AO Foundation

STATION C

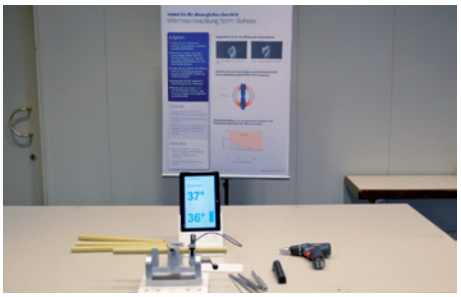
Skills Lab Faculty Guide

Heat generation during drilling

At this station, you will be able to show to the participants, how much heat is generated when drilling through bone cortices, either with a K-wire or with blunt and sharp drill bits. After this station the group should be aware of this potentially hazardous complication and how to take measures to prevent it.

The heat generated as an object passes through bone can cause osteonecrosis and, consequently, fixation failure. This must be taken into account when fixing a fracture, since drill-bit temperatures during drilling can reach levels that can get dangerous for the bone. The same is true for reaming before inserting an intramedullary nail.

The participants can observe how the temperature rises when they drill a hole into the artificial bone and how the results vary when using a K-wire or sharp and blunt drill bits. The graph on the poster explains when osteonecrosis will occur as a result of the temperature on the bone (as shown on the monitor) versus the time of heat exposure.



Learning outcomes

After completing this station, participants will be able to:

- Learn to differentiate between sharp and blunt drill bits
- Predict heat distribution in the bone cortex
- Recognize and compare results from a K-wire and blunt or sharp drill bits

Take-home message

- Use sharp drill bits to reduce heat generation and damage to bone
- Blunt drill bits must be replaced

Station sequences (your tasks)

When you arrive at the station for the Skills Lab module:

- Familiarize yourself with the poster which includes information about the station learning outcomes and tasks.
- Check the set-up before participants arrive.
- Check that the monitor is on and the screen shows two temperatures: „current" and „maximum".

During the group activity (to be repeated for each group):

- Show the participants how to distinguish between sharp and blunt drill bits by comparing the tips of the drill bits in good light. The tips of blunt drill bits reflect light, the tips of sharp drill bits do not. Introduce the principles of heat distribution when drilling.
- Press the button on the screen to reset the thermometer.
- Ask participants to choose a drill bit (sharp or blunt, 3.2 or 4.3 mm), however, it is advisable, to use the sharp 3.2 mm drill bit first, or a K-wire. Let them then drill through the respective drill sleeve into the artificial bone. The drill bit/K-wire must be left in place with the tip sticking out for a while and can then be removed.
- The monitor will show the peak temperature as well as the current. Compare the „maximum" value on the screen with the graph on the poster and explain how long the bone would withstand this maximum temperature before necrotizing. Use the live temperature on the screen to show how the temperature of the bone stays well above body temperature for some time even after removing the drill bit or a K-wire.
- Since heat generation varies with sharpness, it is important that the participants try all the tools available to compare results. Encourage them to test their skills with different drill bits or K-wires; ideally, every participant drills and measures the heat for at least one drill bit or K-wire.
- Move the bone in the bone holder to change the drill hole position. If the screen shows a higher temperature than 36–37°, press the „Reset" button on the screen and then, if a difference persists, move the artificial bone even further away from the previous drill hole.

Discussion points

- Discuss the benefits of using a sharp drill-bit tip.
- Summarize the take-home messages.
- Briefly restate the findings of the exercise:
  - Did all participants pay attention to what drill they were using?
  - Could they figure out while drilling, which drill they were using?
  - Can they explain the causality between temperature, time and osteonecrosis?
  - Were they able to identify the drill bit sharpness only by looking at the tips?

While participants are changing tables:

- Ensure that you reset the screen so it shows 36–37°C also as „maximum".
- Disengage the drill bits from the drilling machine if you want to start your next presentation by showing the drill bits.
- If required, clean the table and the bone holders as well as the drill bits with a cleaning towel.
- If no more holes can be drilled into the artificial bone, replace it with a new one.

Before you leave the station after the Skills Lab module:

- Remove the drill bit/K-wire from the drill.
- Clean the drill bits and bone holder if necessary.

Frequently asked questions (FAQs)

Why does heat necrosis occur?
As the drill bit or K-wire rotates and passes through the cortex, friction occurs. Ultimately friction is the source of heat production (for example, heat is created by rubbing your hands together).

What factors influence heat generation?
Friction is what produces the heat so all those factors that produce more friction produce more heat. Hence, by using a bigger drill bit or K-wire there will be more surface area available subject to friction. The same thing happens with speed and feed rates: the sharpness of the instrument and the amount of pressure applied affects this rate. If you have a sharper drill tip and you put more pressure on it you will have a faster feed rate. Faster feed rates reduce the contact time of the two surfaces, thereby producing less friction and therefore less heat.

What can I do to prevent heat necrosis due to drilling?
The most effective way of reducing heat is by using sharp drill bits, which also have the benefit of reducing soft-tissue penetration, as seen in the station „Soft-tissue penetration during drilling". Where irrigation has a marginal effect on the heat production during drilling on the near cortex, it cannot solve the problem on the far cortex. In either case, the cooling fluid cannot be directed onto the tip of the drill bit, where friction and, in consequence, heat is generated.

How does thermal necrosis alter bone fixation?
This can be easily understood by looking at the figure in the poster. Heat produces a conically shaped area of damage around the drill bit. This area is where the screw will get its purchase to the bone. If this area of bone is dead, it has to be remodeled with consequent loosening of screw anchorage. Dead bone is also an active culture site for infection.