

Screws—Form and function

Chris Colton, Judy Orson

How to use this handout?

The left column is the information as given during the lecture. The column at the right gives you space to make personal notes.



Learning outcomes

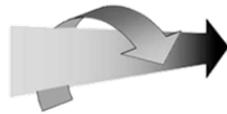
At the end of this lecture you will be able to:

- describe the screw as a mechanical device
- discuss its physical attributes and functions
- discuss functions which screws perform

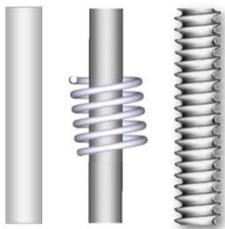
What is a screw?



A screw is a device which converts rotational forces into linear motion.



Screw design



A screw has a core about which is wrapped a spiral surface.



In the surgical context, most screws have a screw-head, the function of which is discussed later.

Most surgical screws are made of either stainless steel or titanium.

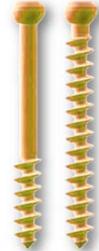
Thread design may vary according to the physical characteristics of the bone in which the screw is intended to gain purchase.



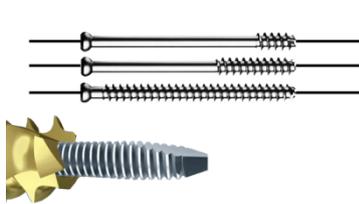
Cortex

The two main thread types of surgical screws are for cortical bone and for cancellous bone.

Each screw type is available in fully threaded and partially threaded format.



Cancellous

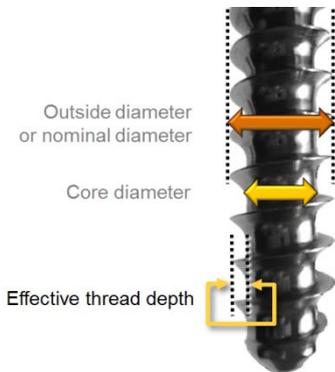


Screws can also be cannulated. Such a screw can be introduced over a threaded-tip guide wire. The guide wire is inserted

preliminarily, partly as temporary fracture stabilization, and partly so that the final orientation can be checked radiologically, prior to screw insertion. These screws are self-tapping.

Screw parameters

Diameter



This is an example of the thread of a cortex screw.

A surgical screw is a device manufactured to high specifications, and is to be used with great care and precision.

In order to select the correct instruments and technique for insertion of any screw, the

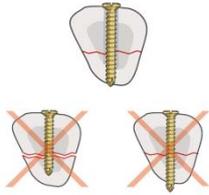
surgeon needs to be familiar with its dimensions. The diameter of the core determines the minimal hole size for the screw to be accommodated in the bone and determines the drill used to create the pilot hole for the screw. In other words the drill to be used will be the same (approximately the same) diameter as the core of the screw.

Length

The nominal length of the screw is from the top of the head to the screw tip.

An appropriate length of screw needs to be chosen.





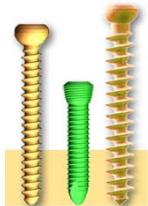
Too short—it will not gain full purchase in the bone.
 Too long—it may cause problems by irritating the soft tissues, or protruding subcutaneously.

Pitch

The pitch of the screw is the length travelled by the screw with each 360° turn of the spiral.



The shorter the distance, the “finer” the pitch; the longer the distance, the “coarser” the pitch.
 Cortical bone screws have a fine pitch; cancellous bone screws have a coarse pitch.



The finer the pitch, the more turns the surgeon will have to make to insert the screw and the more turns of the spiral thread engage in a given depth of cortex. The more threads engaged in the cortex, the greater the pull-out resistance.

Head

The screw head has two basic functions.

- One is to permit the attachment of a screwdriver in order to produce the rotation necessary to insert the screw. This is achieved by producing a shaped recess; this is usually star-shaped, or hexagonal: some very small screws, used in metacarpal and phalangeal surgery, have cross-shaped recesses.



- The second one is to arrest forward motion.



