board at Imam Abdulrahman bin Faisal University.

A total of 360 cases were retrieved from the Quadramed electronic record system at KFHU. Following the application of inclusion and exclusion criteria, the sample size was refined to 167. The gathered data encompassed demographic details (age, sex, and nationality) and clinical characteristics such as length of hospital stay, complication rate, days of sick leave, type of anesthesia, surgery duration in minutes, and the interval in months between implant insertion and removal.

Categorical variables (*e.g.*, anesthetic type and gender) were analyzed descriptively using frequencies and percentages, while continuous variables (*e.g.*, surgery duration and insertion-to-removal period) were characterized by mean and standard deviation. The Student's *t*-test compared continuous variables, and the chi-square test assessed categorical variables. Data analysis employed Statistical Package for the Social Sciences (SPSS) version 25. A significance level of 0.05 was applied to *P* values.

RESULTS

Between February 2016 and August 2022, 360 implants were extracted; however, only 167 meeting inclusion criteria were included in this study. Exclusion criteria led to the dismissal of the remaining implants. Predominantly, patients were male (68%) and Saudi nationals (90%). Hospital stays varied, with 44% extending beyond a day, and 56% requiring only a single day. Complications affected 6% of cases, with all patients experiencing at least one. Among these, 34.1% necessitated sick leave, 4.8% exceeding 14 d. General anesthesia prevailed (88%). Mean (SD) surgery duration was 77.1 (54.7) min, and implant removal occurred on average 18.6 (17.9) months post-insertion. Patients' mean (SD) age was 25 (18) years (Table 1).

Table 2 presents associations between variables and implant areas in 167 participants. Of these, 32.9% had upper limb or spine implants, while 67.1% had lower limb implants. No significant correlation was found between sex and implant area. Both upper and lower limb implant prevalence was higher in Saudis, though statistically insignificant. Age, adults, pediatrics (≤ 14 years), length of stay, and complication rate showed no significant association with implant area. However, the implant area correlated significantly with anesthesia type and insertion-to-removal period. General anesthesia prevailed, yet lower limb implants notably favored regional anesthesia ($P = 0.02$). Upper limb/spine implants had a significantly shorter insertion-to-removal period [14.5 (13.5) mo] than lower limb implants [20.6 (19.5) mo], $P = 0.037$.

Table 3 illustrates associations between variables and age groups (pediatrics, age ≤ 14). Among 167 participants, 57 (34.1%) were children. Males predominated in adults (75.5%) versus pediatric patients (54.4%, $P = 0.006$), signifying a significant sex-age group correlation. Nationality, complication rates, and sick leave showed no age-related significance. However, age influenced hospital stay duration, anesthesia type, and insertion-removal intervals. Adults exceeded pediatric patients in hospitalization beyond one day (55.5% *vs* 22.8%, $P = 0.001$) and regional anesthesia use (16.4% *vs* 3.5%, $P = 0.015$). Pediatrics demonstrated notably shorter mean insertion-removal duration [12.3 (8.3) mo] compared to adults [21.9 (20.6) mo, $P = 0.001$].

DISCUSSION

Our investigation assessed routine implant removal in 167 patients, predominantly Saudi males, revealing a 6% complication rate. Surgical duration averaged 77.1 (SD 54.7) min, and the period between implant insertion and removal averaged 18.6 (SD 17.9) months, with patients averaging 25 (SD 18) years in age. The 6% complication rate imposes a burden on patients without prior complaints. Studies indicate that non-medically indicated removal carries a 28% complication rate, while medically indicated removals had a complication rate of approximately 12%[13]. Another study reported a 10% complication rate[10], and ankle implant removal exhibited a 14% perioperative complication rate[14]. This variability highlights a gray area among centers, influenced by factors like medical necessity, surgeon experience, and anatomical location. Notably, most cases in our study avoided sick leave, whereas 29.3% and 4.8% took ≤ 14 and > 14 d, respectively. In contrast, a different prospective study reported an average of 16 d away from work or school[2]. This underscores the economic ramifications of missed work or school days as a risk factor for implant removal.

