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REVERSE SHOULDER ARTHROPLASTY FOR PROXIMAL HUMERAL FRACTURES

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SURGICAL APPROACH



Preface

Management of proximal humerus fracture remains a clinical challenge. The decision making process in itself is equally if not more challenging than the treatment itself. For non-displaced or minimally displaced proximal humerus fracture, the best treatment is non-surgical. For displaced fractures in patients with good bone quality, open reduction and internal fixation is the preferred surgical option. However proximal humerus fractures often occur in elderly women with osteoporotic bone which makes optimal fixation very difficult to achieve. In unfixable proximal humerus fractures or in those with a high risk of avascular necrosis, some form of shoulder arthroplasty is the default surgical option. A hemiarthroplasty for displaced comminuted proximal humerus fracture is surgically technically challenging and the outcome is often unpredictable. A reverse shoulder joint replacement yields a more predictable outcome.

I cannot over stress the usefulness of a CT scan with 3-D reconstruction for preoperative decision making. However the true quality of the bone sometimes cannot be appreciated until the time of surgery. Therefore it is advisable to be prepared for more than one surgical option.

I am humbled to be asked to share with you my current surgical technique of reverse shoulder arthroplasty for proximal humerus fracture which has evolved over the years. Realizing “there are many ways to skin a cat”, I hope the following description of my technique is of use to you in managing these difficult fractures.

Peter Poon, FRACS

Disclaimer

Limacorporate S.p.A., as manufacturer of prosthesis device, does not practice medicine.

This surgical technique has been developed in consultation with an experienced surgeon team and provides the surgeon with general guidance when implanting SMR System in trauma reverse configuration.

Proper surgical procedures and techniques are necessarily the responsibility of the medical professional.

Each surgeon must evaluate the appropriateness of the surgical technique used based on personal medical training, experience and clinical evaluation of each individual patient.

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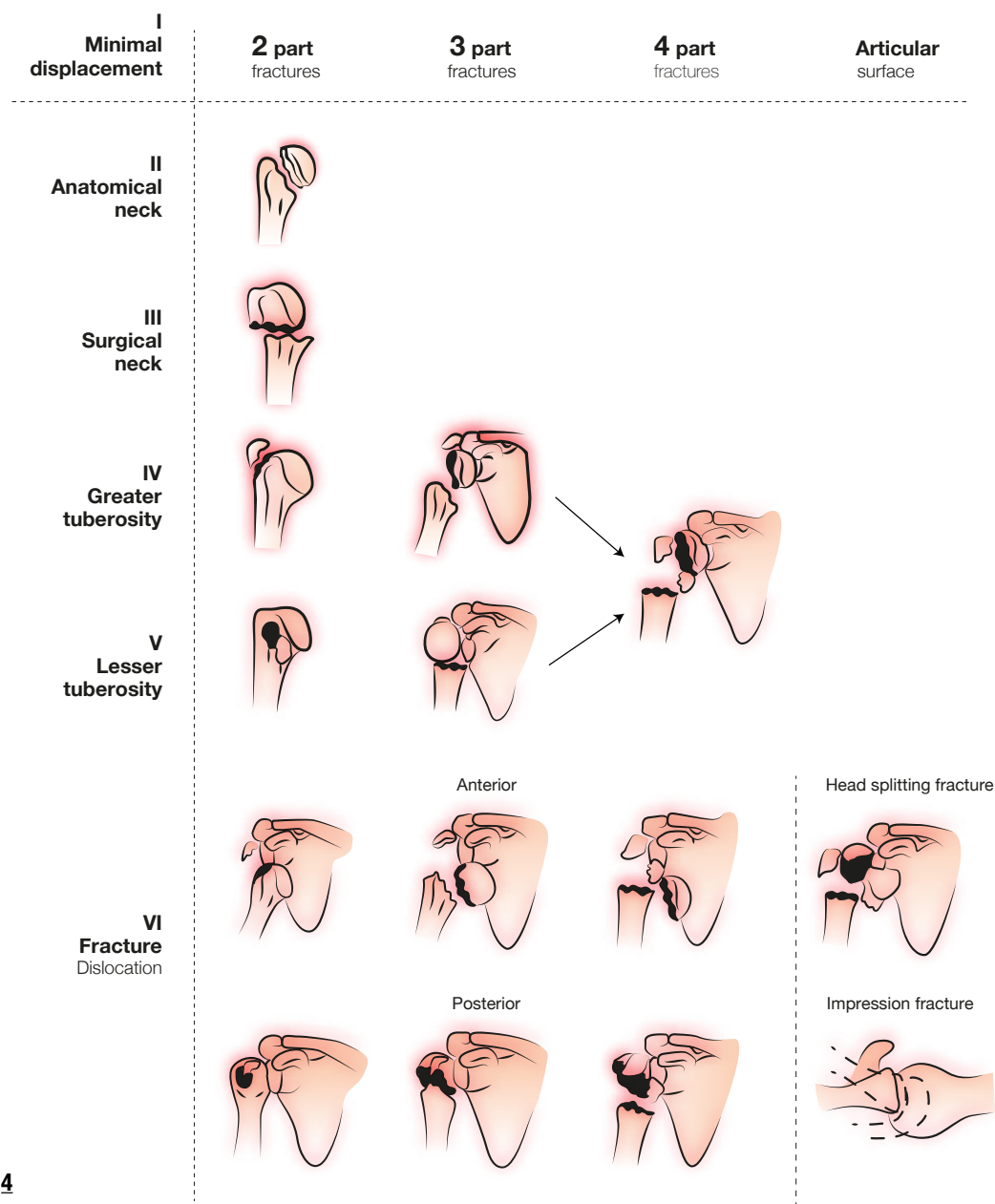


