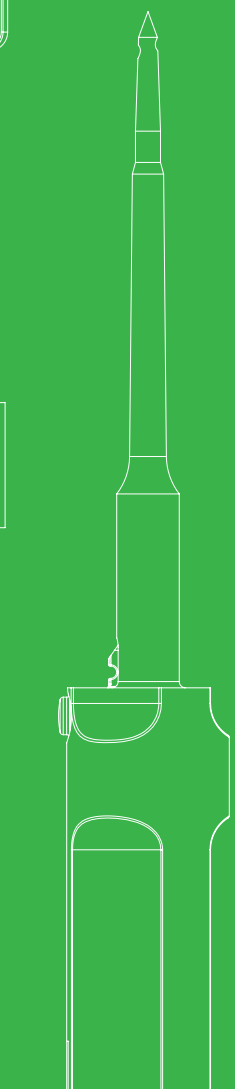
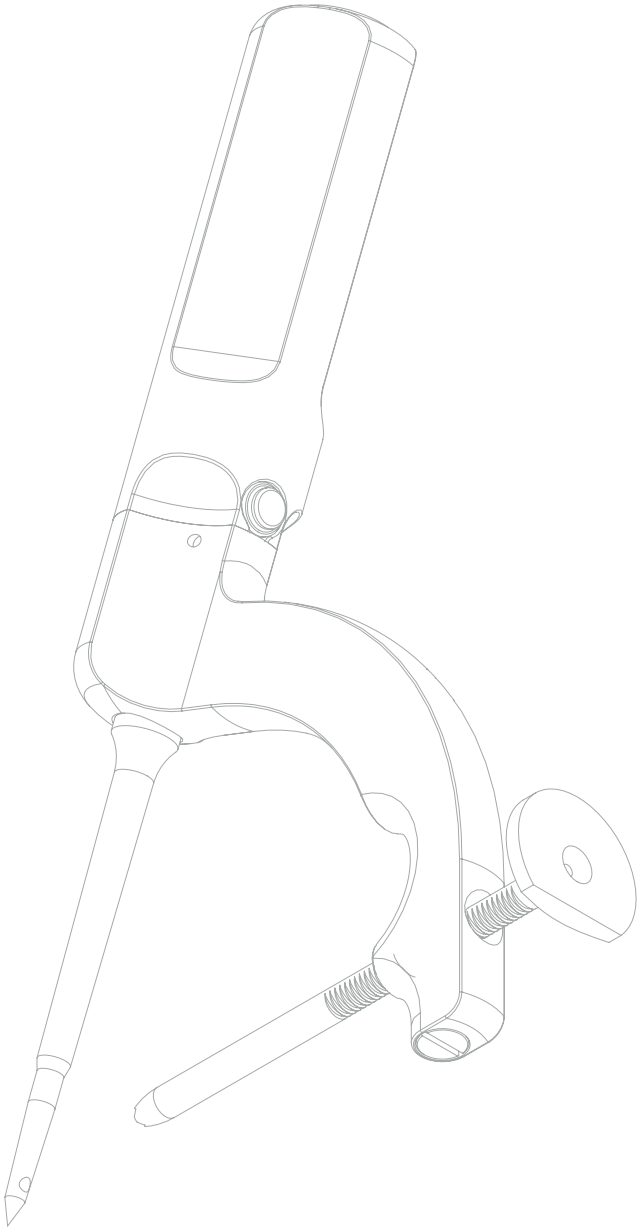
drillbone

SURGICAL TECHNIQUE

Drillbone Tunneler

Rotator Cuff Repair Tunneler





Annex 1/1001/ENG02/20240730

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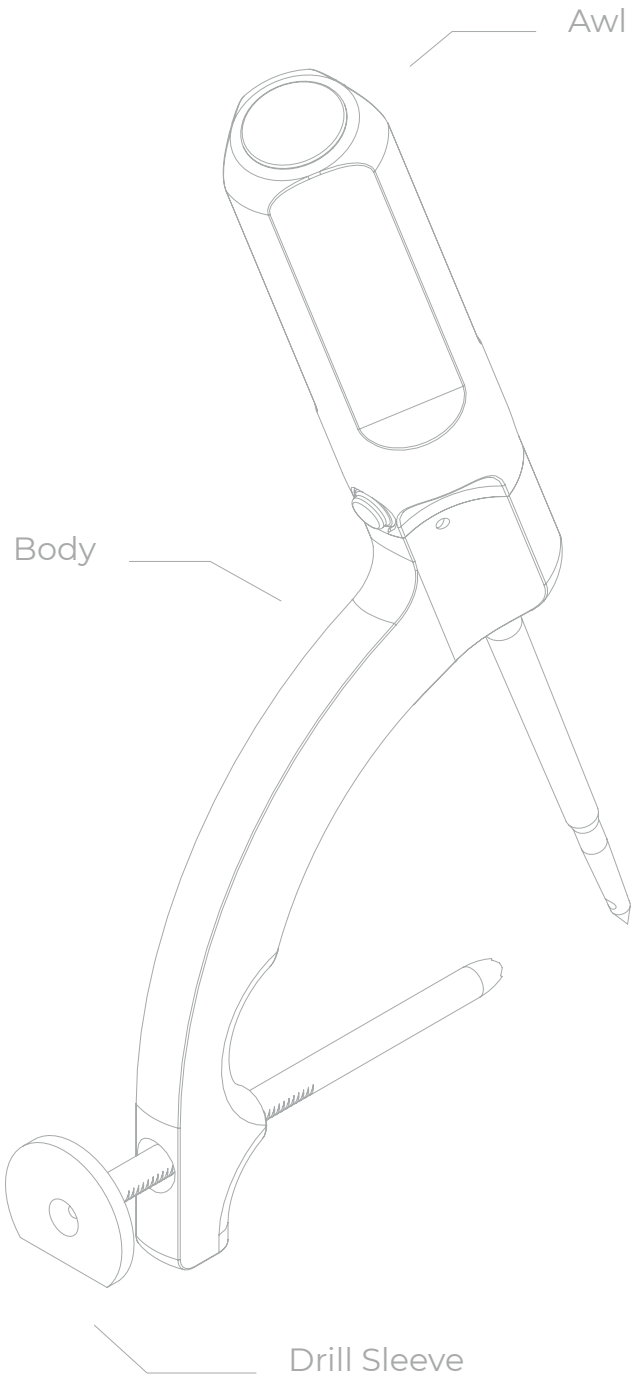
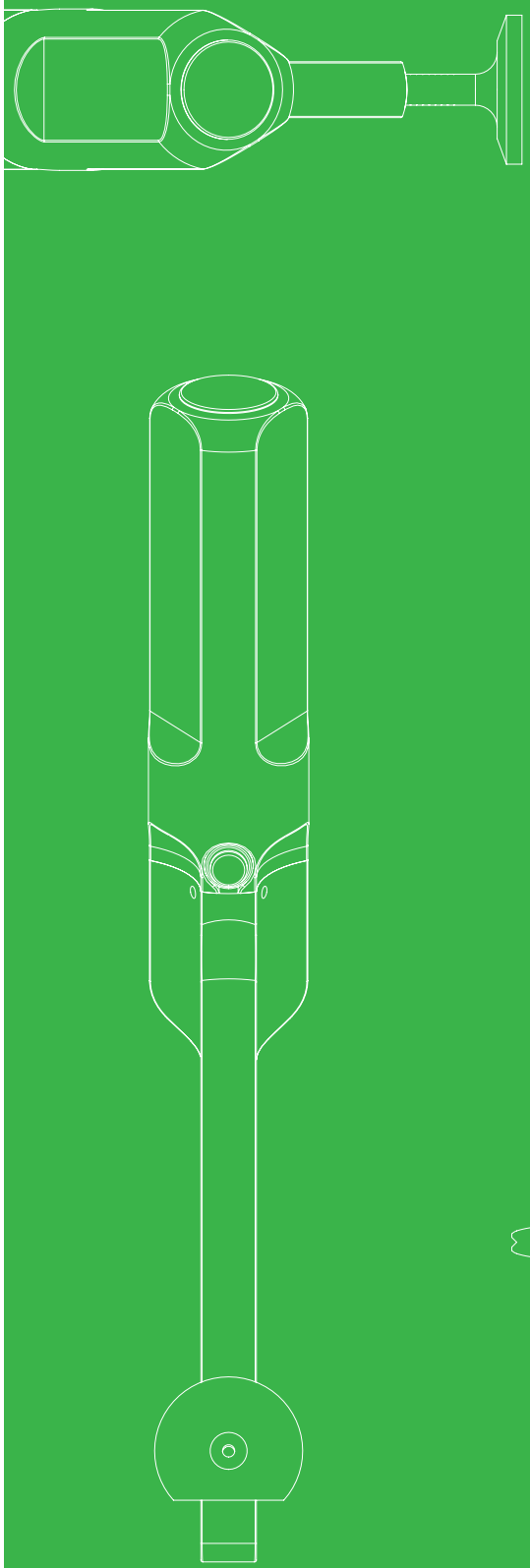
for better healing"





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1. Introduction

Drillbone Tunneler allows for drilling precisely positioned tunnels for performing the transosseous rotator cuff repair. It can be used both in the beach-chair position as well as in the lateral decubitus position. More than one tunnel may be drilled during a single operation.

2. Positioning

For preparing tunnels in the beach chair position it might be better to position the operated extremity with the shoulder in extension to facilitate access to the medial part of the footprint and introduction of the awl.

For an optimal access in the lateral decubitus position the angle of the arm suspended on a traction device against the operating table should not exceed 25 degrees.

