Implant removal
Bruce Twaddle

Presenter’s name
Presenter’s title

<Event-Date>
At the end of this lecture you will be able to:

- Outline the role of ORP in planning for implant removal
- Discuss what is required to remove broken and damaged implants

The complexity and potential pitfalls of removing skeletal implants in trauma is often underestimated. You may be surprised what you find beneath the surface but if you are trained, practiced, and prepared you will be able to overcome most situations. Planning and preparation are paramount.
Implant removal is an operation that is never associated with the concept of "success". It is often left to the more junior members of a surgical team, at the end of the list, when many of the experienced medical and ORP staff have already left. This procedure, therefore, has the highest incidence of minor, and sometimes serious, complications of any that we perform and can often result in a more prolonged period of recuperation for the patient than anticipated. It is important to realize that implant removal is certainly not easy and all members of the surgical team should be prepared for a number of unforeseen incidences, have available the appropriate equipment and all information referring to the implanted device(s).

It has been said that implants are like fish-hooks: they are easier to put in than to take out!
Planning for implant removal

- Never underestimate implant removal
- It requires meticulous planning and communication

“Failing to plan is planning to fail”
Benjamin Franklin
Rule of W’s or five questions will help with the preparation for implant removal surgery:

1. What needs to be removed? Which implants have to be removed?
2. Why does the implant need removal?
3. When was it implanted?
4. Where is the implant located?
5. Who will do the removal?
Rule of W’s

1. **W**hat needs to be removed?
2. **W**hy does the implant need removal?
3. **W**hen was the implant inserted?
4. **W**here is the implant located?
5. **W**ho will do the removal?

Rule of W’s or five questions will help with the preparation for implant removal surgery:
1. What needs to be removed? Which implants have to be removed?
2. Why does the implant need removal?
3. When was it implanted?
4. Where is the implant located?
5. Who will do the removal?
What needs to be removed?

This is the first and most obvious question. Here are some examples shown.
There are some fundamental principles that are essential if you are to avoid, not only the embarrassment of not being able to remove the implant, but additional risk to the patient.

- Is the implant broken? Which additional instruments are likely to be needed?
1. What needs to be removed?

- Broken or intact implants?
- All implants or only a few?
  - What is the surgical plan?
- Titanium or steel?
- Who manufactured it?
  - Is it a standard known implant?

- Are all parts removed which need to be removed?
- Of which material is the implant? (e.g., stainless steel is less brittle and easier to remove than titanium and there is less adhesion)
- Of which make and model is the implant? The extraction set of intramedullary nail depends on the type.
- What is the surgical plan?

With the wide range of trauma implants now available, it is very important to have a very clear idea of what implant is involved and what product it is. For example, some IM nail locking screws will have a hexagonal head and some more recently inserted nails will have a stardrive head. The precise details of the implant is very important. Corresponding extraction tools will need to be made available before scheduling the patient for surgery.

Ask participants to reflect on what resources they have available to them.
2. Why does the implant need removal?

- After consolidation of fracture
- Timing
  - Wires and screws: 3 months
  - IM nails: 18 months
  - Long bone plates: 18 months
  - Periarticular plates: 18 months
- Different regions, countries
  - Different regulations

Why must the implant be removed?

Here are some recommended guidelines:

- Wires and screws should be removed at 3 months
- Plates of long bones should be removed at 18 months
- Periarticular plates should also be removed at 18 months
- Intramedullary implants (eg, nails) should also be removed at 18 months

These are guidelines for removal after a normal fracture healing process. Different countries, regions, hospitals have different protocols.

Not every implant needs to be removed and every country has different legal, cultural, and perceptional influences that dictate if an implant should be taken out.

- Ideally an implant should not be removed before the fracture is solidly united and the implant is no longer serving any purpose.
- In some countries the law or custom makes implant removal almost mandatory.
If the implant, by being subcutaneous or irritating some other structure, is causing the patient symptomatic disability then it is beneficial to try to remove it, provided the fracture has united.