Figure 1.1
Neer's classification of proximal humeral fractures.^[1, 2]

1.

CLASSIFICATION OF PROXIMAL HUMERAL FRACTURES

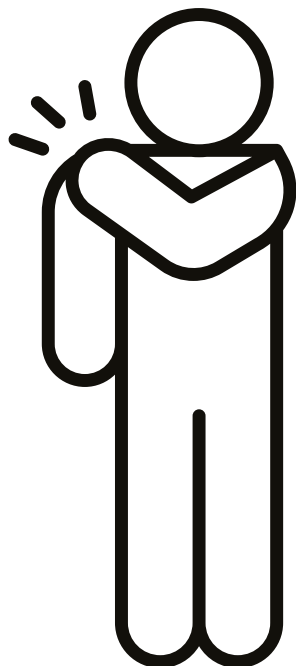
Over the years, various classifications of proximal humerus fractures have been proposed. Nowadays, the most important ones are Neer classification,^[1,2] the system of Arbeitsgemeinschaft für Osteosynthesefragen (AO classification)^[3] and Hertel classification.^[4]

Neer classification is the most commonly used. It was proposed by Dr. Charles Sumner Neer in 1970 and it identifies four main “segments” involved in the fractures of proximal humerus: the humeral head, the Greater Tuberosity, the Lesser Tuberosity and the humeral shaft.

There are several ways to repair a proximal humerus fracture and CT-scan with 3D reconstruction is therefore highly recommended.

Four-part fractures with dislocation and head-splitting fractures are commonly indicated for reverse shoulder arthroplasty.^[6,7,9-12,23]

Three-part fractures need to be carefully evaluated: if adequate fixation is difficult (poor bone stock) or the likelihood of avascular necrosis is high, a reverse implant is recommended.^[6,7,9-12]



2.

PATIENT CHARACTERISTICS

- Patient factors need to be evaluated in the implant decision-making: the parameters most commonly used are age and gender - i.e. female over 65 years of age need to be considered as potential candidates for RSA, given the high incidence of osteoporosis.
- Additional factors to be considered include diabetes and smoking - which are known to impair bone healing.^[13-14]
- Surgeons have to then evaluate all the different parameters and focus on the main objective: choose the most reliable surgery, minimizing the risk of reoperation.