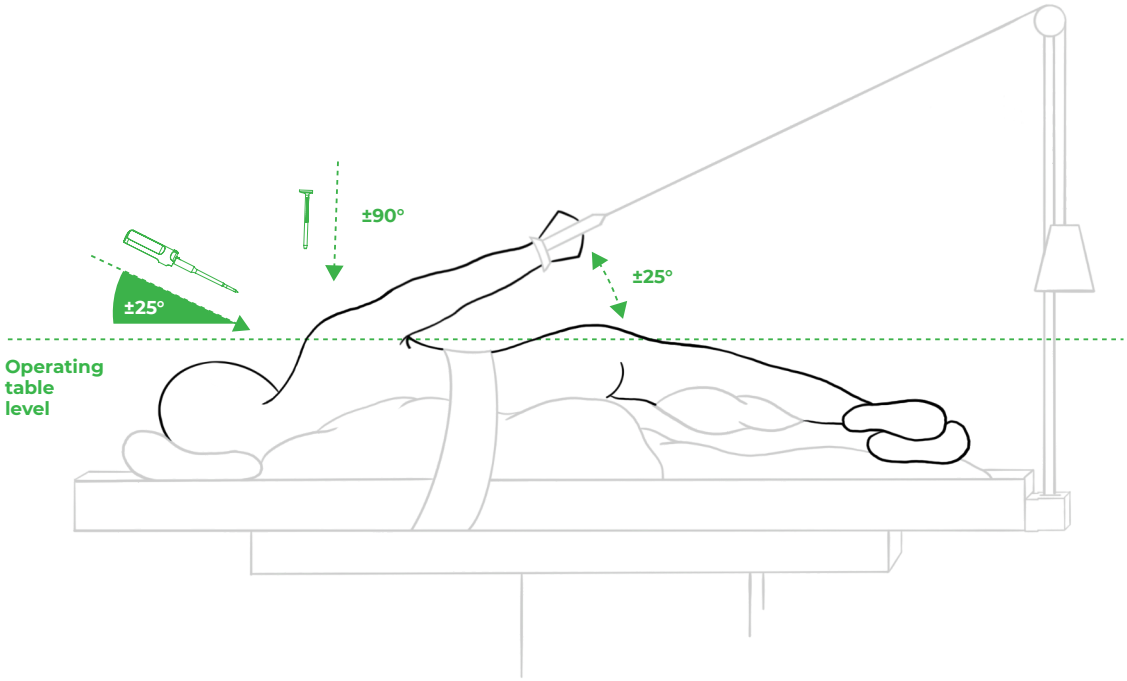

Fig. 1: *Patient in lateral decubitus position with arm suspended on traction device.*

3. Course of the surgery

The actual operation is carried out according to the surgeon's habits and preferences. For a successful result it is necessary to ensure proper mobilisation of the cuff and treatment of associated lesions (biceps, subscapularis, AC joint, etc.). Attention should be paid to careful bursectomy, especially subdeltoid on the lateral side. After a standard preparation of the footprint the next step is to prepare the tunnels. Depending on the type and size of the tear the surgeon prepares one or two (in exceptional cases three) tunnels. In an ideal situation, the orientation of the tunnels should respect the direction in which the damaged tendon attaches to the tuberosity, i.e. supraspinatus parallel (craniocaudal direction) and infraspinatus slightly angled (dorsoventral position) to the longitudinal axis of the humerus.

After establishing the tunnels and pulling the definitive braided highstrength sutures through each of the tunnels, the surgeon continues in a usual way, i.e. with passing sutures through the cuff and knot tying one by one. Biomechanical studies and our experience show that the most effective and at the same time the easiest configuration is to perform simple convergent sutures. The surgeon passes sutures through the cuff using preferred tools, in antegrade or retrograde fashion. The sutures coming out of the vertical tunnels should be passed through the cuff gradually and at regular intervals. The result will be three to six sutures in triplets running from the upper side
of the cuff down to the lateral tunnels.

In 60 % to 70 % of all the cases it is fully sufficient to perform just one tunnel, in the remaining cases two tunnels are usually enough. The three-tunnel situation is extremely rare. It is also possible to choose other suture configurations than the simple convergent sutures or to combine the technique with anchors (so-called hybrid rotator cuff repair). In this phase of the operation the surgeon may fully apply his or her creativity and skill when dealing with less common situations.

Knot tying should commence dorsally and continue ventrally. The preferred type of knot is the non sliding knot (e.g. the Revo kn ot), the limb that comes out of the vertical tunnel and passes through the cuff is the post. The knot is established on the upper surface of the cuff and by gradual pulling the surgeon pushes the cuff to the medial edge of the footprint. The limbs that run along the surface of the cuff into the lateral tunnel create compression along the entire prepared bone bed. After completion of the knot tying the cuff is firmly repaired via bone bridge into the prepared footprint. If the cuff is properly mobilised, in most of the cases the coverage of the footprint is 90 % and more.

4. Preparing the tunnel

4.1 Step 1: Inserting and locking the tunneler

First, the tip of the awl is hammered into the selected place at an ideal angle of 45° to the longitudinal axis of the humerus (i.e. 45° to the plane of the footprint). In this phase of the operation it is necessary to take into account the anatomy of the humerus. The ideal plane in which the tunneler shall be positioned towards the arm is in the case of the supraspinatus the plane pointing to the lateral epicondyle of the humerus, and in the case of the infraspinatus the plane pointing slightly ventrally angled to the longitudinal axis of the humerus (see Chapter 5.1, Fig 11a and 11b). The awl shall be hammered in up to the second laser-etched mark. In rare cases only, e.g. if the patient is very small or if the acromion is in the way of tilting the awl to the ideal 45° position to the longitudinal axis of the humerus, less hammering is required but the tip must always go in beyond the first marker. A hammered-in awl serves as a fixed point and the body of the tunneler swivels around it.

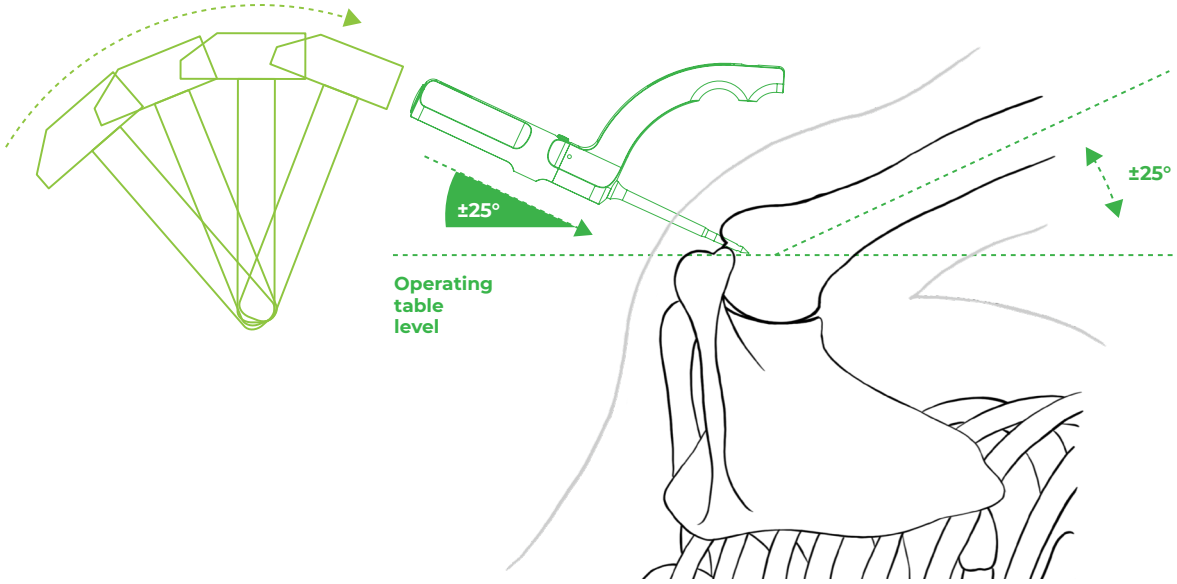

Fig. 2: *Introduction of the awl into the humerus.*

By rotating the tunneler the surgeon selects the correct position to make a distal lateral portal to target the drilling sleeve onto the cortex of the tuberosity. Make sure that the tunneler is rotated in the correct direction, depending on whether the supraspinatus or the infraspinatus are repaired (see Chapter 5.1, Fig 11a and 11b). The position of the portal shall be identified using a long size 20G (yellow) needle to make sure that the drilling sleeve will be introduced against bone. The design of the tunneler also allows for blind introduction of the drilling sleeve. If the 45° angle of the awl against the longitudinal axis of the humerus and the introduction of the awl above the first marker are adhered to, the entrance to the horizontal tunnel is always located at least 10 mm from the summit of the tuberosity.

After the distal lateral portal is done, the bone condition in this place shall be checked by palpation, e.g. using an arthroscope obturator. After that the drilling sleeve is slid onto the bone via the body of the tunneler. The ratchet system on the drilling sleeve allows for gradual sliding of the drilling sleeve and thus for achieving a firm fixation of the tunneler to the bone and locking in the given position. The ratchet works if the flat part of the drilling sleeve is oriented in the caudal direction.