Theoretically routine removal is usually straightforward, but remember do not underestimate any implant removal!

Ask participants to reflect on their own experiences.
If the implant, and usually the fracture that it was fixing, has obviously failed, then in the majority of cases, unless the condition of the patient dictates otherwise, the implant should be removed and an alternative form of fixation applied. An example of this is if a screw has penetrated an articular surface either by incorrect placement or collapse of the fracture, then it should be removed as soon as possible.
This is an example (A) of a fracture of the proximal humerus in a patient with a complex history of anorexia, substance abuse, and drug overdose. The original fracture fixation was complicated by an infection. The fracture was revised to this construct (B) but, as it collapsed and healed, the fixed angled screws penetrated the joint one by one and had to be removed sequentially, until all the screws in the proximal portion of this locking plate were removed.

The picture on the right shows the last screw having penetrated the joint (C). Fortunately the fracture united without avascular necrosis (AVN) and because of vigilance and anticipation of this problem, a satisfactory result was achieved, considering the complexity of the case.
2. Why does the implant need removal?

- Protruding implant that causes pain

A protruding implant that obviously needs to be removed!
2. Why does the implant need removal?

- Plate failure—fatigue
  - Broken screws (A and C)
  - Broken plate (B)

In this case, the fracture did not unite and the repeated stresses on the plate and screws have resulted in fatigue failures.
2. Why does the implant need removal?

- Implant failure—fatigue
  - Plate: LCP
  - Screws: LHS

Here is an example of a LISS plate with broken LHS.
2. Why does the implant need removal?

- Infection
  - Fracture not yet healed but infected

1. Implant stays in situ
   - Treated surgically and pharmaceutically (Twaddle, 2006)

2. Implant has to be removed
   - Deep and severe infection
   - Chronic infection

In infected fixations, if the implant is no longer providing stability, its removal will be part of the treatment program. The implant has to be removed when the infection is deep and severe.

Twaddle states that even infected implants can stay in tact until bone healing has been achieved.

When infection occurred:

Step 1
- Try to keep the implant in situ until union for as long as it stabilizes the fracture.
- Treat the infection with debridement, local and general antibiotics.

Step 2 - Infection is very severe and deep. Implant is unstable.
- Implant must be removed
- Consider temporary splintage.
- Alternative stabilization, often an external fixation.
- Treat the infection with debridement, local and general antibiotics.
ORP preparations for removal

- Provide equipment and broken implant removal set
- Consider bone grafting
- In case of infection:
  - Debridement and lavage
  - Local antibiotics (eg, beads)
  - Special dressing
- Consider alternative fixation method
  - External fixator

ORP considerations will be derived from the surgical plan.

- Is all correct equipment available? Is the broken implant removal set available in case this is needed? Screws can also break while removing.
- In case of implant failure, will there be an alternative fixation?
- Are bone grafts an option?
- Was there a previous infection? This may determine the need for microbiological studies of tissue biopsies to check for any continuing infection.
- In case there is an infection:
  - What is needed for debridement and lavage?
  - Are local antibiotics required?
  - Are special dressings available? VAC dressings?
  - Is specimen collection needed?

- Important also is improvisation.
3. When was the implant inserted?

- The longer an implant has been in place, the more difficult it may be to remove
  - Ingrowth of tissues in threads of implant
  - Connective tissues on smooth implant surfaces
  - Severe corrosion
  - Titanium implants may be more difficult to remove
- Search for date of implantation

The longer an implant has been in place, the more difficult it may be to remove.
  - Ingrowth of tissues in threads of implant
  - Connective tissues on smooth implant surfaces
  - Severe corrosion
  - Titanium implants may be more difficult to remove

Search for date of implantation.
Where is the implant located?

The location of the implant will define the position of the patient. In this example a rarely used position was needed for the implant removal in a humeral shaft fracture—with a posterior approach.
5. Who will do the removal?

- Experienced or less experienced team
  - The insertion/extraction technique must be known by the entire team
  - Ideally the surgeon who implanted should also remove the implant

- Assistance for advice
  - Should be available

Who will perform the operation?