POLY GLENOSPHERE

Large diameters to provide for extra stability and inverted bearing materials aiming at scapular notching prevention.^[19-20]

DEDICATED HUMERAL BODY

With 2 fins to reattach tuberosities.

CEMENTLESS CONVERTIBLE STEM

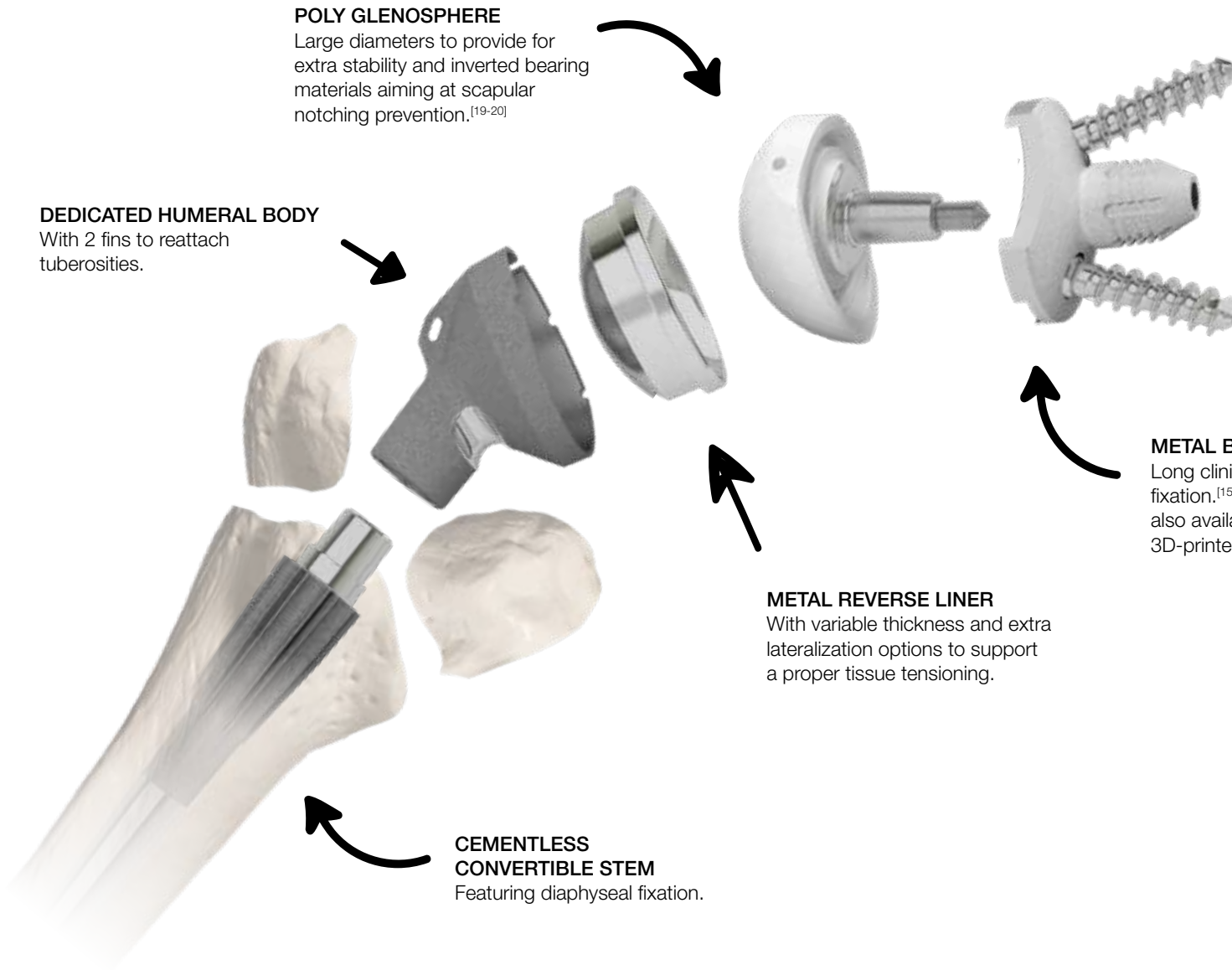
Featuring diaphyseal fixation.