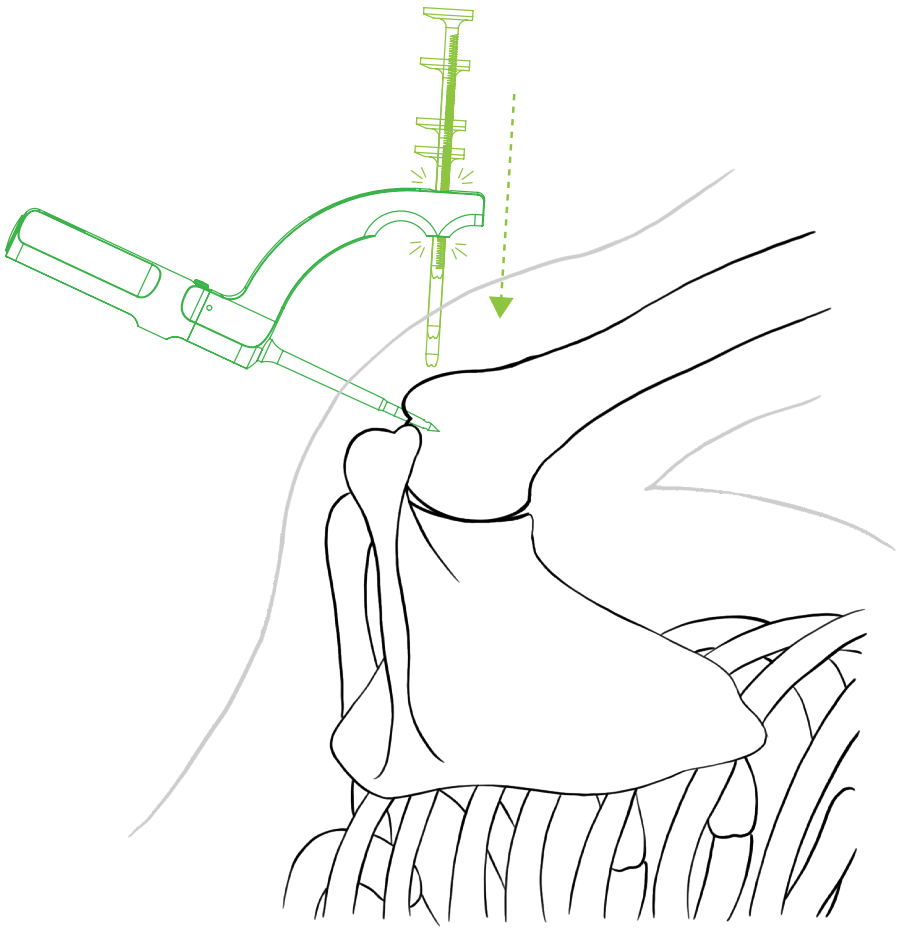

Fig. 3: *Introduction of the drilling sleeve into the body of the device and its tightening by leaning against the humerus.*

Using the drilling sleeve, a passage through the soft tissues is established all the way to the bone, which allows for an accurate targeting of the drill to the point where the horizontal tunnel is to be drilled, and then also the passage for the shuttle loop.

4.2 Step 2: Drilling and inserting the loop

The drill (K-wire, 2 mm thick and 13 cm long) shall be drilled all the way to the limit, i.e. to the touch of the drill and the drilling sleeve. That way the K-wire goes through the drilling sleeve, penetrates the bone, and comes out through the opening in the fixed tip of the awl to about 1 – 3 cm beyond this tip, and the tunnels connect.

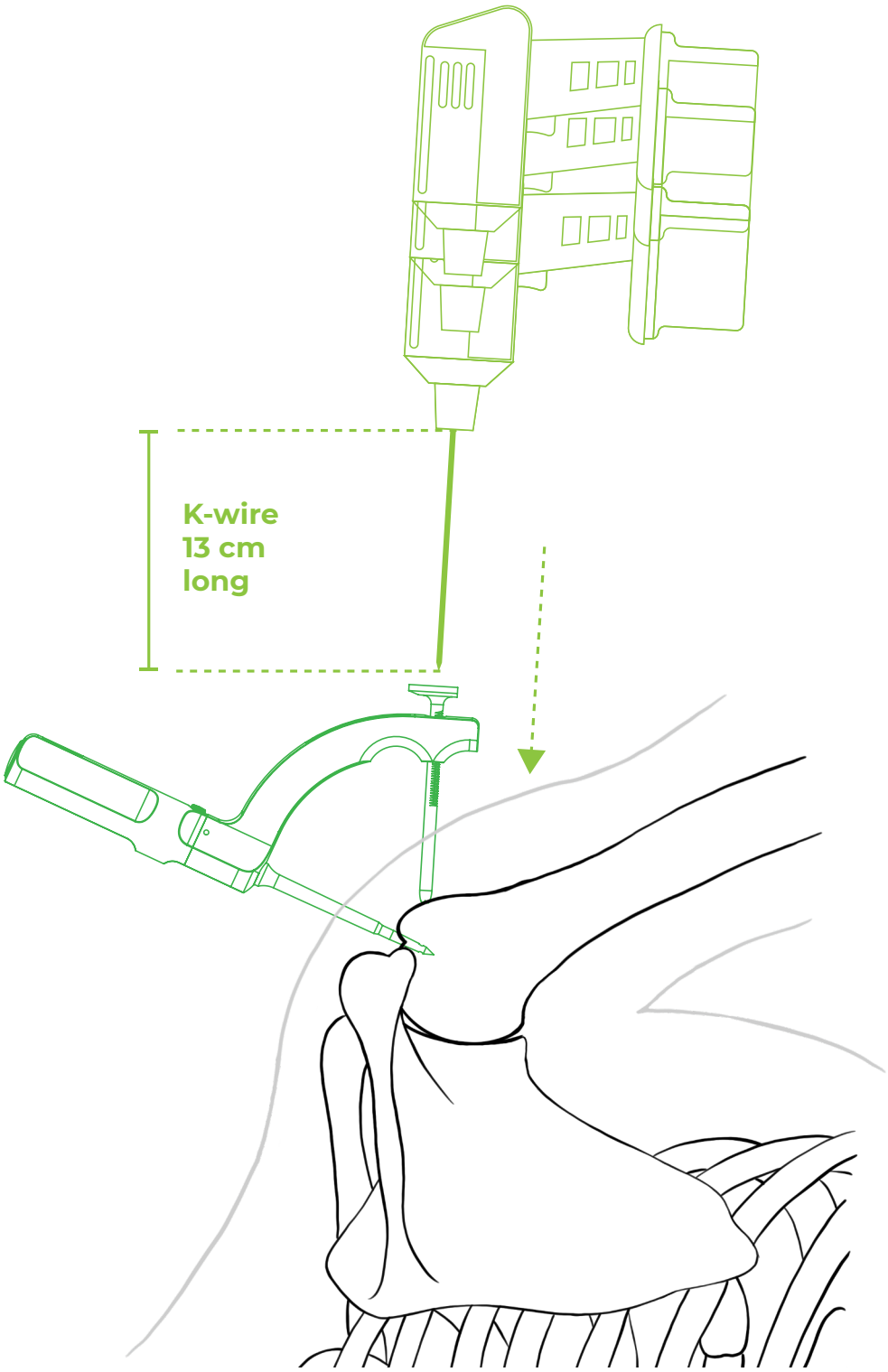

Fig. 4: *Drilling of a horizontal tunnel.*

Through the drilling sleeve the surgeon inserts a shuttle loop into the lateral tunnel. The bend of the loop should be first held clamped for a while to form a pointed tip that will be easier to insert into the tunnel. Introduce the loop slowly, sliding it all the way down to the end of the entire 13 cm long tunnel. When the tip reaches the end of the tunnel a firm stop should be felt. After that the surgeon may catch the loop by the awl.

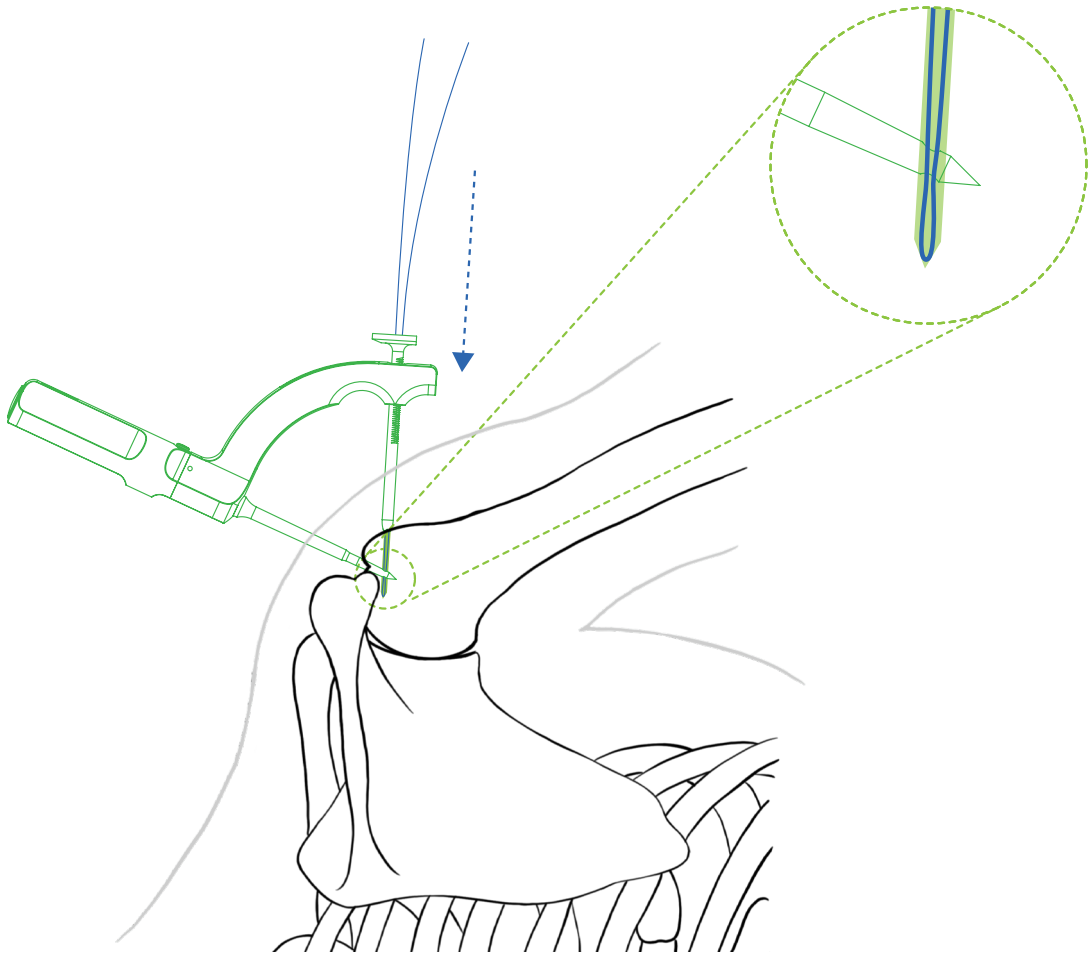

Fig. 5: *Inserting the loop to the end of the tunnel.*

4.3 Step 3: Catching the loop

By pressing the button on the handle of the awl and turning the awl (and the tip with the loop through it) 360° the shuttle loop winds around the tip of the awl. At this moment it is no longer possible to pull the loop out of the drilling sleeve; check this by pulling the part of the loop that sticks out – give it a few firm pulls (pull test, see Chapter 6.2).

