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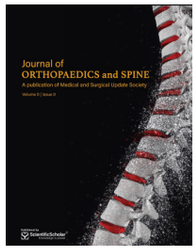

Original Article

Our experience regarding indications benefits complications in 200 cases with summarizing various techniques for orthopaedics implant removal

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ABSTRACT

Objectives: The removal of orthopaedic implants is one of the most frequently executed popular surgical procedures. There is currently insufficient data on postoperative patient satisfaction in the literature. The purpose of our study was to evaluate the patient's implant removal on the basis of indication complications and patient satisfaction. In addition, compile the different techniques of implant removal.

Material and Methods: We explored trauma centres, that underwent Implant removal in February 2017 and January 2020, about their personal experiences with implant removal.

Results: The majority of hardware removals in 200 individuals were at the leg at 19%, thigh at 18%, and forearm at 13%. The most frequent indications are Surgical Site infection 15%, and CI Children with growing age 10.5%. I Exposed Perforating implant 10%, BI Broken hardware non-union, and malunion 6%. The patient-reported complication rate of implant removal was 7% out of which Impaired healing in 3 cases 22% infection in 4 cases 29% Nerve injury in 2 cases 14% Refracture in 1 case 7%. Importantly, after implant removal because of pain or impaired function, patients reported an improvement in function (85%) as well as decreased pain (95%).

Conclusion: Regardless of the difficult removal of the surgical implant with less satisfaction as widely held view our data repudiate that implant removal is having a positive trusted effect on patients with fewer complications. To better plan for implant removal, it is helpful to outline several techniques for removing implants. These citations may affect the surgeon's approach towards implant removal.

Keywords: Complications, Implant removal, Nail, Patient satisfaction, Screw.

INTRODUCTION

In orthopaedics, implant removal is a regular common surgery performed.

There are so many ongoing arguments regarding implant removal related to indication complication timing.[1,2] At paediatric age implant removal is necessary before skeletal maturity to prevent deformity growth arrest later removal of the implant is difficult.[3]

Regarding Indication, it was divided into Absolute and Relative indication. Absolute indication surgical failure of the osteosynthesis broken hardware non-union, malunion, surgical site infection, metal allergy (cancer), soft tissue compromise, growing skeletal children's compromised skin' prevention of post-union stress-shielding implant migration, tenosynovitis, tendon rupture. Relative

indications are 'relative meaning that they are unnecessary and are often driven by patients' complaints and symptoms of prominent implant, intra-articular implant, pain, prevention of future bacterial colonization, mechanical problems, functional impairment, swelling, paraesthesia, problem in daily living, cosmetic, litigation.[4,5] Contraindication – Old age, Metabolic bone disease, Malignancy.

Deep late infection, metal allergy, toxicity tumorigenicity, hardware migration, metal failure, and secondary fracture at plate ends are all issues with retaining metal implants.[6]

There are so many predetermined benefits of surgery in absolute and relative indications as relief of pain paraesthesia foreign body sensation checks future related surgical procedure implant breakage, joint migration, and prevention of future bacterial colonization.

Tissue damage neurovascular injuries, infections, impaired wound healing, refractures, post-operative bleeding, incomplete removal, anaesthesia, and surgery-related complication also depend on the specific localization of the implanted material.[7,8]

With the modification of the implant's metal, titanium has better biochemical properties and can prolong life so can be left in situ. Also, modification in the implant design made it difficult to remove as locking plate as cold-welding stripped screw and nail proximal femoral nail jammed nail broken helical blade.[9]

There are many different types of implant removal techniques for various implant breakage. Hardware removal can take a long time, and no single procedure is guaranteed to work[10] [Table 1].

Summary of Broken or Stripped or Cold-welding screw Jammed screw Broken plate

In the procedures for removing locking screws, instruments such as extraction bolts, modular devices, conical extraction screws, hollow reamers, and carbide drill bits have been stated. Stripping of the screw head recess, cross-threading, and cold welding of the screw with the plate are highlighted as difficulties with titanium locking plates. Overtightening of orthopaedic screws unintentionally, resulting in screw purchase loss.