METAL REVERSE LINER

With variable thickness and extra lateralization options to support a proper tissue tensioning.

METAL BACK

Long clinical FU and proved fixation.^[15-18] T7 Metal Back also available, with modular 3D-printed central pegs.



3.

SMR REVERSE TECHNICAL FEATURES: HOW SMR CAN WIN IN TRAUMA CASES

The SMR Reverse provides options for both cemented and uncemented fixation. The fixation of the cementless stem is distal in the diaphyseal fragment, thus allowing to adjust the height of the prosthesis by varying the stem diameter^[22]; tuberosities reconstruction is then supported by a dedicated metaphyseal component, the Reverse Finned (Trauma) Humeral Body.

Whilst the common practice is to use a cemented stem to decrease the risk of periprosthetic fractures,^[5] there are several publications indicating that the cementless prosthesis can be a safe option.^[6,7,22]

On the glenoid side, a larger glenosphere may be recommended -where possible- as it appears to decrease the risk of dislocation.^[5,8]

4.

SURGICAL TECHNIQUE

INTRODUCTION

The repair of both tuberosities is recommended,^[9-12] with the aim to:

- **Improve stability;**
- **Provide rotation by the rotator cuff;**
- **Reduce dead space between the prosthesis and the deltoid.**

Please note that before proceeding with the tuberosities repair, it is crucial to identify the best prosthesis height and version. Once these factors have been evaluated and the prosthesis has been implanted accordingly, the tuberosities can be reattached.

The following technique is recommended with beach-chair or supine position with a deltopectoral approach.