Threaded head

Some screw heads have a third function. The development of the threaded, or locking, head has allowed screws to lock into threaded plate holes and by creating an angularly stable construct. This is explained in greater detail at a later stage.

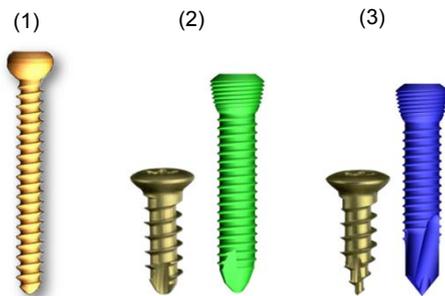


Tip

Standard, self-tapping and self-drilling screws

Screw tips are of three major types:

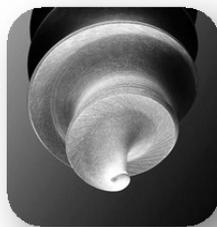
- The standard, round-tipped screw needs pre-drilling of a pilot hole and then tapping (the creation of a thread in the bone by the use of a separate thread-cutting tool - a tap). (1)
- The self-tapping screw needs pre-drilling of a pilot hole, but creates its own thread in the cortical bone by virtue of cutting flutes at the tip. (2)
- The self-drilling screw requires no preparation of the bone before insertion. It is also self-tapping. (3)



Cancellous screws

The tips of cancellous screws are designed as a tapering spiral.

These tips create their own threads in cancellous bone, as the tapered spiral advances, it pushes the spongy cancellous bone aside to thread its way into the bone.



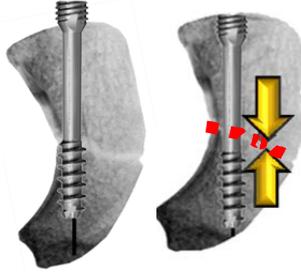
Special screws



In small bones, such as the scaphoid, self-compressing, double pitch screws can be used.

These are usually cannulated.

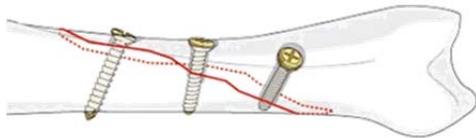
As the fine pitch of the thread on the head engages the bone, it travels less far on turning than the coarse-pitched tip and so compression is applied across the fracture plane.



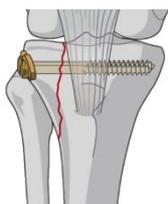
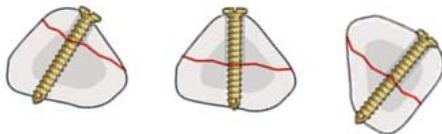
Screws—what are they used for?

To produce interfragmentary compression

In fracture surgery screws are often inserted across a fracture plane to produce interfragmentary compression, as in this spiral metacarpal fracture.



Note how, because of the spiral nature of the fracture and the need to insert the screws perpendicular to the fracture plane, they vary in direction.



Partially threaded cancellous bone screws

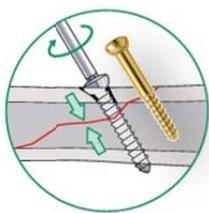
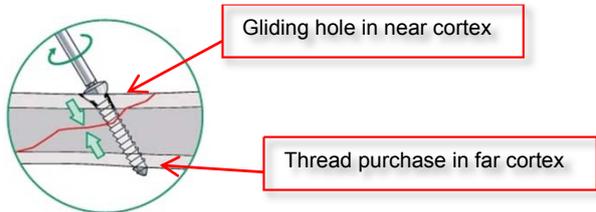
Partially threaded cancellous bone screws inserted across a fracture to produce interfragmentary compression, are used in joint areas, as in this tibia head fracture.

Washers spread the load applied by the head on the underlying cortex and are used to prevent the screw head from breaking through the thin cortex.