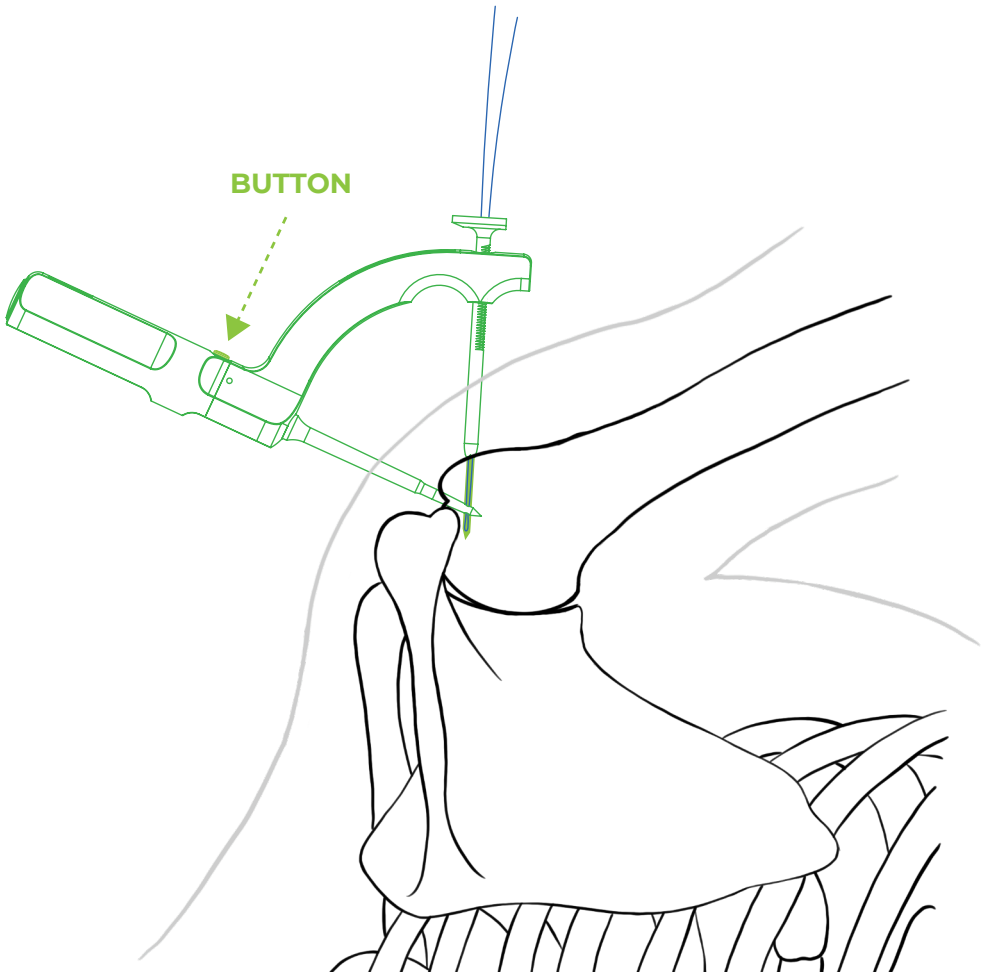

Fig. 6: *Releasing the rotation of the awl in the device body by pressing the button.*

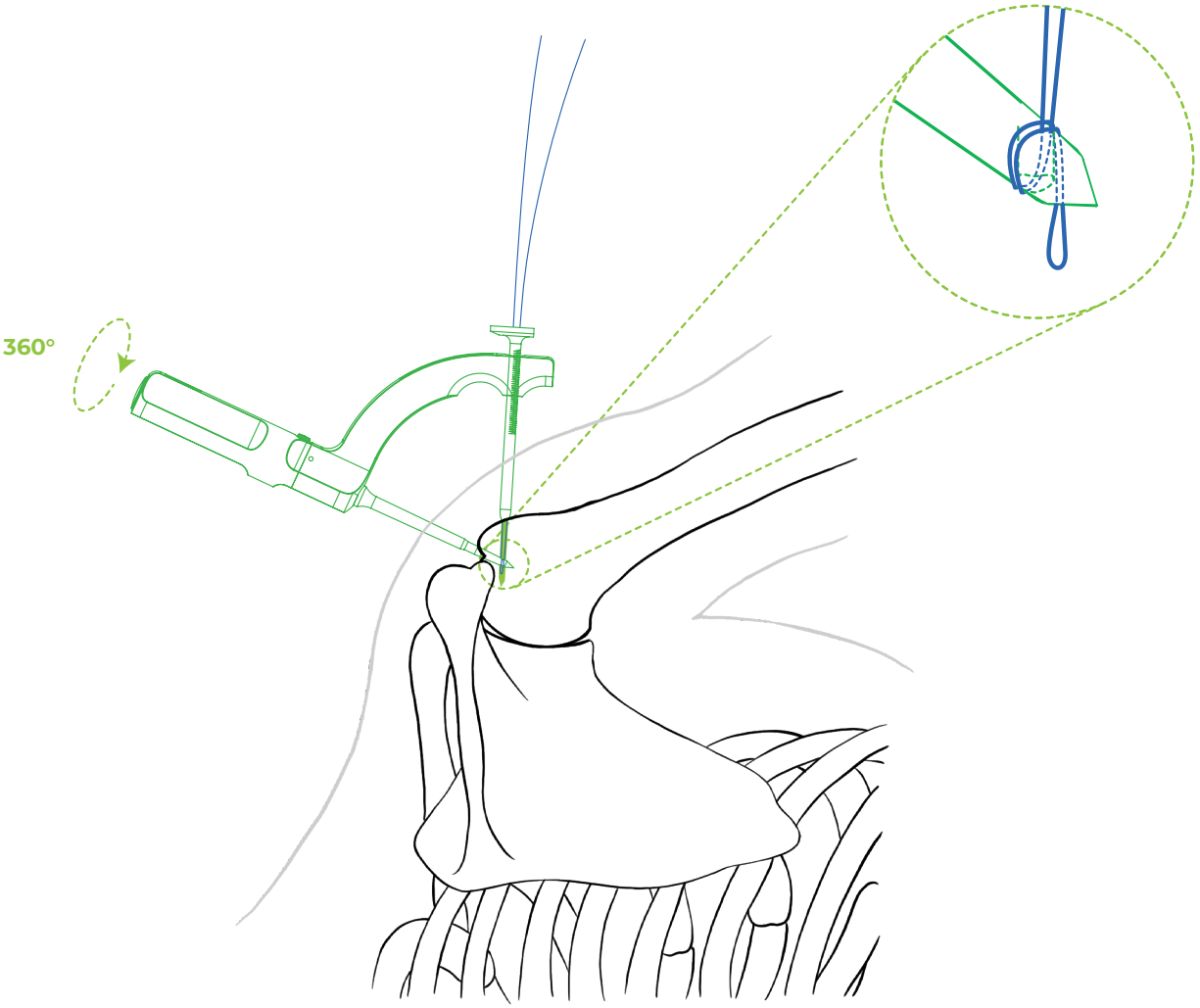

Fig. 7: *Loop wound around the tip of the awl.*

By rotating the drilling sleeve 180° around its axis the ratchet releases from its lock bolt and the firm connection between the tunneler and the bone is released too. For easier handling, the surgeon shall remove the drilling sleeve from the body of the tunneler. At this point, fixate the end of the shuttle loop with a clamp that will prevent the end of the loop coming under the skin when the awl is being pulled out.