Pattison G 1999[11]	Using a little swab or foil wrapped around the tip of the screwdriver to increase torque for removal at the screw head provides an interference fit between the screwdriver and the stripped screw.
Georgiadis GM 2004[12]	Remove the screws after cutting the LISS plate if the Jammed screw.
Phisitkul P 2007[13]	Screws levered off the bone with the plate are useful in osteoporotic bone but not useful when screws are inserted in compression mode.
McElvany M, Hak DJ 2008[14]	Drilling out the screw head using carbide drill bits or diamond-tipped burr threaded part removed with hollow mill thermal necrosis and metallic debris present Also using conical extraction bolt if not successful in cases of cold welding and cross-threading.
Hamilton P 2004[15]	If there is enough room between the plate and the bone, the screw shaft can occasionally be cut with a big bolt cutter but not feasible when the screw is fixed in the compression method.
Kumar and Dunlop 2011[16]	To release screw heads using a high-speed Radial cut made in the plate that creates an interference fit between the screwdriver and the head creating more torque for the removal of thermal necrosis and metallic debris present.
Alok Chandra Agrawal 2018[17]	Bent both ends of the broken medial plate around the screw and removed the screw by just rotating the bent plate anticlockwise.
Mandeep Singh Dhillon 2013[18]	Cutting reconstruction plate large bolt cutter at narrow portions and between the holes each screw and plate acted as a crew. The stuck screw and plate as a unit is removed after being unthreaded.
MK Kwan 2009[19]	Using a trephine reamer drilling from the far cortex to the tip of a stripped screw is approached from the far cortex and then, in the direction of the screw, reamed with a trephine reamer until both cortices are unobstructed. By circulatory movements, the plate around the single stripped screw can be unscrewed.
Bhavuk Garg 2011[20]	Divide the plate into both sides of the locking hole with a high-speed metal cutting saw, then remove the jammed screw with the screw head locked in the plate's locking hole as a unit.
AO Technique	Cut with Midas Rex® pneumatic high-speed metal cutting burr the metal plate around the stripped screw hole to facilitate removal of the plate or to destroy the interface between the threaded screw head and plate hole. Screws were either torque screwdriver or the Synthes screw removal set or left in situ.

Summary of Broken Drill bit Gide wire

Technique to remove broken drill bit Broken guide wire used a cannulated drill bit, DHS reamer, depth gauge.

Puneet Mishra 2003[21]	Intrapelvic protrusion of guidewire removed by Kocher forceps or a needle holder after making the window made in the femoral neck.
Lalit Maini 2008[22]	With the use of a hand drill, a dynamic hip screw reamer was threaded over the damaged guidewire until the beginning of the guidewire's threads were engaged, and then it was removed.
Daya Krishna 2021[23]	The base of the broken drill bit is grasped by Kerrison rongeur/grasper before drilling 3 times, at the base of the drill bit.
Khaled F. Al-Kharouf 2021[24]	A curved hook depth gauge is introduced and caught onto the edge of the broken cannulated drill bit to recapture and remove it from the proximal reaming tract in a clock anti-clock motion.
Devendra K Chouhan 2015[25]	The Langenbeck retractor blade is turned 90 degrees after being inserted with the blade tip facing proximally and progressing well beyond the medial cortex of the femur. The drill bit is moved back with the help of the retractor blade.

Summary of Broken Locking bolt in Nail

Study	Technique
SJ Matthews 2006[26]	The incision is made on one of the two sides of the broken screw with a fractured screw, the head is removed by the use of an appropriate screwdriver. A cortical hole is made from one end to insert a 10 cm stainless steel tube. From the other side of the bone, a smaller cortical hole is made and a thin stainless steel rod punch is inserted to push the fracture fragment into the tube so the screw is removed with minimum damage to soft tissues.
Sancineto CF 2001[27]	The broken screw head is removed with an appropriate screwdriver. Nail blocking hole is matched with a broken locking bolt with the extraction of nail A trocar from the proximal/distal locking system (consisting of tissue protection sleeve, drill sleeve, and trocar; is passed through the skin incision and positioned with the screw remnant under image intensifier direction to tap it out of the nail and bone and into the soft tissue. If the trocar diameter is bigger, it may be essential to widen the near cortex with a proximal/distal locking drill in some nails.

Summary of Broken nail

The technique to remove the broken nail with instruments Ball tipped guidewire, K wire, Washer, K nail, Hook Screw, Kuntscher's nail with a guidewire, and T reamer with guidewire used can be extracted antegrade or retrograde.