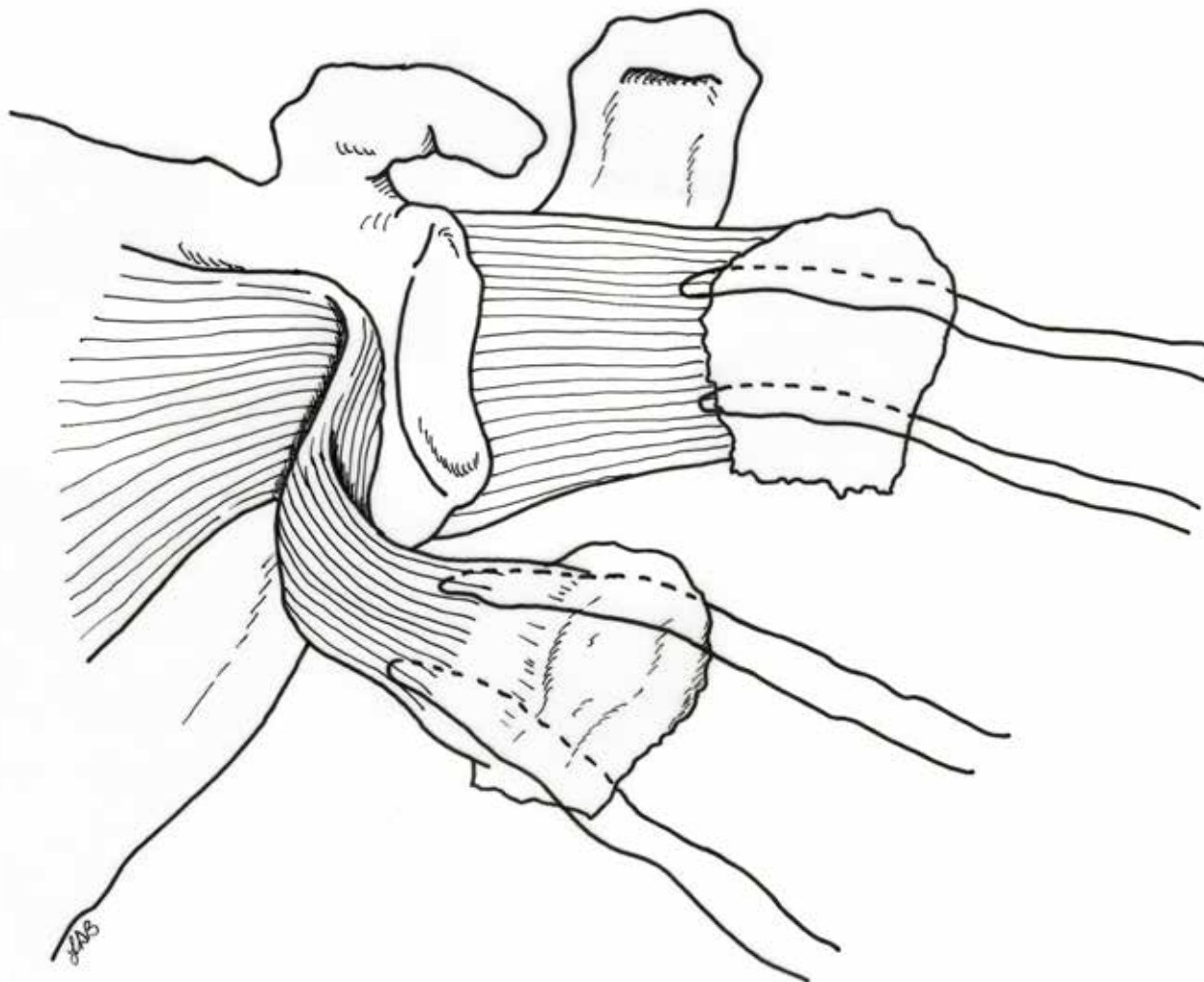


FRACTURE EXPOSURE

After the approach, the first step is to identify all the fracture fragments. The long head of the biceps is a useful reference to find the tuberosities (and is usually tenotomised with or without tenodesis at the surgeon's discretion).

Typically, the anterior longitudinal fracture line of the Greater Tuberosity (GT) is located 6-8 mm posterior to the bicipital groove. The Lesser Tuberosity (LT) fragment usually contains the bicipital groove (*Figure 4.1*).

Remove the fractured humeral head and save it for use later as morselized bone graft beneath tuberosities and around the prosthesis.