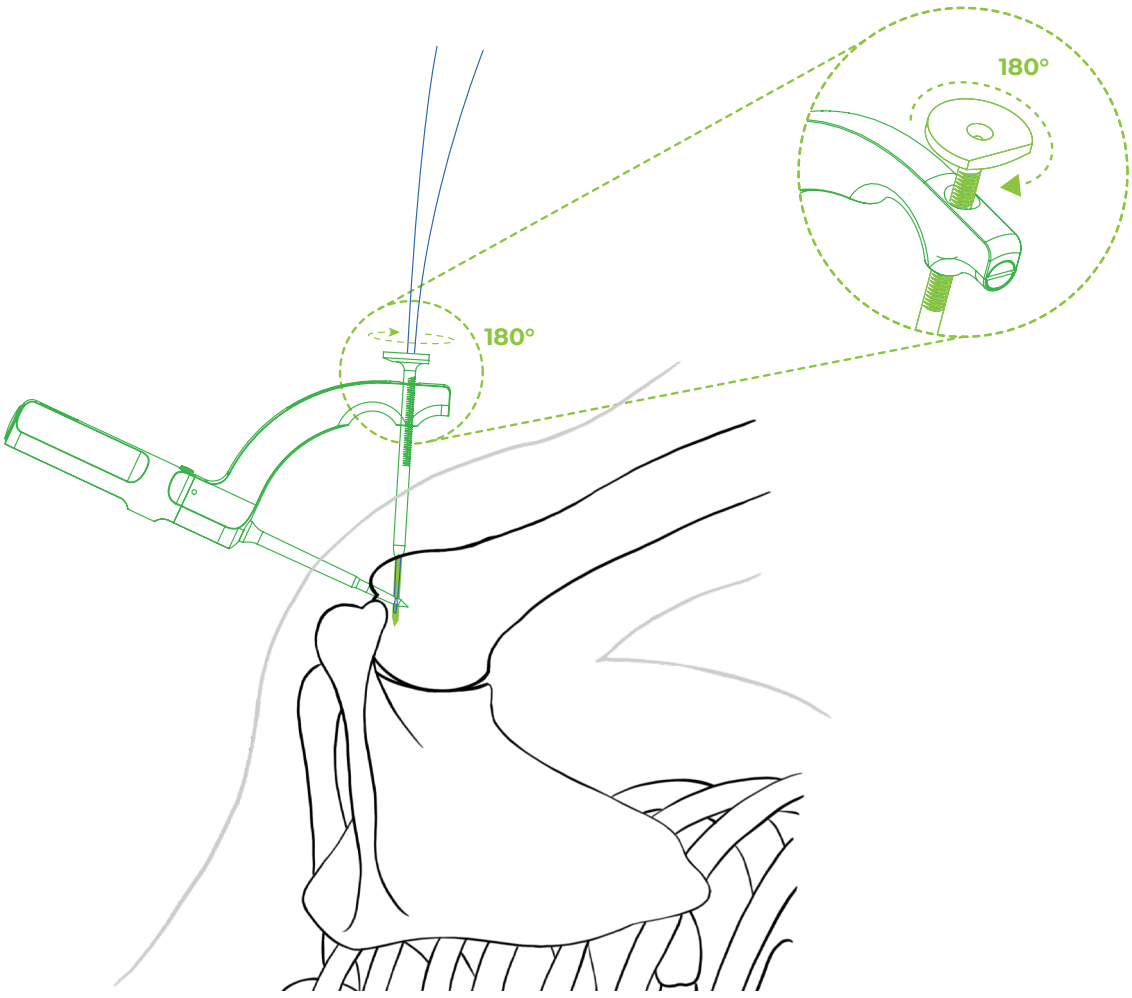

Fig. 8: *Releasing the drilling sleeve in the device body.*

4.4 Step 4: Retrieving the loop and pulling through the sutures

By pulling the awl out of the bone you also retrieve the shuttle loop from the vertical tunnel and from the patient's body. The shuttle loop for pulling through the definitive sutures comes out of the cranial port; the clamped end of the loop comes out of the distal lateral port.

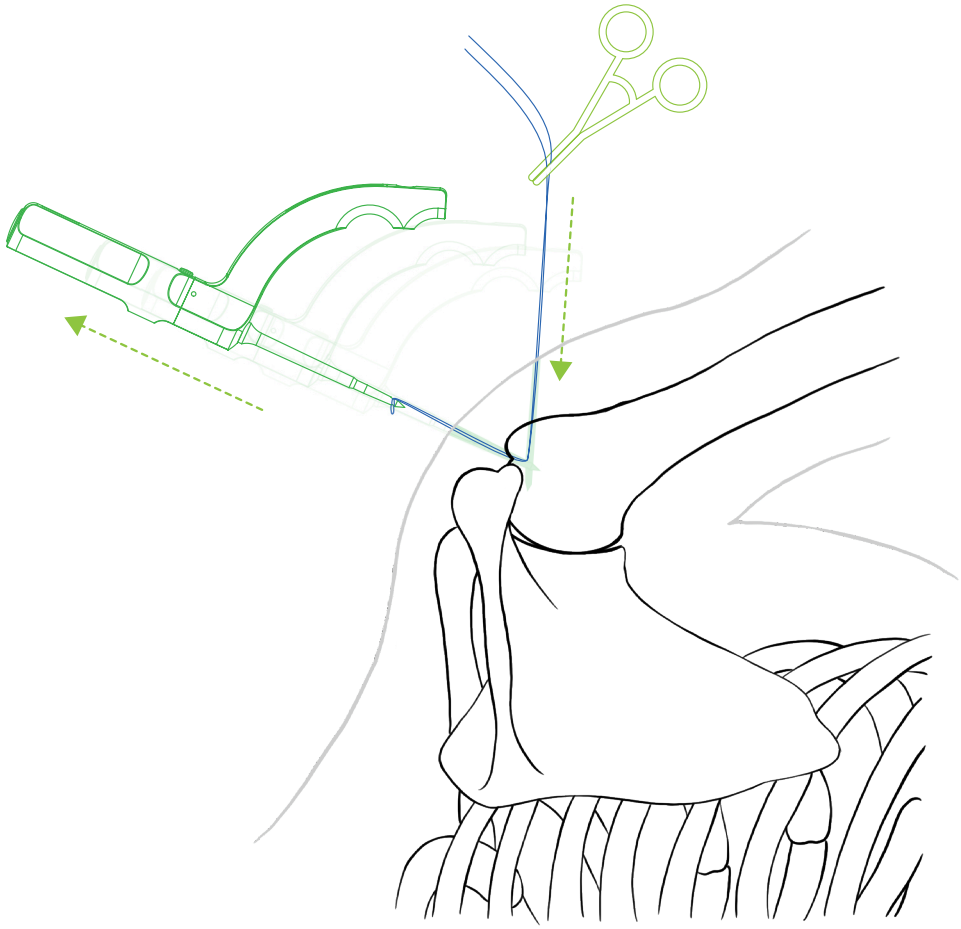

Fig. 9: *Pulled-out shuttle loop.*

Load the shuttle loop with three #2 braided high-strength sutures (ideally in different colours each). After pulling the shuttle loop back, you retrieve these sutures through the tunnel out of the lateral portal. For a smoother passage of the sutures in the tunnels and greater firmness during knot tying, catch the sutures by both ends and pull them up and down the tunnel several times. This way you slightly blunt the edge at the meeting of the two tunnels and make the work easier.

5. FAQ

5.1 How do I tell that my tunneler is positioned correctly? Sometimes it is harder to obtain good visibility and the lateral side of the uberosity is not clear enough.

Some shoulders are rather tight, more difficult to visualise, and even after a very careful bursectomy no visual control can be established laterally. In such a situation you can blind-position the tunneler, its design guides the surgeon to reach the correct point. If the shoulder is suspended on traction of in a beach chair under 25° angle against the longitudinal axis of the body and if the awl of the tunneler penetrates into the footprint under the recommended 45° angle against the longitudinal axis of the humerus (and at the same time against the plane of the footprint) the entire assembly is symmetrical and the drilling sleeve points perpendicular to the longitudinal axis of the body. This means that in the lateral decubitus position it points vertically to the floor, in the beach chair position it is parallel with the floor. A small deviation from the ideal 45° angle to the longitudinal axis of the humerus has no effect on the position of the lateral tunnel, and this tunnel will always be in the recommended zone of 10 – 30 mm from the summit of the tuberosity.

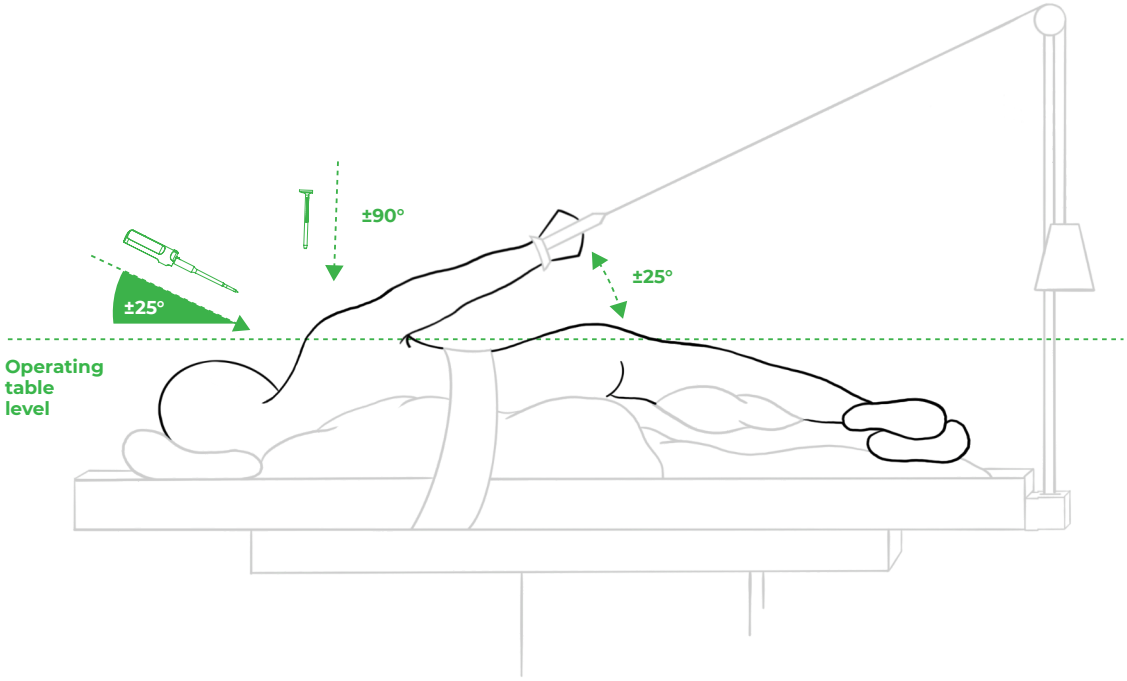

Fig. 10: *Pacient na trakcii v polohe na boku*

It is also necessary to bear in mind the anatomy of the humerus. The ideal plane in which the awl shall be positioned towards the arm in the case of the supraspinatus repair is the plane pointing to the lateral epicondyle of the humerus. This plane respects the anatomy of the tuberosity and points slightly dorsally to the longitudinal axis of the arm. The surgeon may intuitively position the tunneler along the longitudinal axis of the arm, upon which the drilling sleeve may slip down ventrally, to the bicipital sulcus. In such a case it is possible to push the drilling sleeve atypically deep or to not achieve a fixed connection between the tunneler and the bone. This situation is a warning for the surgeon who must rotate the awl to achieve a position in which the drilling sleeve points against the tuberosity, and when pushed to the limit the ratchet allows for establishing a firm connection with the bone.