Lag screw principle

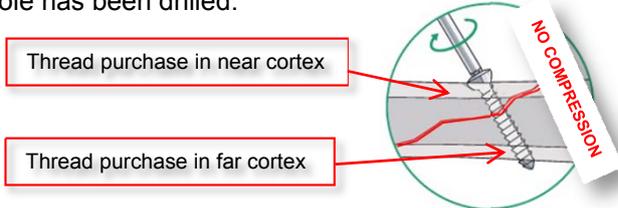
For a screw that crosses a fracture plane to produce interfragmentary compression, the thread must purchase in only the far cortex. A gliding hole is drilled in the near cortex.



Special partially threaded cortical, or shaft-screws are also available for this purpose. The drilling procedure is the same, except in softer bone, no gliding hole needs to be drilled.

If the screw that crosses the fracture plane purchases in both cortices, it cannot produce interfragmentary compression.

This would be the case if the screw hole has been drilled with 3.2 mm through both cortices. No gliding hole has been drilled.



To attach implants to the bone by compressing them onto the bone surface

Screws are also commonly used to attach implants, such as plates, to bones.

As the plate hole is larger than the outside diameter of the conventional cortex screw and the screw has good purchase in the underlying bone, as it is tightened it compresses the plate to the bony surface.

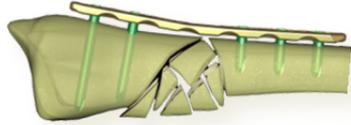


To attach implants to bone producing angular stability

By using a threaded head screw in its matching locking plate, an angularly stable construct results. The concept of angular stability will be explained more fully later in the course.

This is especially useful in metaphyseal fractures.

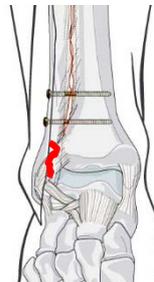
When such screws are used in the shafts of healthy long bones, *monocortical screws* will often suffice.



To hold two bones in correct relationship—position screws

Screws are sometimes used to hold a relationship between two bones: these are called “position” screws. Their threads purchase in both bones and the screws do not compress the bones together.

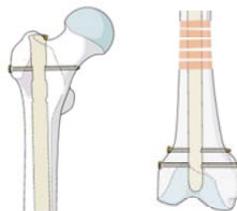
In this example, the fibula is fractured high up at its neck and the interosseous ligaments are torn: the fibula has been pulled into its normal anatomical relationship to the tibia, and held in position with two screws, each purchasing in two fibular and two tibial cortices.



In this instance, where the screws are being used to stabilize the tibio-fibular syndesmosis, they are sometimes referred to as “syndesmosis” screws.

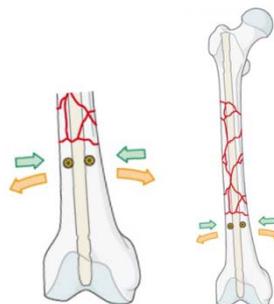
To lock an intramedullary nail to the cortices

Screws passed through the cortices and through holes in IM nails increase stability by resisting deformation in rotation and shortening. These are referred to as interlocking screws.



To block movement of a main fragment around an IM nail – Poller screws

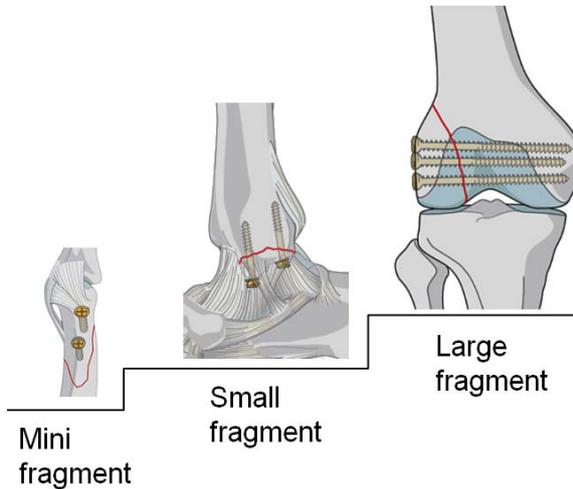
Screws passed through the cortices and directly alongside IM nails increase stability by blocking angulation of a main fragment in relation to the nail. Such screws are called “Poller” screws.