TRACTION SUTURES OF TUBEROSITIES

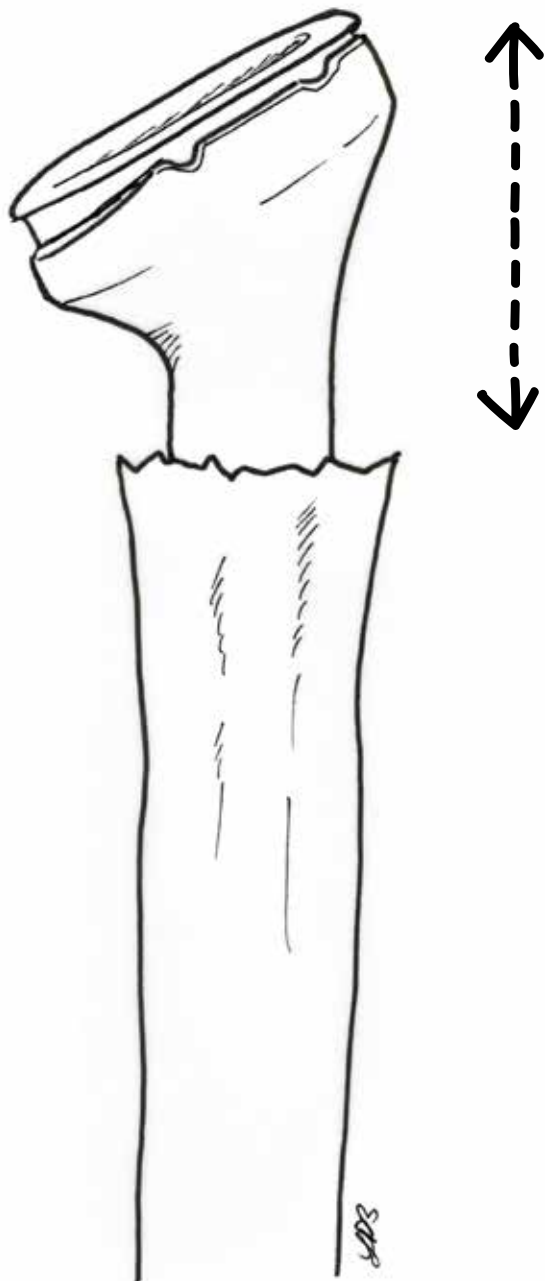
Once the Greater Tuberosity (GT) and Lesser Tuberosity (LT) have been identified, use four strong, non absorbable polyester sutures and position them as described in the steps below:

Two sutures are passed around the Greater Tuberosity fragment, one through the supraspinatus tendon and one through the infraspinatus tendon.

Two sutures are passed around the Lesser Tuberosity fragment, through the subscapularis tendon (*Figure 4.2*).

These sutures will initially be used as traction wires; later, during tuberosities repairing, they will serve as relay sutures.

Separate the tuberosities to expose the glenoid and perform the glenoid implantation according to the SMR Reverse surgical technique.



PARAMETERS OF THE IMPLANT

Once the glenoid implant has been completed, it is possible to move back to the humerus and assess the following parameters.

Height can be assessed based on:

1. Pre operative radiograph of contralateral humerus.
2. Intraoperative anatomic parameters of fractured humerus: reduce the Greater Tuberosity fragment and align the tip of the reverse body with the proximal tip of the Greater Tuberosity - approximately 50 mm from the upper border of the intact Pectoralis Major, varying on patient anatomies (*Figure 4.3*).
3. Version: 20° of retroversion referencing it to the supinated forearm, 20° is closer to normal anatomy and tuberosities may have less distraction.

Soft tissue tensioning can be evaluated during the trial reduction.

This step is based on surgeon's preferences: as general guidelines the joint should not be too easy to enlocate/dislocate, there should be no gapping while doing the shuck test and the tension of conjoined tendon and middle deltoid should be assessed. To adjust tension, stem size and reverse liner thickness can be changed.