Study	Technique
Interference Fit Guide Wires	
D. J. Hak 2008[14]	The distal nail tip is pierced with a ball-tipped guidewire and another non-tipped guidewire. (occasionally in large nails, 2–3 nontipped guidewires may have to be passed to gain a good fit inside the nail outlet). Then the ball-tipped guide wire is pulled back to extract the nail. The end of the ball-tipped guidewire can be bent to maximize its chances of pulling the broken nail fragment.
A. H. Karladani 2006[28]	Technique in which a guidewire was used to trap in the canal using a 3.5 mm screw inserted through the locking hole to get interference fit with the guide wire.
Brewster et al. 1995[29]	Used several guidewires in addition to a hook or bulb-tipped guidewire to form a stable construct that could easily be removed as one piece, respectively a guidewire was inserted into the broken nail, and after this, the space between the nail and the inner side of the cortical bone was then enlarged with a reamer.
S. M. Blake 2009[30]	Used an olive-tipped guidewire which was passed completely through the nail second, non-olive tipped, the wire was passed through the distal fragment adjacent to the previously placed wire. The olive-tipped wire was retracted back, causing it to infringe against the non-tipped wire and the outer tip of the nail. The proximal end of the olive-tipped wire was gently pressed back with a T-handled chuck, bringing the distal fragment with it.
Metikala and Mohammed 2011[31]	Under fluoroscopy imaging, a plain guidewire was inserted distally into the knee joint. Over this wire, a 5-millimeter (mm) cannulated large drill bit was used to create a track up to the distal broken nail segment. Ball-tipped wire passed through the knee retrograde and nail fragments were extracted in an antegrade manner.
J. W. Levine 2004[32]	The hole is made at the medial malleolus ball-tipped guide wire passed the tibia nail extracted from the knee joint.
Magu et al. 2004[33]	Used ball-tipped guidewire with a 7 mm washer to extract the nail.
Zhao and Slater 2017[34]	Plain guidewire passed through the nail fragment and was extracted out distally by a cortical window below the fragment. Over the guidewire, a flexible reamer was used to remove fragments from the window.
Hooks	
Franklin 1988[35]	Franklin et al. used a custom-made hook Hooks are inserted into the nail outlets and grab the nail's end. With the shattered distal piece, the hooks are then pulled back. Often, another guidewire is needed to stack the hook to increase its chance of catching the end of the nail and pulling the nail with back extraction of the hook.
Park 2006[36]	Described a method of making a "groove" and a "bend" in a guidewire to operate as a hook for use in a nail with a small diameter.
Acharaya 2008[37]	Described bending a guidewire to obtain a "fishhook" It is utilized to remove the nail by hooking into the distal piece's end; the guide rod can be passed inside or outside the nail. K wire 30 cm can also be used as a hook.
Hook with Stacking from the Locking Hole	
Amr A. Abdelgawad 2013[38]	Along with Hook also a flexible nail inserted through distal locking gets incarcerated with and broken distal piece pulled out.
Press Fitting in the Hollow of the Nail	
Amr A. Abdelgawad 2013[38]	Inside the nail, conical threaded stainless-steel extractors are threaded and have a block effect prior it rotational stability being controlled. With the nail attached, the extractor may be pulled.
Sivananthan et al. 2000[39]	Used a nail 3 mm smaller than the removed proximal piece of the nail to gain press fitting inside the broken piece Smith et al. described the use of a 3.5 mm tap to grip the cannulation of the nail.
Steinberg et al. 2004[40]	Kuntscher nail is pressed fit in the distal part of the nail then a guidewire and hook are passed through the distal part of the nail and the broken part of the nail is pulled out.
Georgilas 2009[41]	A 10.5 mm reamer was inserted via the intramedullary canal over a guidewire and jammed into the distal broken piece. Under fluoroscopic guidance, the nail was carefully removed using rotatory movements.

Maini et al. 2009[42]	Used flexible nail engaging flat tip at the distal part of nail extracting retrograde.
Mazzini et al. 2009[43]	Cement rongeur and cement extraction hook are used to extract out the nail after the opening of the fracture end.
Vijay Kumar 2014[44]	An arthroscopic Flip cutter (Arthrex) was utilized to remove the distal part forwarded across the far end of the broken nail flipped to engage the nail following which a T handle and back hammer were applied over the Flip cutter to extract the broken nail. A flip cutter is a reamer and guide pin that can be used to create tunnels in arthroscopic cruciate repairs.
Pongsamakthai W 2016[45]	T-reamer with appropriate size was inserted and impacted into the distal nail fragment with gentle twisting of the T-reamer until the T-reamer and the nail moved as a single unit before it the femur is over reamed in the proximal part.
Henrique Antônio 2010[46]	A broken distal fragment was taken out of a femoral intercondylar notch after hammering it with a femoral nail with a diameter larger than 2 mm compared with the diameter of the extracted nail.
Faizan Iqbal 2021[47]	A ball-tipped guidewire was inserted with A pre-bend plain wire and then inserted in a broken nail. with the help of a vice-grip, both wires were twisted to make a secure handle between guidewires and a broken implant. Extract a broken segment of the nail mallet upward-directed blows.
Juan Pretell Mazzini 2009[43]	Introduction of the curved thin hook through the femoral and nail canal into the nail tip for the removal of the distal fragment.
Bipul K Garg 2021[48]	A U-shaped bend was formed on the distal end of the guidewire at the tip of the broken nail to hook and extract the nail.
Kongkhet Riansuwan 2013[49]	The intercondylar notch of the femur entry point with a 6 mm T-reamer, passing a guidewire over the nail-contoured Harington rod (6 × 400 mm) was inserted until the round trip of the rod engaged into the nail's cavity canal. Multiple impactions could then be applied firmly on a wise grip or T-chuck handle gripping the Harrington rod. The nail was impacted upward along the tract controlled by the guidewire and eventually removed directly from the wound.
KL Pan 2012[50]	30 cm long 2.0 mm Kirschner wire is used as hook bending small acute-angled "hook" reached the distal screw holes extracted out the broken nail from trochanteric opening with the help of T handle.
Georgiadis et al. 2004[12]	In jammed nails, the slot is created in the proximal part with a high-speed drill with a carbide metal cutting, allowing for connecting a hook for consecutive removal.
Extraction of the nail from outside	
Gosling 2005[51]	With the help of guidewire bending engaging at the distal lock hole, a custom-produced extractor with an over-reaming 3–4 mm nail is extracted from the fracture side.
Extraction of several broken nail removal Three Segment	
Liodakis et al. 2010[52]	Retrograde from the knee a 3 mm guide wire is passed through the broken distal part of the nail and reamer and extraction devices are used to hammer out the nail.