General anesthesia predominated in upper limb, spine, and lower limb procedures. Notably, regional anesthesia exhibited a higher prevalence in the lower limb cohort, indicating a statistically significant discrepancy ($P = 0.02$). The predominant modality of regional anesthesia was spinal, administered *via* a needle insertion at L4-L5 to mitigate spinal cord injury and prevent intrathecal drug injection. Consequently, its utilization in upper limb procedures was less frequent, necessitating advanced training and ultrasonography for nerve blocks (*e.g.*, supraclavicular and interscalene). Unilateral targeting may be insufficient, and patient preferences could influence the adoption of novel anesthesia methods[15,16].

The mean (SD) interval between insertion and removal in the lower limb [20.6 (19.5) mo] surpassed that in the upper limb or spine group [14.5 (13.5) mo], exhibiting statistical significance ($P = 0.037$). Notably, implant removal timing in uncomplicated fracture healing cases tends to be briefer in the upper limbs, aligning with our findings[17]. This variance may be attributed to the distinctive physiological function of the lower limb (*e.g.*, weight-bearing), intricate anatomical structures, and prolonged healing duration, prompting surgeons to defer the removal procedure.

Table 1 Total sample with demographic and clinical characteristics (n = 167)

Variable	Frequency (%)
Gender	
Male	114 (68)
Female	53 (32)
Nationality	
Saudi	150 (90)
Non-Saudi ¹	17 (10)
Length of stay	
1 d	93 (56)
> 1 d	74 (44)
Complication rate	
At least 1 ²	10 (6)
No complication	157 (94)
Sick leave	
No sick leave	110 (65.9)
≤ 14 d	49 (29.3)
> 14 d	8 (4.8)
Type of anesthesia	
Regional	20 (12)
General	147 (88)
Duration of surgery (min)	
Mean (SD)	77.1 (54.7)
Period between insertion and removal (mo)	
Mean (SD)	18.6 (17.9)
Age	
Mean (SD)	25 (18)

¹Non-Saudis include patients from Yemen, Palestine, Nigeria, Nazih (no nationality), Pakistan, Australia, Somalia, Sudan, Sri Lanka, Philippines, and Jordan.

²Complications include stiffness, contaminated wound, pain, and limited range of motion.

The adult cohort exhibited a markedly elevated male prevalence in contrast to the pediatric group ($P = 0.006$). This divergence is attributable to the predominant impact of motor vehicle collision-related fractures on young adult males in Saudi Arabia, as opposed to pediatric patients who demonstrate a comparable incidence across genders[18]. Notably, most orthopedic hardware removal interventions target young adult males[19,20]. This explains why the number of adult women in this study was less than that of adult males, which is consistent with national and global literature.

The hospitalization duration following implant removal exhibited a statistically significant disparity between adults and the pediatric cohort ($P = 0.001$), with adults experiencing prolonged stays. While our study diverges from the reported average pediatric length of stay (2.9 d), it is crucial to note the non-routine nature of implant removal in the reported patient population[21]. In a retrospective analysis, noninfected implant removal in adults averaged 5 d[1]. Although a comprehensive age-group comparison is absent, our findings align with the prevailing literature, reinforcing the noteworthy impact of non-routine removal on hospitalization duration.

Our data indicates a notably higher utilization of regional anesthesia in adults compared to pediatric patients. Despite its proven safety and efficacy for perioperative pain management, regional blocks are less prevalent in the pediatric demographic[22]. This discrepancy may stem from a potential lack of awareness among families regarding the advantages of regional anesthesia for their children.