TRIAL REDUCTION AND STABILITY TEST

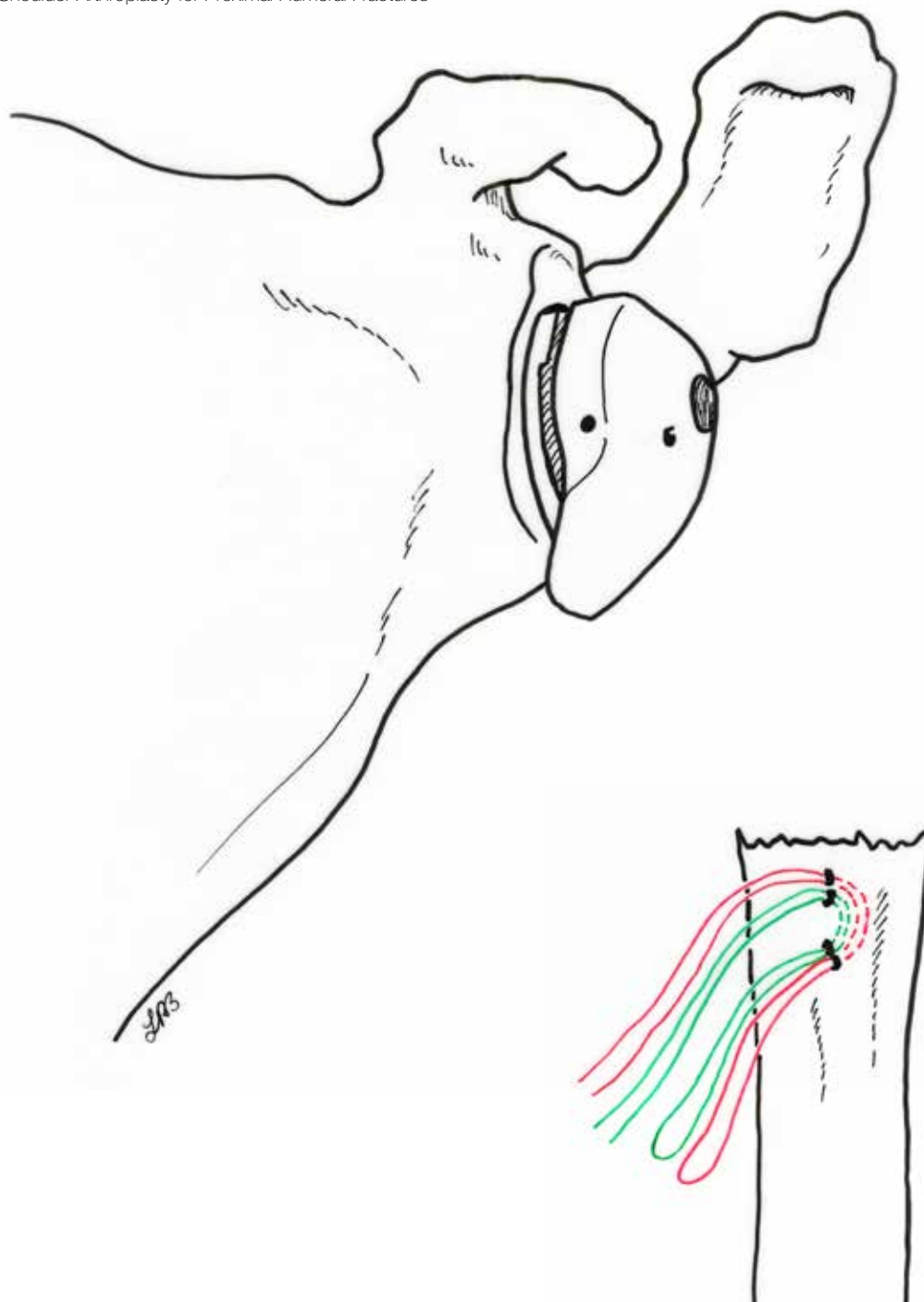
Prosthesis should not dislocate:

1. With arm at the side, in neutral rotation, the humerus is pushed from behind.
2. With fist in armpit, the humerus is extended, externally rotated and pushed (simulating anterior superior dislocation).

Potential impingement must be evaluated in:

- Adduction (inferior impingement against capsule, long head of triceps, scapular neck).
- Internal rotation (anterior impingement against conjoint tendon, coracoid, anterior glenoid).
- External rotation (impingement against posterior capsule or glenoid).
- Elevation and abduction (impingement against acromion).