Summary of Bend Nail

The deformity seen is an anterior apex or Varus coronal 30–35 degrees. The technique used for reduction is close using the F-Tool perineal post to straighten the nail to facilitate removal through the original proximal insertion site. The F-Tool allows forces to be concentrated at the apex of the deformity or percutaneous reduction by locking plate bone holding reduction clamp percutaneous drilling by steel drill or open reduction cutting with a High-speed drill.

Gianluca 2019[53] You-Sung Suh 2020[54]	Using a high-speed cutting burr drilling Midas Rex high-speed burr, the apex part of the bent nail was progressively sectioned until the nail could be straightened.
Manjeet Singh Dhanda 2015[55]	Jumbo Cutter at the apex of the visible nail and sectioned the nail into two parts with multiple bites by the jumbo cutter. With proximal fracture fragment extracted by using pliers as it was posted isthmic wide marrow region. The proximal nail portion was removed using an extraction system.

Summary of Broken PFN with Blade or Screw

Direk Tantigate 2015[56]	After removing the broken lateral part in this reaming tract, the bone is broken lag screw interface was reamed manually using a trephine. The customized removal tool was then applied gently until gripping the broken lag screw firmly was finally removed anticlockwise turning the removal tool into a screwdriver. A Customized Removal Tool (A specific socket screwdriver was created by modifying a used 12 × 40 mm (AO) femoral nail and another identical lag screw as a template).
Yohei Yanagisawa et al. 2021[57]	Removed the Proximal lag screw broken screw shaft using a trephine using screw extractors or vice grip–style pliers if not removed then excised the outer cortical bone and cut the circumference of the nail around the lag screw insertion using a carbide drill 6.0 mm. After cutting the lag screw, removed the nail later cut the lag screw in the nail. Then the tip of the lag screw left on the bone fragment on the head side using forceps was removed.

Ebrahimpour et al. 2020[58]	K wire is placed from lateral to medial at the tip of the nail to prevent additional distal migration of the nail during extraction. An extraction set is used to remove the helical blade and the proximal broken nail. From the previous entry 4.5 mm, the Schanz pin was inserted completely fixed at the distal broken end of the nail canal extracted proximally by a T-handle bar.
Ming-de Cao 2020[59]	A uni cortical hole was drilled by a 5-mm tungsten carbide bur at the end of the blade, and a 2-mm double-strand steel wire was threaded through the drilled hole. The SS wire was twisted and strongly tied up to the lag screw or helical blade in the hard loop to extract by applying blows of the combined hammer.
Cho Hong Man 2018[60]	A window is formed distal to the fractured tip of the nail, then a ball-tipped guide is introduced retrogradely, and the nail is retrieved with the help of a Schanz pin.

MATERIAL & METHODS

Study design Description – Metanalysis Systemic review

Data collection – A total of 200 cases were operated in 3 years between the February 2017 and January 2020 survey by outpatient consultation. The mean age was 32 years ranging from 7 years to 55 years and Sex was 65% Male and 35% Female

Criteria Inclusion criteria Age 10–50 years, common orthopaedics fracture fixation, assessment of pain relief Visual Analog Scale (VAS) score, both absolute and relative indication, informed consent with explained individual subjective benefits and burdens of surgical implant removal.

Excluded were removals of external fixators, arthroplasty old age, osteoporotic bone metabolic bone disease, and bleeding disorder. Improvement scores VAS Score, 36-Item Short-Form Health Survey (SF-36).

Table 1: Implant removal devices.

Broken stripped screw	
Universal screw removal instrument system	Hex screwdrivers, screw extractors, trephines, extraction bolts, easy-out extractors, Screwdrivers, screw-removal forceps, conical Extraction screws, hollow reamers, carbide drill bits, screw-removal bits for stripped screws, conical extraction bits, intramedullary nail extraction tools
Xtract-All stripped bone screw removal system and broken screw removal	Eight sizes of twisted screw extractors (1.5 to 5.0 mm), ratcheting T-handle, parallel jaw pliers, and mallet ratcheting T-handle with 13 different sizes of extractor shafts
Proximal Femoral Nail with Helical blade	
Intramedullary Nail Extractor	Trephine, screw extractors or vice grip–style pliers, carbide drill 6.0 mm 4.5 mm Schanz pin, T-handle bar, SS wire
Bend Nail	
Intramedullary Nail Extractor	High-speed cutting burr. Jumbo Cutter, pilers
Broken intramedullary Nail	
Nail extractor hook	When used for other nail brands, confirm that the extraction hook fits through the nail opening
Offset punches	Used to push out broken so lid nail segments
Intramedullary Nail Extractor	Includes three-eighths inch and one-half inch conical extraction bolts for removal of both fluted and unfluted cannulated nails
Nail extractor hook	Small and large sizes are available in implant extraction sets, along with various intramedullary nail extraction tools
Solid nail extraction system	Various sizes of trephines and extractor heads for solid 8-, 9-, 10-, 11-, and 12-mm intramedullary nails
Intramedullary nail extraction set	Includes various diameters of smooth and beaded guidewires, corkscrew extractors, and extractor bolts
Cold-welded plate	
Carbide drill bits, diamond wheel burrs	Part of the Synthes Screw Removal System
General	
Ortho Vise	Vise-grip pliers with an attached slap hammer
Broken Drill bit Gide wire	
Extraction set	DHS reamer Drill bit 3,2, Kocher forceps or a needle holder, Kerrison rongeur, pituitary rongeur, Hand drill, Depth gauge