Furthermore, our study reveals a significantly longer mean interval between implant insertion and removal in adults compared to pediatric patients. Consistent with similar research, a majority of adults opted for implant removal within 1-2 years post-implantation[23]. Additional investigations support these findings, showing that adults typically remove orthopedic implants within a 4-36 mo interval[24]. In a retrospective case series involving pediatric patients undergoing

Table 2 Upper limb or spine vs lower limb with demographic and clinical characteristics of patients

Variable	Upper limb or spine, n = 55 (%)	Lower limb, n = 112 (%)	Test (P value)
Gender			$\chi^2 = 2.48$ (0.115)
Male	42 (76.4)	72 (64.3)	
Female	13 (23.6)	40 (35.7)	
Nationality			$\chi^2 = 0.106$ (0.744)
Saudi	50 (90.9)	100 (89.3)	
Non-Saudi ¹	5 (9.1)	12 (10.7)	
Age			$t = -0.355$ (0.723)
Mean (\pm SD)	24 (\pm 16)	25 (\pm 18)	
Adults or pediatrics			$\chi^2 = 0.598$ (0.439)
Adults	34 (61.8)	76 (67.9)	
Pediatrics	21 (38.2)	36 (32.1)	
Length of stay			$\chi^2 = 0.618$ (0.432)
1 d	33 (60)	60 (53.6)	
> 1 d	22 (40)	52 (46.4)	
Complication rate			$\chi^2 = 0.041$ (0.839)
At least 1 ²	3 (5.5)	7 (6.25)	
No complication	52 (94.5)	105 (93.75)	
Sick leave			$\chi^2 = 1.606$ (0.448)
No sick leave	37 (67.3)	73 (65.2)	
≤ 14 d	17 (30.9)	32 (28.6)	
> 14 d	1 (1.8)	7 (6.2)	
Type of anesthesia			$\chi^2 = 5.411$ (0.02)
Regional	2 (3.6)	18 (16.1)	
General	53 (96.4)	94 (83.9)	
Duration of surgery (min) mean (SD)	74.7 (57.1)	78.2 (53.8)	$t = -0.387$ (0.699)
Period between insertion and removal (mo) mean (SD)	14.5 (13.5)	20.6 (19.5)	$t = -2.104$ (0.037)

¹Non-Saudis include patients from Yemen, Palestine, Nigeria, Nazih (no nationality), Pakistan, Australia, Somalia, Sudan, Sri Lanka, Philippines, and Jordan.

²Complications include stiffness, contaminated wound, pain, and limited range of motion. Bold indicated significant associations.

hardware removal, the mean period between insertion and removal was 16 mo[25]. Surgeons in the pediatric population generally prefer post-fracture healing implant removal due to potential growth issues if left in place for an extended period.

The investigation was conducted within a government-owned healthcare facility, characterized by complimentary healthcare services, rendering precise cost determination challenging. Nevertheless, the burden on the hospital can be approximated through various indicators, such as length of stay, surgical duration, and routine implant removal frequency from orthopedic procedures. The average hospital stay was 4.2 d, with a mean (SD) surgery duration of 77.1 (54.7) min, imposing strain on the operating room schedule. Between January 2016 and August 2022, the Department of Orthopedic Surgery performed 4583 operations, including 167 routine implant removals (3.6% of the total). A prospective economic analysis indicated the cost of single-implant removal as \$708.37 (\pm 22.10) with a range of \$366.97-\$1100.92[2].

The study was limited by its small sample size and only one center's experience. Therefore, we recommend conducting a large prospective multicenter study to investigate routine implant removal.

CONCLUSION

The contentious nature of routine implant removal in clinical discourse lacks a definitive consensus. Surgeons often