Screws—what size?

Screws come in various size ranges, depending on the size of the bone being fixed.

There are mini-, small- and large-fragment sets.



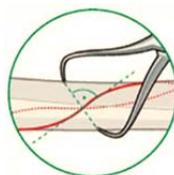
Screw size charts are readily available, indicating associated drill and tap sizes.

Screw type	Cortex screw	Cortex screw	Cancellous bone screw, partial thread	Cancellous bone screw	Cortex screw	Cancellous bone screw, short thread	Cancellous bone screw, long thread	Cancellous bone screw, full thread
Screw size, mm	2.7	3.5	4.0	4.0	4.5	6.5	6.5	6.5
Drill bit for gliding hole, mm	2.7	3.5	—	—	4.5	4.5	4.5	4.5
Drill bit for pilot hole, mm	2.0	2.5	2.5	2.5	3.2	3.2	3.2	3.2
Tap size, mm	2.7	3.5	4.0	4.0	4.5	6.5	6.5	6.5

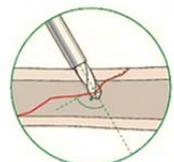
Lag screw technique—step-by-step

The steps of the lag screw technique in cortical bone should be followed in a logical order.

Normally, after holding the fracture fragments in a position of anatomical **reduction** ...



... the near cortex is drilled to produce a **gliding hole**.

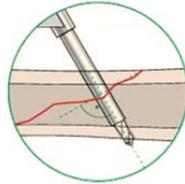


The chosen drill for the gliding hole is that of the outside (or nominal) diameter of the selected screw. For example, if a conventional 4.5 mm

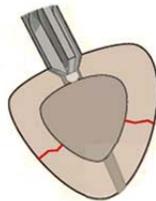
cortex screw is selected, then the gliding hole drill will be of 4.5 mm diameter.

NB. In this series of illustrations the pointed reduction forceps is omitted, for the sake of clarity.

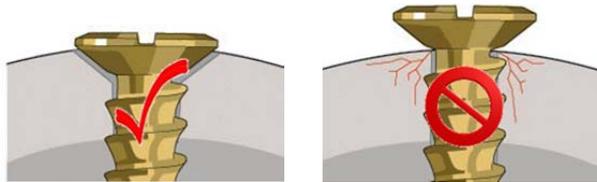
The drill sleeve for the core diameter drill bit is then inserted into the gliding hole, and through it the **pilot hole** is drilled in the far cortex (for a conventional cortex screw this is 3.2 mm diameter).



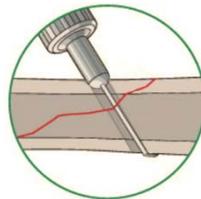
The near cortex is then **countersunk** to spread the load of the head of the screw on the underlying cortex.



Failure to countersink can result in very high stresses at the screw-head/bone interface, causing microfractures, leading to screw loosening.



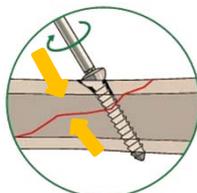
The depth of the screw track is then **measured**, taking care to engage the hook of the depth gauge against the obtuse edge of the exit hole, not the acute angled edge. It is important to follow this order of steps of technique to make sure that the correct length of the screw is measured. If measuring takes place before countersinking then the length of the screw will be too long.



The far cortex is then **tapped** by hand, using the drill sleeve in the gliding hole – this step is omitted when using self-tapping screws.



The selected screw is then carefully **inserted**, tightening it to produce interfragmentary compression.



Summary

You should now be able to:

- describe the screw as a mechanical device
- discuss its physical attributes and functions
- discuss functions which screws perform

Questions

1. **The core size of a screw defines the size of which instrument?**
2. **Which stability is obtained with LHS?**
3. **When does the surgeon countersink? Give the correct steps of procedure.**

Reflect on your own experiences

- **Which screws do you use? Do you know the correct steps of procedure and the correct size of instruments for each of them?**
- **What would you take out this lecture and transfer into your practice?**

Notes