Table 2: Anatomical region implant removal.

Sr.	Region	No	Duration Month	Plate	Nail	K wire	Screw	Complication
1	CLAVICLE	4	24	2%				Impaired wound healing
2	SPINE	4	24				2%	
3	PELVIS	2	24	1%				Infection
4	HIP	6	24	3%				Infection
5	HIP	4	24		2%			
6	THIGH	6	26	3%				Infection
7	THIGH	30	26		15%			
8	KNEE	14	18	7%				Impaired wound healing Incomplete removal
9	PATELLA	6	12			3%		
10	LEG	6	18	3%				Impaired wound healing
11	LEG	32	18		16%			Others
12	ANKLE	8	18	4%				Infection
13	ANKLE	4	18				2%	
14	FOOT	6	2-6			3%		
15	SHOULDER	2	24	1%				
16	ARM	8	18	4%				Nerve injury
17	ARM	4	18		2%			
18	ELBOW	16	24	8%				Bleeding
19	FOREARM	20	24	10%				Nerve injury Refracture
20	FOREARM	6	24		3%			
21	WRIST	6	2-6			3%		Others
22	HAND	6	2-6			3%		
	Total cases	200		92	76	24	8	14 cases
	Total %			46%	38%	12%	4%	7%

Table 3: Outcome SF 36 score preoperative postoperative.

Outcome	Preoperative	Postoperative After 4 Months	Cases
Physical functioning	40	85	85%
Pain	45	90	95%
Role Physical	35	91	75%
Vitality	46	77	80%
Social Functioning	60	90	77%
General Health	72	80	80%
Role emotional	65	90	40%
Mental Health	70	88	45%

Table 4: Outcome VAS score preoperative postoperative.

Preoperative	VAS Score	Postoperative	VAS Score
5% cases	10	5% cases	0
65% cases	7–9	50% cases	0
		10% cases	1–3
		5% cases	No Change
30% cases	4–6	30% cases	0

VAS: Visual analog scale.

RESULTS

Different anatomical sites and different implant nail plate screw k wire were studied the majority of implant removal was from the lower extremities' thigh leg. The most frequent anatomical region from where implant removal was done Leg 19%, Thigh 18%, and Forearm 13%. Different regions with the different implant of surgical implant Clavicle P 2%, Spine S 2%, Pelvis P 1%, Hip P 3%, Hip N 2%, Thigh P 3%, Thigh N 15%, Knee P 7%, Patella K 3%, Leg P 3%, Leg N 16%, Ankle P 4%, Ankle S 2%, Foot K 3%, Shoulder P 1%, Arm P 4%, Arm N 2%, Elbow 8%, Forearm P 10%, Forearm N 3%, Wrist K 3%, and Hand K 3%. P Plating N Nailing K Wire K Screw S. The most common IR was Plating 92 cases 46%, Nailing 76 cases 38%, K wire 24 cases 12%, and Screw 8 cases 4% [Table 2, Charts 1 and 2].

Table 5: Indications of implant removal.

Absolute Indication	%	Cases	Relative Indication	%	Cases
Surgical Site infection implant (SSI)	15%	30	Pain	6%	12
Exposed Perforating implant (EI)	10%	20	Swelling	4.5%	9
Broken Implant (BI) Broken hardware non-union, malunion	6%	12	Prominent Material	5.5%	11
Failure Implant (FI)- Cut out Surgical failure of the osteosynthesis	5.5%	11	Paraesthesia	2.5%	5
II Intraarticular or Malposition of the metal	4.5%	9	Future bacterial colonization	1%	2
Children Implant (CI) with growing age	10.5%	21	Impairment of function problems in daily living	4.5%	9
Refracture Implant (RFI)	4%	8	Cosmetic	2%	4
Soft tissue compromise implant (SCI)	2.5%	5	Problems with metal detectors	1%	2
Tendon rupture implant (TRI)	1.5%	3	Professional recommendation	5%	10
TSI Tenosynovitis	1%	2	Foreign body sensation	1%	2
Bursitis Implant	1%	2	Metal Allergy Fear of cancer	0.5%	1
Others	3.5%	7	Others - Patient request not part of the body, litigation	1.5%	3
Total	65%	130		35%	70