Is the team experienced with the technique?

- A rule is: The surgeon who implanted it should remove it. He/she knows exactly how it has been implanted and if there were any difficulties, closely related anatomical structures, etc. However, this is not always possible.
- It is also important to know in advance whom to contact for help should you have a problem.
It is essential to have recent x-rays of the affected bone and implant in case something may have changed in the interim. A common example of this is when a diastasis screw for an ankle fracture is to be removed and it has broken since the patient was last x-rayed.

Make sure to have always
- Recent x-rays present (as they might show implant breakage, etc)
- AP and lateral views present

Ask participants about the communication channels available to them and if they are effective.
- Booking, preoperative meeting, etc.
How to get all the information?

How many distal bolts are there?

Ask question on slide before explaining.

This slide shows that if the surgical planning is based on the AP view only we might think that only two distal bolts must be removed.
The lateral view, however shows that there is a third bolt to be removed.
**Difficult implant removal**

1. Broken screws
   a. Shallow seated screw shaft
   b. Deep seated screw shaft
   c. Screw with stripped recess
   d. Jammed locking dead screw

2. Intramedullary nails

In the next slides difficult removal of broken screws and intramedullary nails will be discussed.
Removal of broken screws

There may be no information prior to surgery that broken screws need to be removed.

When broken screws are present, the set for removal of broken screws should be prepared before the operation starts. The picture shows an example of such a set.

• As already emphasised, it is important that a recent x-ray be available and also that OR personnel should be able to identify broken screws on an x-ray.

• The set contains many different items. It is extremely important that the scrub-nurse and the surgeon both know exactly which instrument is used and for what purpose.

Note to use of instruments:

The surgeon should only use the instruments for their designed purposes, eg, hammer blows should not be delivered onto a T-handle. The scrub nurse is responsible for the correct use of instruments.
Procedure for a shallow-seated screw shaft (or sheared head)

1. First enlarge access to screw shaft with a gouge
2. Then try removing shaft anticlockwise with pliers. If the screw shaft is not sufficiently exposed the conical extraction bolt can be used. This is explained in the next slides.
Procedure for a deep-seated screw shaft (or deep broken screw)

1. When removing a deep seated screw shaft it is recommended first to use a countersink clockwise to enlarge the screw hole and get good access to the screw shaft.
2. Then drill anticlockwise around the shaft using a hollow reamer, which is assembled with its centering pin. Take care to select the correct reamer size! Assembling the reamer may seem difficult as it is all reversed thread. ORP must try this out before surgery.
Procedure to remove
b. Deep seated screw shaft

3. Insert extraction bolt over shaft
4. Remove shaft counterclockwise

Then insert the correct size extraction bolt counterclockwise and remove the shaft fragment.
The most common problem with implant removal is the screwdriver type and size. ORP should make every effort to ensure that they have the correct instruments.

Note: A screwdriver’s name is closely related to the shaft of the screw it is designed to insert and remove. For example a small fragment screwdriver is named 2.5 mm screwdriver.
Procedure to remove
c. Screw with stripped recess

- Prevention
  - Insert screw manually (final tightening)
  - Use torque limiter for insertion of LHS
  - Loosen the screw manually
  - Use the correct screwdriver
  - Use a standard screwdriver also for removal of LHS

Remember that any torque limiter is a very expensive tool in comparison to a standard screwdriver, so always use a standard screwdriver for removal.
1. The conical extraction bolt is assembled onto a T-handle. Note that there are 2 sizes available.
2. The thread of the bolt is inserted in the screw recess by turning it counterclockwise.
3. Light pressure and continuously turning counterclockwise results in removing the screw.

Procedure to remove
c. Screw with stripped recess

1. Try to insert the conical extraction screw counterclockwise and remove screw
Procedure to remove

1. Try to insert the conical extraction screw counterclockwise and remove screw

2. Destroy screw recess with high speed drill bit
   - Note the large amount of metal debris

If the thread of the conical bolt does not grip and the screw cannot be removed, destroy the screw recess with a larger high speed drill bit, until the head becomes loose.