Table 3 Demographic and clinical characteristics of pediatric vs adult patient

Variable	Pediatrics, <i>n</i> = 57 (%)	Adults, <i>n</i> = 110 (%)	Test (<i>P</i> value)
Gender			$\chi^2 = 7.69$ (0.006)
Male	31 (54.4)	83 (75.5)	
Female	26 (45.6)	27 (24.5)	
Nationality			$\chi^2 = 0.188$ (0.665)
Saudi	52 (91.2)	98 (89.1)	
Non-Saudi ¹	5 (8.8)	12 (10.9)	
Length of stay			$\chi^2 = 16.2$ (< 0.001)
1 d	44 (77.2)	49 (44.5)	
> 1 d	13 (22.8)	61 (55.5)	
Upper limb and spine or lower limb			$\chi^2 = 0.598$ (0.439)
Upper limb or spine	21 (36.8)	34 (30.9)	
Lower limb	36 (63.2)	76 (69.1)	
Complication rate			$\chi^2 = 0.081$ (0.776)
At least 1 ²	3 (5.3)	7 (6.4)	
No complication	54 (94.7)	103 (93.6)	
Sick leave			$\chi^2 = 4.13$ (0.127)
No sick leave	43 (75.4)	67 (60.9)	
≤ 14 d	13 (22.8)	36 (32.7)	
> 14 d	1 (1.8)	7 (6.4)	
Type of anesthesia			$\chi^2 = 5.89$ (0.015)
Regional	2 (3.5)	18 (16.4)	
General	55 (96.5)	92 (83.6)	
Duration of surgery (min) mean (± SD)	77.07 (37.8)	77.05 (61.9)	<i>t</i> = 0.003 (0.997)
Period between insertion and removal (mo) mean (± SD)	12.3 (8.3)	21.9 (20.6)	<i>t</i> = -4.27 (< 0.001)

¹Non-Saudis include patients from Yemen, Palestine, Nigeria, Nazih (No nationality), Pakistan, Australia, Somalia, Sudan, Sri Lanka, Philippines, and Jordan.

²Complications include stiffness, contaminated wound, pain, and limited range of motion. Bold indicated significant associations.

grapple with conflicting data and familial pressures, presenting a dilemma. This study elucidates the repercussions on patient well-being, healthcare resources, and workforce absenteeism, contributing to a comprehensive understanding of its public health and systemic impact. Positioned as a fiscal and health burden, particularly for adult patients and healthcare institutions, routine implant removal engenders avoidable complications and protracts hospital stays. Additionally, it depletes hospital resources, monopolizing operating rooms that could serve critical procedures. Conclusively, establishing explicit institutional directives is imperative to regulate this practice.

ARTICLE HIGHLIGHTS

Research background

Elective removal of asymptomatic implants remains a controversial area, with no defined guidelines to direct this orthopedic practice. Hence, placing a considerable clinical and economic burden on both patients and healthcare systems.

Research motivation

Little data is known regarding routine orthopedic implant removal in the literature, particularly in the Middle East.

Research objectives

The objective of this study is to measure the burden of routine implant removal on both patients' health and hospital

facilities.

Research methods

A retrospective cohort study was conducted at a single tertiary center between February 2016 and August 2022 and included participants across all age groups who underwent asymptomatic implant removal in the orthopedic department. Participant's demographic and clinical data were retrieved from the electronic record system and statistically analyzed *via* Statistical Package for the Social Sciences version 25.

Research results

Complications were observed in 6% of the patients in our study, and sick leave was given in 34.1% of all cases. In 56% of cases, a single day in the hospital was necessary, whereas 44% required more than one day. These findings will shed light on this obscure area of literature, encouraging scholars to do further investigation in this area.

Research conclusions

In conclusion, this study proposes that routine implant removal places a heavy load on patients and healthcare facilities.

Research perspectives

More prospective multi-center studies with larger sample sizes are needed to investigate further the impact of elective implant removal on patients and hospitals.

FOOTNOTES

Author contributions: AlOmran AK, Alosaimi N contributed to the concept; Alshaikhi AA, Bakhurji OM contributed to design; Alzahrani KJ, Salloot BZ, Alabduladhem TO, AlMulhim AI contributed to study execution; AlOmran AK, Alosaimi N, Alshaikhi AA, Bakhurji OM, Alzahrani KJ, Salloot BZ, Alabduladhem TO, AlMulhim A contributed to manuscript writing and review; Alumran A contributed to statistical analysis.

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