2.14 Implant removal

2.14.1 Introduction .......................................................... 239
2.14.2 Indications for implant removal .............................. 239
2.14.3 Risks of implant removal ........................................ 240
2.14.4 Techniques of implant removal ................................. 240
2.14.5 Techniques for special problems ............................... 242
2.14.6 Conclusion ........................................................... 244
2.14 Implant removal

2.14.1 Introduction

Implant removal is unfashionable, neglected, occasionally disparaged, often delegated to junior surgeons, but full of surprises and traps for the unwary.

2.14.2 Indications for implant removal

We should start from the position that there is no such thing as “routine” removal of an implant. Asymptomatic metalwork is generally best left in situ because all surgical procedures are risky. There must therefore be a reason to advise a patient to accept these risks. These reasons include:

Prominence: Prominent implant, particularly those adjacent to joints such as the LISS plates and plates on the lateral malleolus of an ankle, may impinge on the soft tissues, cause pain, and inhibit movement.

Loosening and failure: An implant that is loose or has broken generally means that the race between biological success (fracture healing) and mechanical failure of the implant has been lost. Fig 2.14-1 illustrates such a case. The implant must be removed before further treatment is possible.

Infection: Most pathogenic organisms have the ability to adhere to the surface of implants and to protect themselves with a mucopolysaccharide envelope or shelter where they cannot be reached by the body’s defences or antibiotics. Organisms in this “colonic” form remain a constant threat for recurrent infection. To eliminate this risk, it is usually necessary for the implant to be removed.

Pain: Pain may be due to prominence, impingement, or occasionally a biological reaction to the implant. Stainless steel implants are more likely to cause such a reaction than titanium implants. It may be difficult to establish the precise reason for pain in the vicinity of an implant and it may be that it is only the resolution of the pain when the implant has been removed that confirms that it was the implant causing pain.

Proximity to growth plate: Metaphyseal implants in children are generally removed because of fears that they may impede or distort bone growth.

To facilitate other procedures: Implanted metal may interfere with or prevent subsequent surgery. For example, a sliding-hip screw in the proximal femur would prevent hip replacement unless it was removed, and a corrective osteotomy for malalignment may be complicated by a previously implanted fixation device. In some fracture nonunions (Fig 2.14-2), the original implant must be removed before the nonunited fracture can be stabilized.

Fig 2.14-1 Fracture fixation has failed. Fracture fixation has failed.

Fig 2.14-2 Nonunion of the humerus, the nail must be removed and the fracture stabilized.
Biological effects of the products of corrosion: All metals corrode, and the products of corrosion are generally biologically active. Some metals corrode more than others. Stainless steel, particularly if of poor quality, corrodes much more than materials such as titanium. Corrosion may be “fretting” or “galvanic.” Fretting corrosion occurs when two metal fragments rub together and release small particles. Galvanic corrosion occurs when an electrical current is established between two components of the metal implant. This is particularly important if different metals are used within the same implant.

Corrosion results in the release of metal ions into solution. These products of corrosion are biologically active. They may cause an allergic reaction and there is concern that prolonged exposure to some metal ions may be oncogenic, although this has not yet been clearly established. This is an important area of research but has no immediate implications for the enormous benefits of using these materials in fracture fixation, although it may be a reason to consider implant removal in younger people.

Risks of implant removal

The general risks of all surgery, including risks of anesthetic, are inevitable. These include infection, wound breakdown, poor scarring, and deep vein thrombosis (DVT).

The specific risks to implant removal are:

Failure to remove implants: this is a disastrous outcome which occasionally reflects a challenging technical difficulty but more often stems from poor planning and inadequate provision of equipment. Broken implants, mainly locking bolts of intramedullary nails, stripped screw heads, cold-welded implants (particularly sliding hip screws manufactured from steel of different quality), and cross-threaded locking screw heads all pose unusual difficulties. These must be anticipated.

Refracture: defects in the bone from removed implants, mostly screws, weaken the bone by 30% or more. Refracture has been reported to occur in 1–3% of patients following implant removal. Patients must be advised to avoid load bearing or impact for up to 12 weeks following implant removal depending on the circumstances. Equally, premature removal may lead to early refracture. Figures given below for timing of fracture removal are only guides. The fracture must first heal.

- Metaphyseal fractures: 3–6 months
- Diaphyseal plates: 12–18 months
- Intramedullary nails: 8–24 months

Nerve injury: removal of forearm plates, mainly from the radius, has been linked to a high level of nerve injury.

Techniques of implant removal

Planning is as important in implant removal as in fracture fixation. It requires:

Recent x-ray: Implants may be buried in new bone, broken, or may have moved, especially K-wires. Updated x-rays are crucial.

Implant identification: Populations and patients are increasingly more mobile. It is possible that the implant to be removed was put in at another hospital or even in another country. Many implants look similar but require different equipment for removal. It may be necessary to contact the original hospital for details.

 Obtain the correct equipment: Generic equipment for removal of intramedullary nails has been available for some years. However, there are difficulties in using this equipment. For legal reasons relating to copyright and patent, generic equipment cannot be linked specifically with implants of other manufacturers. This restriction makes generic nail extraction sets surprisingly difficult
Anticipate the unexpected

Problems are encountered in which locking screws from intramedullary nails or indeed the nails themselves unexpectedly turn out to be broken. Screws may break or screw heads may be stripped so they do not engage with the screwdriver. The implant may be deeply buried in bone or bony bridges may pass through the implant. Locking screw heads, particularly if slightly cross-threaded or over tightened may be permanently fixed to the implant so that the head will strip before the screw can be removed. It is not acceptable to undertake an operation for implant removal without anticipating these difficulties, as they are common. Specialist metal removal sets exist to deal with many of these problems and can be ordered in advance (Fig 2.14-4).