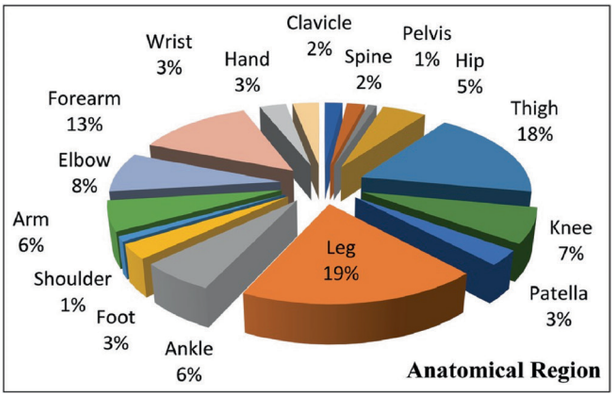

Chart 1: Anatomical region Implant removal.

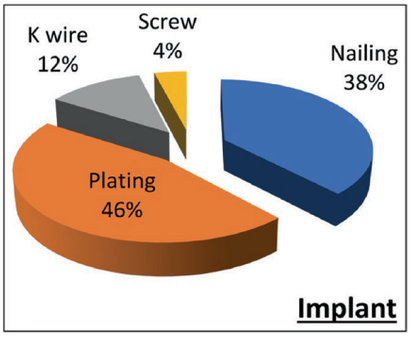

Chart 2: Different types of implants.

Table 6: Timing of implant removal.

Time of removal after the initial operation	Cases	Cases %
Less than 6 months	3	13.6%
7–12	1	4.5%
13–18	7	31.8%
19–24	9	40.9 %
More than 25 months	2	9.09 %

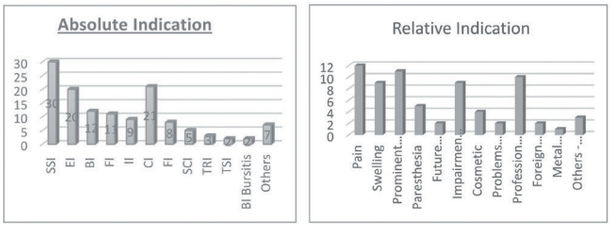

Chart 3: Indications of Implant Removal.

Regarding Indication, it was divided into Absolute and Relative indication. Absolute indication surgical failure of the osteosynthesis broken hardware non-union, malunion, site infection, metal allergy (cancer), soft tissue compromise, growing skeletal children's compromised skin' prevention of post-union stress-shielding implant migration, tenosynovitis, tendon rupture [Figures 1-12].

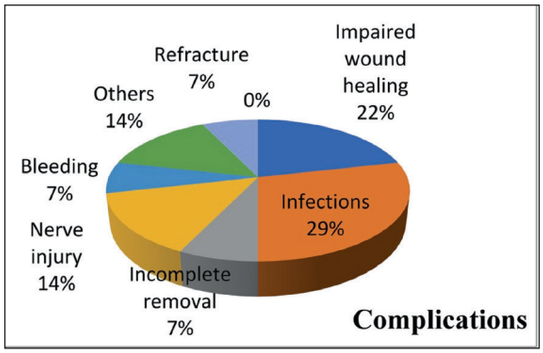

Chart 4: Complications of implant removal.

Figure 3: Exposed Perforating Implant.

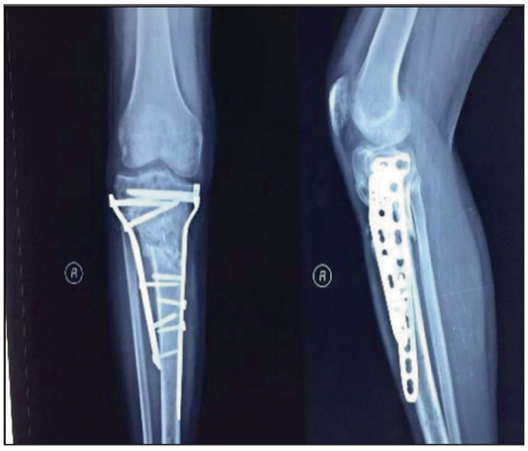

Figure 1: SSI Surgical Site Infection.

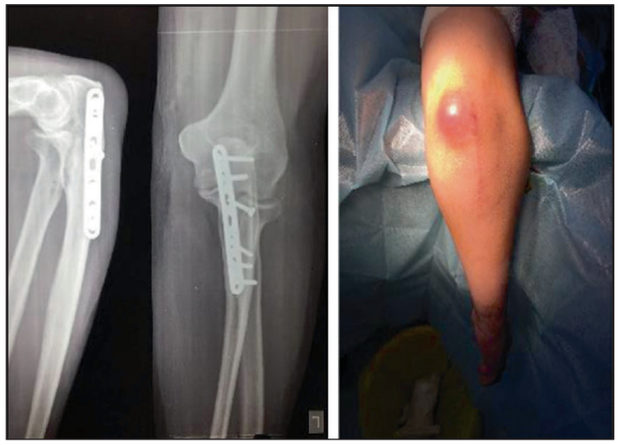

Figure 4: Bursitis.