A different situation comes in the case of the infraspinatus repair. The plane of the tunnel copies the axis of this muscle, pointing slightly ventrally. Again, check correct positioning of the device using 20G needle and if necessary, adjust the positioning by swivelling the tunneler around the awl until a firm connection between the tunneler and the humerus is achieved after the insertion and tightening of the drilling sleeve.

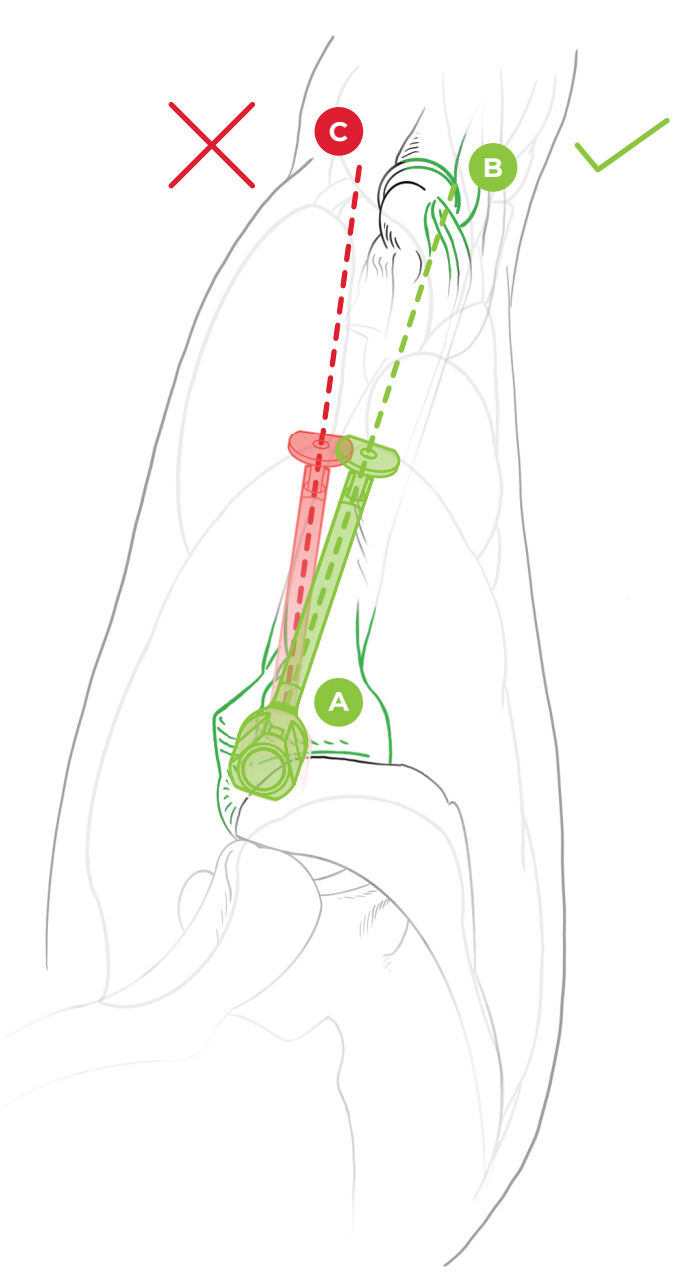

Fig. 11a:
Supraspinatus repair
– tunneler points to the lateral epicondyle of the humerus.

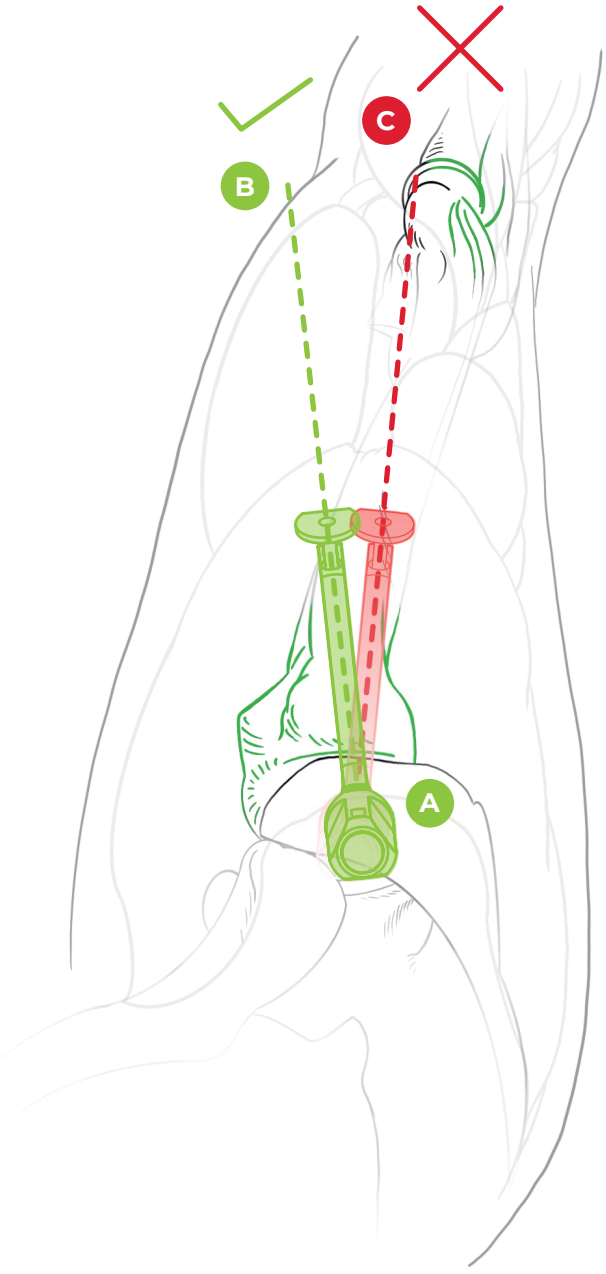

Fig. 11b:
Infraspinatus repair
– tunneler points slightly ventrally off the longitudinal axis of the arm.

5.2 How do I tell that the K-wire passed through the eye in the awl tip? What if it misses the eye?

In extremely rare cases it may happen that due to the flexible nature of the K-wire the wire deforms during drilling and passes outside the eye in the tip of the awl. The situation can be checked by slightly turning the awl with an inserted K-wire (wire test, see Chapter 6.1). If the awl wouldn't turn it means the K-wire passes through the eye. If the K-wire is inserted 13 cm deep and still it is possible to turn the awl, the wire is off and misses the awl. If this happens, release the drilling sleeve, slightly rotate the awl around its axis and lock the tunneler to the bone again, in a different position. In this situation it is also advised to replace the K-wire with a new sharp and straight one.

5.3 What to do if the loop wouldn't go all the way down to the end of the drilled tunnel?

In this case use the K-wire to check whether the horizontal tunnel is drilled correctly and the wire passes through the awl (see Chapter 5.2). If it does, just drill back to remove debris from the tunnel and then, with the K-wire already inserted, push the ratchet one step further to firmly lock the tunnel and make it passable for the loop. After that there is usually no problemwith sliding the shuttle loop all the way down to the end. You should feel a firm stop of the loop against the end of the tunnel.

5.4 What to do if I pull the shuttle loop after turning the awl and the loop doesn't stay inside?

If, after turning the awl you perform a pull test (see Chapter 6.2) and the shuttle loop can be pulled back out of the drilling sleeve, there are two possible causes. Either the horizontal tunnel is not meeting the tip of the awl at all – continue following Chapter 5.2. Or the loop wasn't inserted all the way to the end and had slipped off the tip while you rotated the awl. In this case make sure that your K-wire is adjusted to 13 cm length and then continue following Chapter 5.3. Before turning the awl make sure that while pushing on the loop you feel a firm stop as it is hitting the end of the tunnel.

5.5 What to do if, even after repeated check and due to unknown reasons, the shuttle loop still wouldn't go through and I cannot complete this phase of the operation?

The tunneler is designed in such a way that you can complete the operation using the suture anchors at any point. The hole made by the awl can be used to insert a suture anchor, either for single-row repair or for medial anchor in double-row or transosseous-equivalent repair. Any commonly used suture anchor can be used as long as its diameter is at least 5.5 mm. If in doubt regarding the quality of the bone or the size of the hole made by the awl it is better to use self tapping suture anchors. Holes of 2 mm diameter in the lateral cortex of the tuberosity are no obstacle for inserting lateral-row suture anchors.

5.6 What to do if, in a porotic bone, the limb coming out of the lateral tunnel starts cutting out during knot tying?

This complication has been reported in less than 2 % of transosseous rotator cuff repairs and is possible in extremely porotic bones only. Be extra careful especially if, during the probing for a suitable position of the distal lateral portal for the drilling sleeve you feel a noticeably soft bone (see Needle test, Chapter 6.3) and if you feel minimum resistance during K-wire drilling. If this situation occurs it is again possible to resort to rotator cuff repair using suture anchors and to apply anchors that you know from your experience as good for operating in a porotic terrain.