Surgical tactic: This is no different from an operation for fracture fixation. Planning should include clarity of the type of anesthetic, the position of the patient, surgical approach, necessary equipment, and whether or not an x-ray will be required. It is helpful to the surgical team to have a written plan (see chapter 2.8). Implant removal can be challenging. Fig 2.14-3 illustrates a preoperative x-ray together with the subsequently removed implants. The broken nail with the broken locking screws had defeated two previous attempts at removal. Instead, a cable grip plate and a strut graft had been added at various times. Removal was only possible with careful planning.

Fig 2.14-3a–b  The challenge of implant removal.
  a  Before.
  b  After.

Fig 2.14-4  Screw extraction set with three modules for different screw sizes.
Operative technique
When planning is performed carefully, the operation should be straightforward. In general, it is important to use the same scar. Adjacent parallel scars look careless and may threaten a narrow bridge of skin between them. The principles of soft-tissue handling, anatomical dissection, and careful wound closure apply as in any other operation.

Aftercare
A postoperative x-ray is vital. Refracture is a recognized risk in this procedure. It is important to establish that the implants have been completely removed and that there was no intraoperative fracture. Thought should be given to activity levels, weight-bearing status, and the question of physiotherapy.

In the case of a weight-bearing bone with a large defect following implant removal, it may be prudent to arrange extended follow-up for 3–6 months, both to emphasize the risk of refracture to the patient and to confirm with x-ray that the bone has remodeled. It is difficult to assess the point at which the risk of refracture has passed by means of an x-ray. The period awaiting review may simply mean restricting loading until sufficient time has passed for the bone to strengthen.

2.14.5 Techniques for special problems

Broken bolts in locked intramedullary nails
The fragment attached to the head should be removed by a standard approach. Provided the nail has not moved, a Schanz screw or unthreaded Steinmann pin can be passed through the locking hole and gentle taps with a hammer will generally push the distal bolt fragment out of the nail and through the bone on the other side, where it can be retrieved through a separate incision.

If the nail has moved because the bolt broke, it may be necessary to withdraw the nail to the original position in which it was locked before using this technique.

Broken intramedullary nails
Hollow nails are usually relatively straightforward to remove. The sequence is as follows:
1. Remove any locking screws.
2. Approach the proximal end of the nail and remove it.
3. Pass a guide wire through the distal (remaining) fragment of nail.
4. Over ream the proximal part of the bone by at least 2 mm.
5. Pass a hooked wire, engage the distal fragment of the nail, and withdraw it using a T-wrench and slotted hammer.

Solid nails represent a much more difficult problem; however, they rarely break. When they do, the proximal portion can be removed in the standard way. If possible, drill and countersink the proximal end of the distal fragment to extract it. It may still not be possible to remove this nail fragment without windowing the bone, sometimes in several places, and cutting the nail into smaller fragments with a high-speed metal cutter.

Broken screws
The Synthes broken screw removal set contains in one tray the tools necessary for removal of screws broken in different ways (Fig 2.14-4). It also includes a metallic sheet printed with instructions for use. This is important as this set of instruments is usually unfamiliar to both surgeon and operating room personnel. It is strongly recommended that this set, or equivalent instrumentation, is available during all implant removal and particularly when problems might be reasonably anticipated.
Head-sheared off
This is a common mode of failure for older implants. The implant, generally a plate, can usually be removed. The shaft of the broken screw can then be removed either with the dedicated pliers (Fig 2.14-5) from the broken screw removal set if it is prominent, or with a hollow extraction screw, by overdrilling, if it is buried (Fig 2.14-6). The recess in the head may strip so that the screwdriver will no longer engage. In this situation, the damaged screw head can be drilled with a high-speed harden drill bit. A conical extraction screw can then be used to engage and unscrew anticlockwise the damaged screw (Fig 2.14-7). As the screw head remains in place, the implant cannot be removed until the damaged screw is removed.

Cold-welded locking screw head
This represents a particular problem with titanium implants when the “weld” is frequently stronger than the force which can be applied by a screwdriver to the screw head before the screw head strips. This is common and requires metal-cutting equipment to cut the plate from the screw head. The screw can then be removed with suitable pliers. The alternative method of drilling out the screw head from the plate makes removal of the screw remnant more difficult.

![Fig 2.14-5a–b](image) Broken screw shaft removal.
a The screw shaft is exposed with a gouge.
b The screw shaft is extracted with the screw removal pliers.

![Fig 2.14-6a–e](image) Broken screw shaft removal for deep-seated fragment.
a The screw hole is enlarged with a countersink.
b–c The screw shaft is overdrilled anticlockwise with a hollow reamer, which has been assembled with a centering pin.
d–e The extraction bolt is screwed anticlockwise over the threads of the broken screw and the fragment removed.
2.14 Implant removal

2.14.6 Conclusion

Implant removal should be carefully considered. The reasons for the operation should be clear. Planning should be meticulous. Difficulties are common and must be anticipated. Appropriate equipment must be available. Aftercare should be thoughtful.

Fig 2.14-7a–b  Screw removal when recess is damaged.

a The recess of the screw is "drilled out" with a high-speed drill bit (use HSS drill bit for steel screws and carbide drill bits for titanium screws).

b A conical extraction screw is inserted. The extraction screw will grasp the recess when turning under pressure anticlockwise and can then be removed.