Figure 2: Children with Implants.

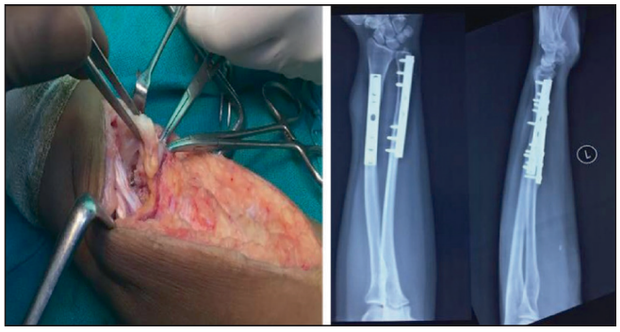

Figure 5: Tenosynovitis with Screw Impingement.

After postoperative complications following surgical hardware removal, the overall complication rate are7% in 14 cases only. Infection 4 cases 29%, Impaired healing 3 cases 22%, Nerve injury 2 cases 14%, Refracture 1 case

Figure 6: Broken Implant with Nonunion.

Figure 8: Prominent Material.

Figure 7: Pain.

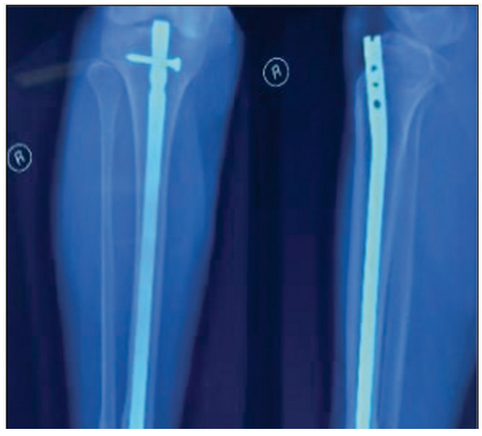

Figure 9: Intra Articular Metal.

7%, Incomplete removal 1 case 7%, Bleeding 1 case 7%, Refracture 1 case 7%, and others 2 cases 14% (anaesthesia and surgery-related complication) [Chart 3].

Relative indication of prominent and intra-articular material pain, prevention of future bacterial colonization, mechanical problems, daily living problems, functional impairment swelling, paraesthesia, cosmetic, and litigation.

In our study VAS Score, 36-Item Short-Form Health Survey (SF-36), was used to assess the improvement in pain and function. In our study pain was assessed with VAS score improvement in 95% of cases, and physical function was assessed by SF 36 score it was improved in 85% of cases [Tables 3 and 4].

DISCUSSION

In our study, the most common implant removal was plating with screw 92 cases 46% Nailing 76 cases 38%, K wire 24

Figure 10: Swelling.

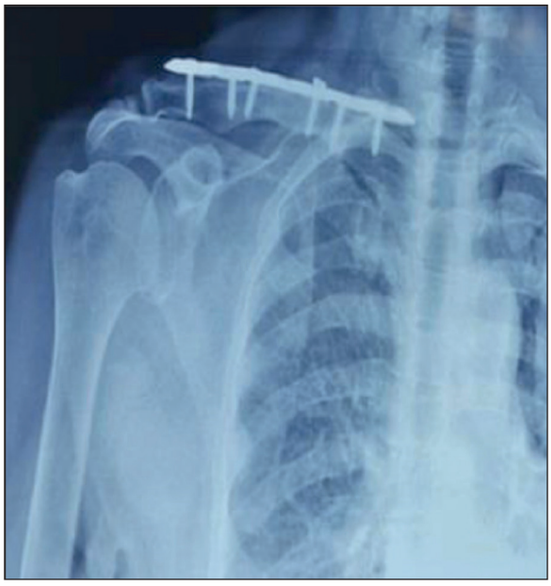

Figure 11: Impairment of Function.

cases 12%, and Screw 8 cases 4%. At our centre, total surgery 750 surgeries were done in 3 years out of this 200 were implant removal nearly 27% which is a satisfactory number for elective surgery. The regions – Clavicle P 2% Spine S 2% Pelvis P 1% Hip P 3% Hip N 2% Thigh P 3% Thigh N 15% Knee P 7% Patella K 3% Leg P 3% Leg N 16% Ankle P 4% Ankle S 2% Foot K 3% Shoulder P 1% Arm P 4% Arm N 2% Elbow 8% Forearm P 10% Forearm N 3% Wrist K 3% Hand K 3% Plating P, Nailing N, K Wire K, Screw S.

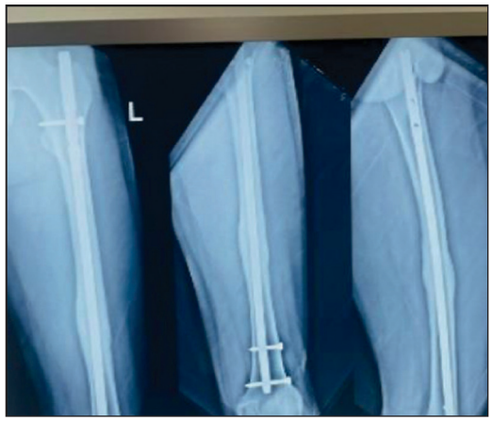

Figure 12: Professional Recommendation.