6. Overview of tests

6.1 K-wire test

After drilling the K-wire down to 13 cm depth the awl still rotates.

Problem: the K-wire passes outside the tip.
Solution: change the position of the drilling sleeve and drill a new tunnel.

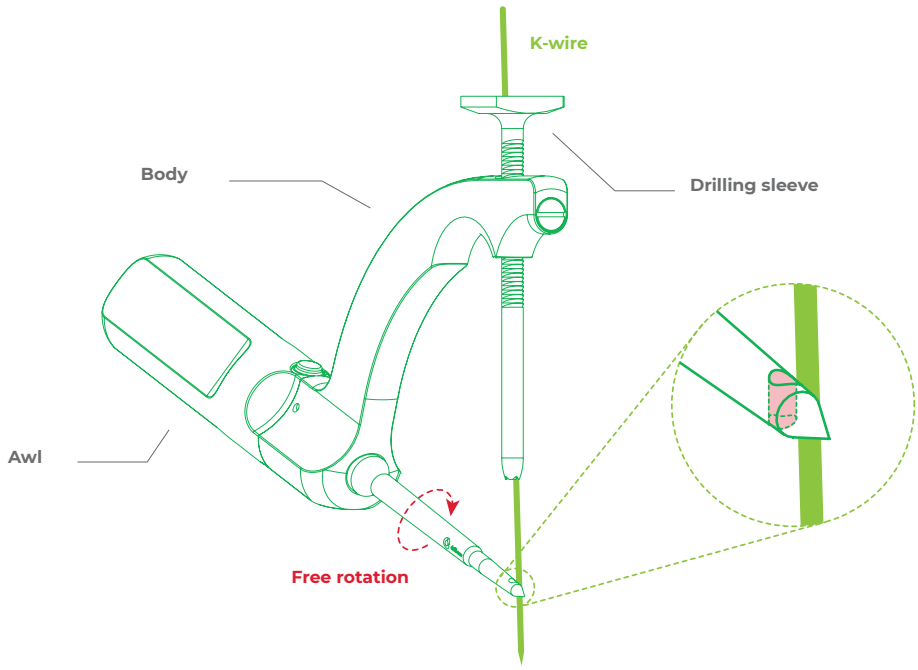

Fig. 12: *The K-wire DOES NOT pass through the eye of the tip.* ***INCORRECT.***

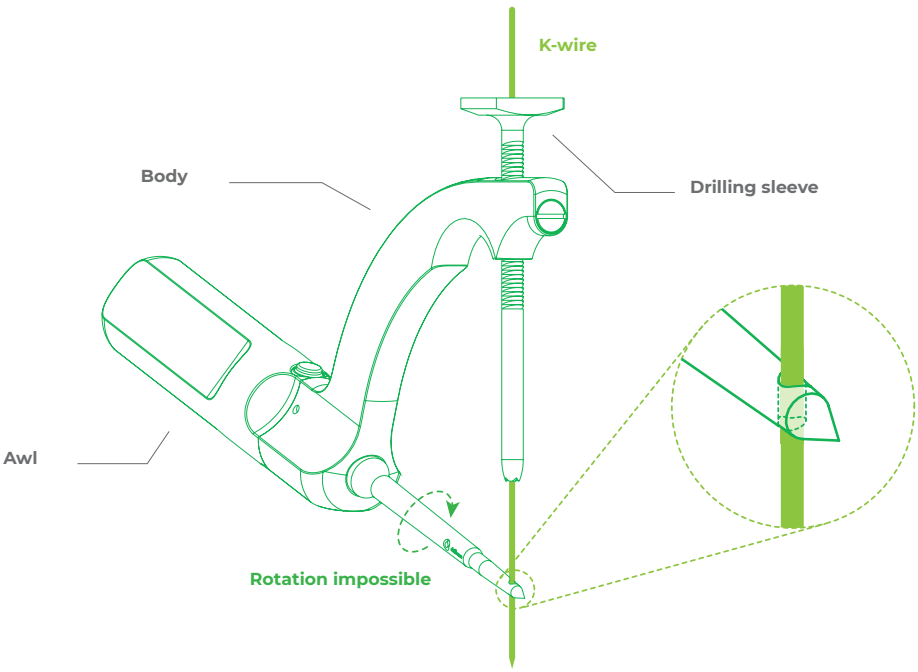

Fig. 13: *The K-wire DOES pass through the eye of the tip.* ***CORRECT.***

6.2 Pull test

After turning the awl the loop comes out of the drilling sleeve.

Problem: the tunnel is not deep enough.
Solution: check the length of the K-wire. It must be set to 13 cm.

Problem: the tunnel is drilled correctly, but it is blocked (by detritus)
Solution: redrill the existing tunnel to remove the detritus.

Problem: the loop had missed the tip or it had slipped out.
Solution: check the position and depth of the tunnel (wire test, see Chapter 6.1) or drill a new one.

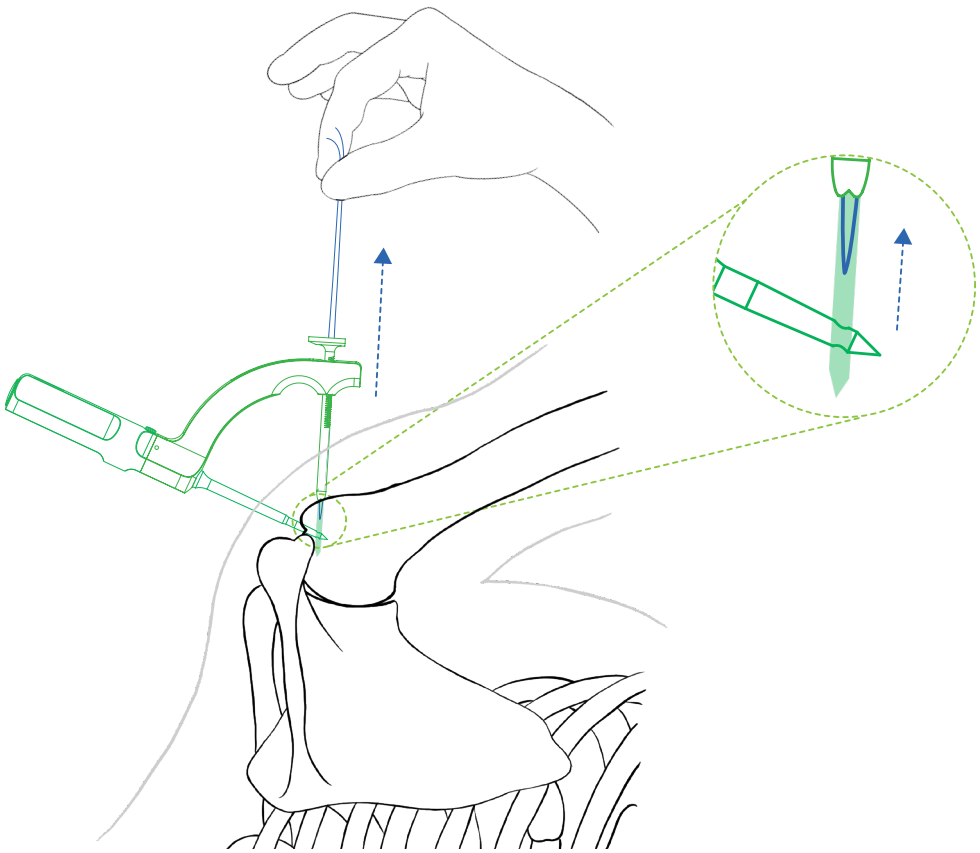

Fig. 14: *Pulling the loop outwards. The loop can be pulled out.* ***INCORRECT.***

6.3 Needle test

An ideal place for distal lateral portal should be identified using a long 20G needle. When probing the lateral tuberosity, you may rarely feel the needle passing strikingly easily through the lateral cortex.

Problem: major osteoporosis, risk of cutting through and breaking the tunnels.

Solution: hammer the awl as deep as possible and drill the lateral canal again, in this position it will be more distal, i.e. in a place with a stronger cortex. Event. consider suture using anchors designed for these situations. If the bone appeared solid, but the bone was cutting through (so-called cut-out) only during the tightening of the stitches, assembly is possible Augment with a metal button strung on threads emanating from the lateral canal, or instead of bridging the plexus anchor, introduced a little more distally.