The photograph on the right shows how much metal debris is produced when drilling out the screw recess to separate the head.

Be sure to irrigate copiously with cold Ringer-lactate solution throughout drilling.

When the screw recess is stripped and the conical extraction bolt does not hold, the screw recess can be drilled out with a high speed drill bit, in order to remove the screw head.
Common problems with locking head screws:

- Seldom do all screws come out easily
- Problems are:
  - Cross threading—screw was not inserted correctly (which should have been perpendicular to the LCP). Oblique insertion and mismatch of threads took place during insertion. Hence the importance of the correct use of the appropriate drill sleeve by insertion.
  - Cold welding—The thread of the screw head becomes cold-welded (fused) with the thread of the plate hole
  - Stripped screw head recess—The recess in the head of the screw can easily be stripped when screw removal is difficult. The material (titanium is softer) will play an important role.
Procedure to remove
d. Jammed LHS

1. Use a high-speed, hardened drill bit to detach screw from plate

If an LCP cannot be removed because a LHS is jammed in the screw hole (cold welding, or damaged recess) the screw head can be detached from its shaft so that the plate can be removed. This is accomplished by using a hardened metal drill bit the same diameter as the screw thread.
Procedure to remove
d. Jammed LHS

1. Use a high-speed, hardened drill bit to detach screw from plate
2. Attach hollow reamer to screw shaft
3. Remove screw with extraction bolt

In a second step the remaining screw shaft will be removed with the hollow reamer and extraction bolt (explained in previous slides).
Use a Do It Yourself (DIY) kit

- A sharp hook
- Best screwdrivers
- Worst osteotomes/gouges
- Different pliers
- Old needle holder
- …

Ask participants to suggest additions in informal discussion forums.
2. Removal of intramedullary nails

- Problem:
  - Interlocking screws are broken
  - Recess of screws/nail is damaged
- Procedure:
  - Prepare correct instruments
  - Remove screws first
    - Leave proximal screw in place
  - Remove nail
    - Attach extraction bolt to nail
    - Remove proximal screw
    - Remove nail

Often only interlocking screws are broken or have damaged recess.

Procedure:
- Have correct instruments available. This is only possible when you know which implant will be removed.
- Removal starts with good access
  1. Interlocking screws are removed (The screw is called an interlocking screw to distinguish from locking head screws.)
  2. Nail is removed—soft-tissue and bony overgrowth must be completely removed from the top of the nail.

Note: The proximal interlocking screw is left in place until the extraction bolt is fixed on the nail. The nail will not rotate while insertion of the extraction bolt.
3. Removal of pediatric implants

- Much care is needed
  - Growth plates still open

- Overgrowth of bone
  - Difficult to access and remove
  - Special pliers are useful
Questions
A screw shaft remaining in the bone may be removed with:

1. Hollow reamer and extraction bolt
2. Hollow reamer and conical extraction screw
3. High-speed drill bit and extraction bolt

Optional
Insert questions to check learning
A screw shaft remaining in the bone may be removed with:

1. Hollow reamer and extraction bolt
2. Hollow reamer and conical extraction screw
3. High-speed drill bit and extraction bolt

Optional
Insert questions to check learning
For the removal of a LHS, what is always required?

1. A torque limiting screwdriver
2. A normal screwdriver
3. A high-speed drill bit

Optional
Insert questions to check learning
For the removal of a LHS, what is always required?

1. A torque limiting screwdriver
2. A normal screwdriver
3. A high-speed drill bit

Optional
Insert questions to check learning
Optional
Insert questions to check learning
When an infection occurs, the implant(s) will:

1. Always be removed
2. Only be removed when severe infection
3. Not be removed until fracture is stabilized

Optional
Insert questions to check learning
You will now be able to:

- Outline the role of ORP in planning for implant removal
- Discuss what is required to remove broken and damaged implants