Timing of Metal Removal

BONE FRACTURE	TIME AFTER IMPLANTATION (MO)
Malleolar fractures	8-12
Tibial pilon	12-18
Tibial shaft	
Plate	12-18
Intramedullary nail	18-24
Tibial head	12-18
Patella, tension band	8-12
Femoral condyles	12-24
Femoral shaft	
Single plate	24-36
Double plates	From mo 18, in two steps (interval, 6 mo)
Intramedullary nail	24-36
Peritrochanteric and femoral neck fractures	12-18
Pelvis (only in case of complaints)	From mo 10
Upper extremity (optional)	12-18

Figure 13: Timing of implant removal.

The average duration of implants before removal in this study was 19 months. The patient's most common indication for removal in this study was SSI Surgical Site infection 15%, CI Children's with growing age 10.5%, EI Exposed Perforating implant 10%, BI Broken hardware non-union, malunion 6%, FI Cut out Surgical failure of the osteosynthesis 5.5%, II Intraarticular or Malposition of the metal 4.5%, in absolute indication and in a relative indication it was pain 6%, prominent material 5.5%, also good number was of professional demand to recruit in defence services 5% [Figure 13, Tables 5 and 6, Chart 4].[62–64]

The most frequent complication following implant removal in this survey is Infection 4 cases 29% Impaired healing 3 cases, 22% Nerve injury 2 cases, 14% Refracture 1 case, 7% Incomplete removal 1 case 7% Bleeding 1 case, 7% Refracture 1 case, 7% others, 2 cases 14% (anaesthesia and surgery-related

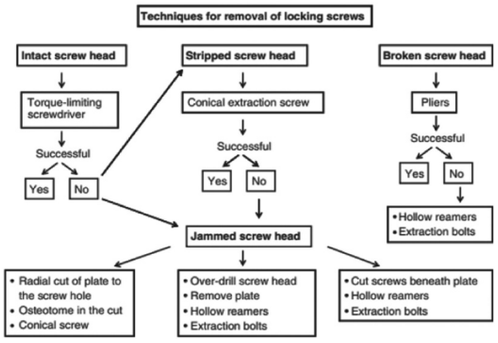

Figure 14: Flow chart removal of the locking screw general guidelines are issued by AO-ASIF for implant removal. AO-ASIF: Arbeitsgemeinschaft für Osteosynthesefragen- Association for the Study of Internal Fixation.

complication). Postoperative complications following surgical hardware removal overall complication rate are 7% in 14 cases. In various other surgery if the comparison is done for complication clavicle fractures is 5 to 15%, radial palmar plate osteosynthesis is 5–27%, intervertebral disc surgeries is 10%, ankle fractures is 5% knee arthroscopies is 1.6 % to other surgery it was a very less percentage only 7%. Orthopaedics implant removal complications range from 0% to 40% in various other research. Our survey suggests nail removal has a less complication rate than plate removal. In the upper extremity, the complication is nerve injury and refracture because it is a small bone, not weight bearing so more plate is used.[65–67]

In reference to pain, in our study recovery rate of pain was 95% with 5% no improvement in 50% of cases VAS Score improved from 7–9 to 0, 10 % of cases VAS Score improved from 7–9 to 1–3, 5% of cases VAS Score improve from 10 to 0, 30% cases VAS Score improve from 4–6 to 0. Regarding Health Survey SF 36 in our study from preoperative to postoperative after 4 months of physical Functioning improvement from 40 to 85 in 85 %, Pain improvement from 45 to 90 in 95%, Role Physical improvement from 35 to 91 in 75%, vitality improvement from 46 to 77 in 80%, Social Functioning from 60 to 90 in 77% General Health improvement from 72 to 80 in 80%, Role emotional improvement from 65 to 90 in 40 % and Mental health improvement from 70 to 88 in 45%. Role emotional Mental Health was already in good score preoperative so much significant change.[68–71] Physiotherapy should be done before surgery to increase ROM mobilize joints, scar lysis, and decrease oedema in healed cases as it benefits implant removal.[72]

Our data reveal a high percentage of subjective improvement in individual satisfaction after surgical implant removal. Refracture osteopenia metal toxicity neoplasia are all possible risks of a retained implant. The goal of this study was to analyse the assessment of the patient's quality of life and level of satisfaction after surgery and also summarize various techniques used for the removal of the implant [Figure 14].

CONCLUSION

The recovery in pain, ROM, function, and FB sensation with tremendous satisfaction after implant removal makes it a specific method and distinguished choice for a patient with implant-related problems. Postoperative complications occurred at a rate of 7%. Currently, indications for removal are mainly absolute with also 'relative' and patient-driven.

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