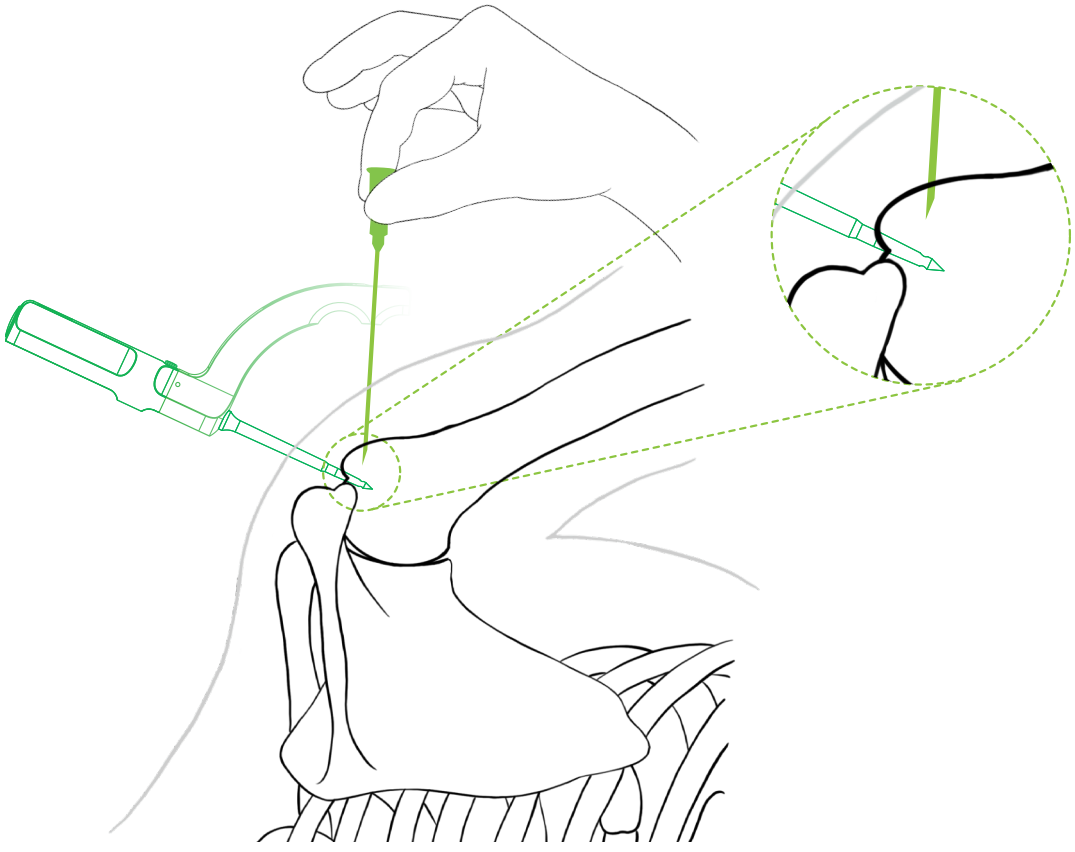

Fig. 15: *The needle enters the soft lateral cortex too smoothly.* ***INCORRECT.***

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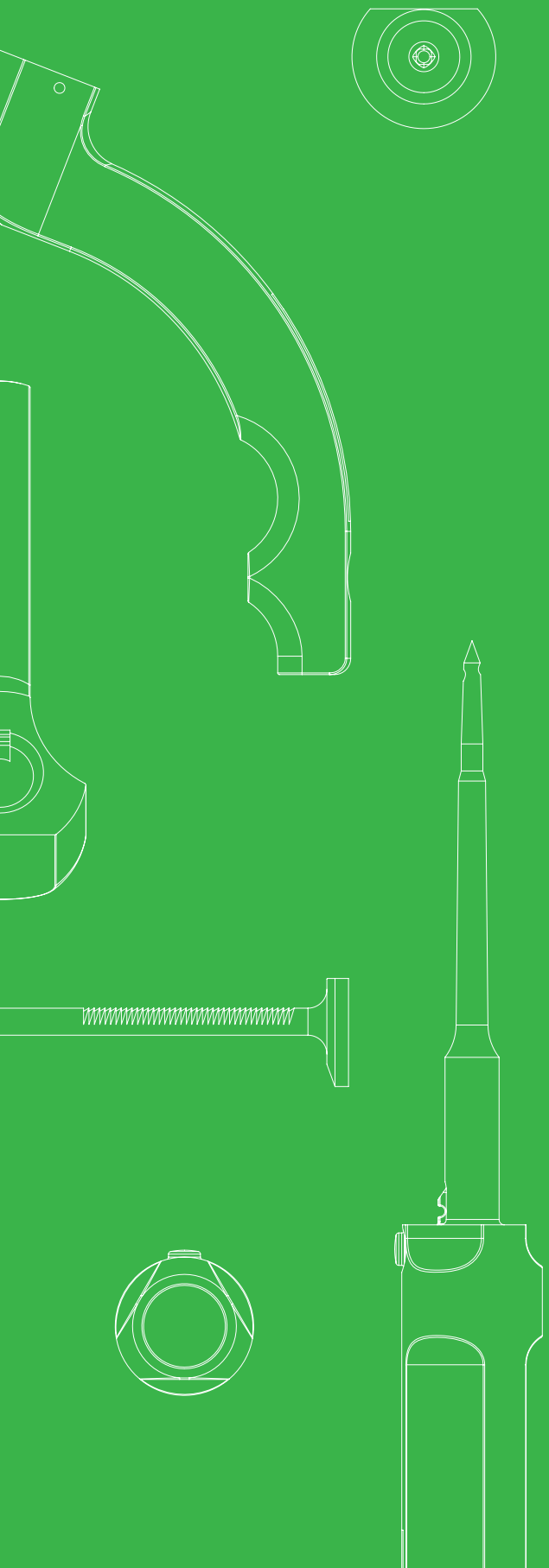

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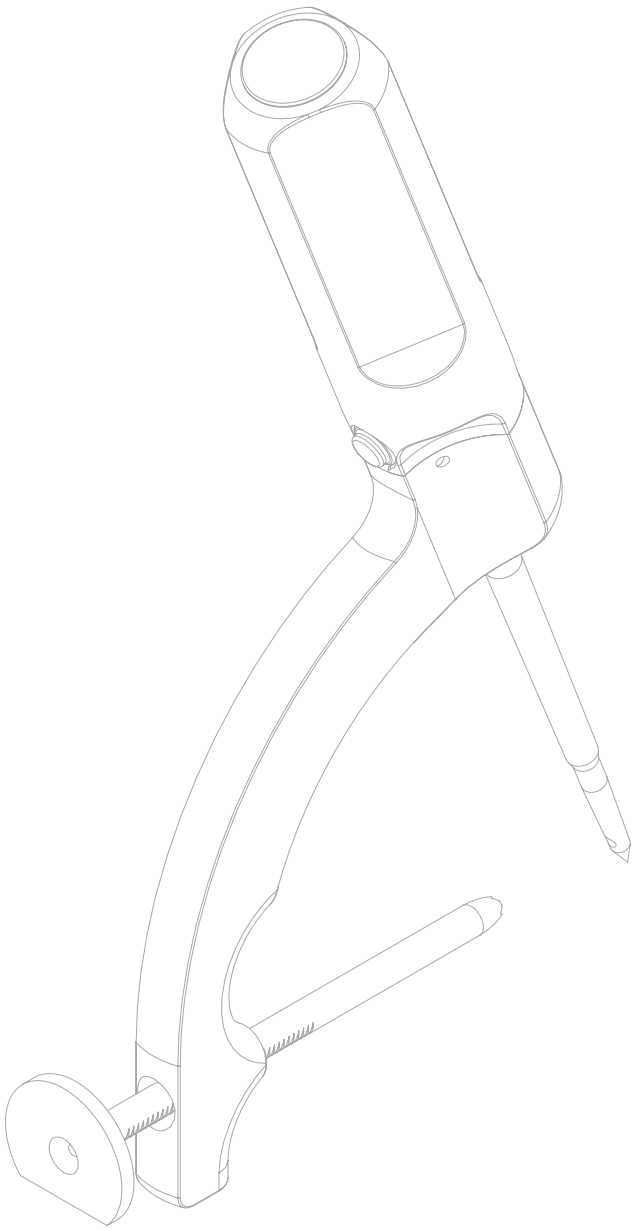

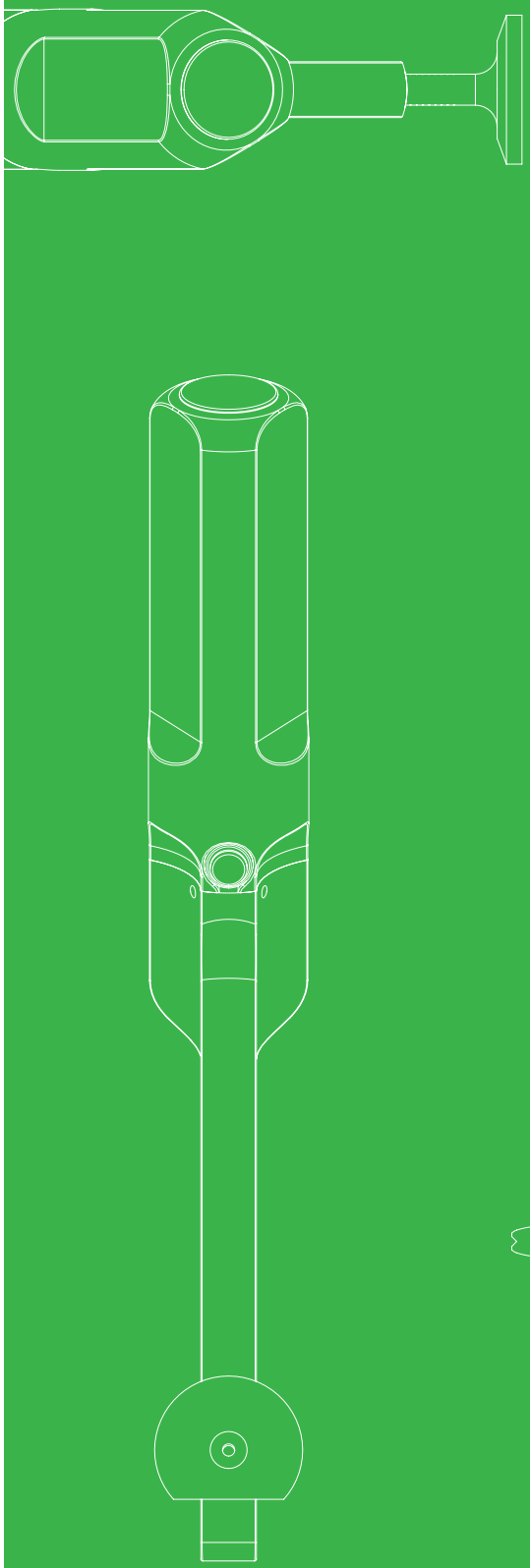

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