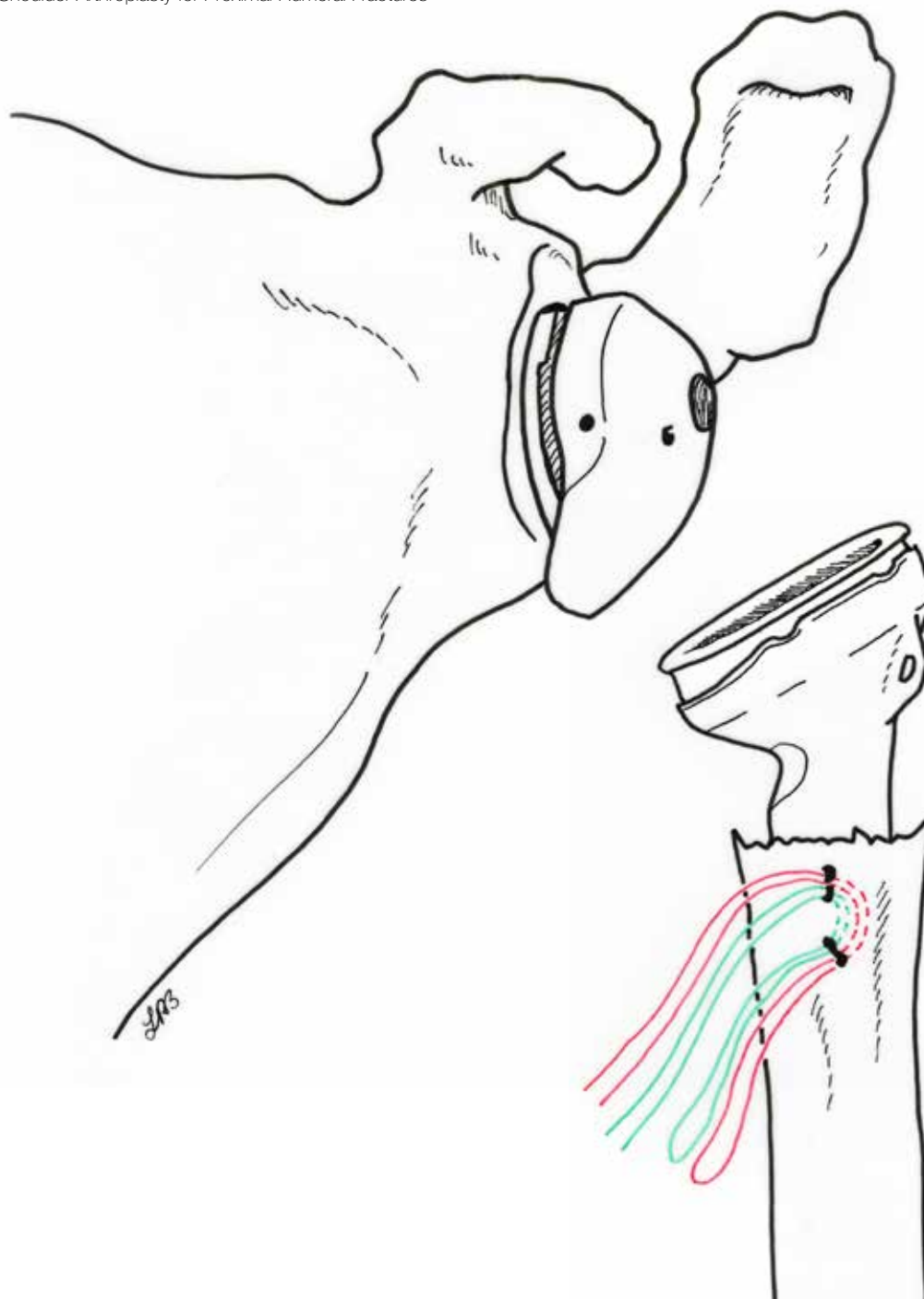
If there is premature impingement, the surgeon may consider further soft tissue releases (like capsule or long head of triceps), changing the size of the glenosphere, use an eccentric glenosphere or lateralize the glenosphere with a lateralizing adaptor (*Figure 4.4*).



DIAPHYSEAL SUTURES

Before implanting the definitive humeral component, pass 2 transosseus sutures, both double stranded (strong non absorbable polyester sutures).

Holes should be placed in the bicipital groove, the superior 1 cm below the fracture rim, the inferior 1 cm further below (*Figure 4.5*).

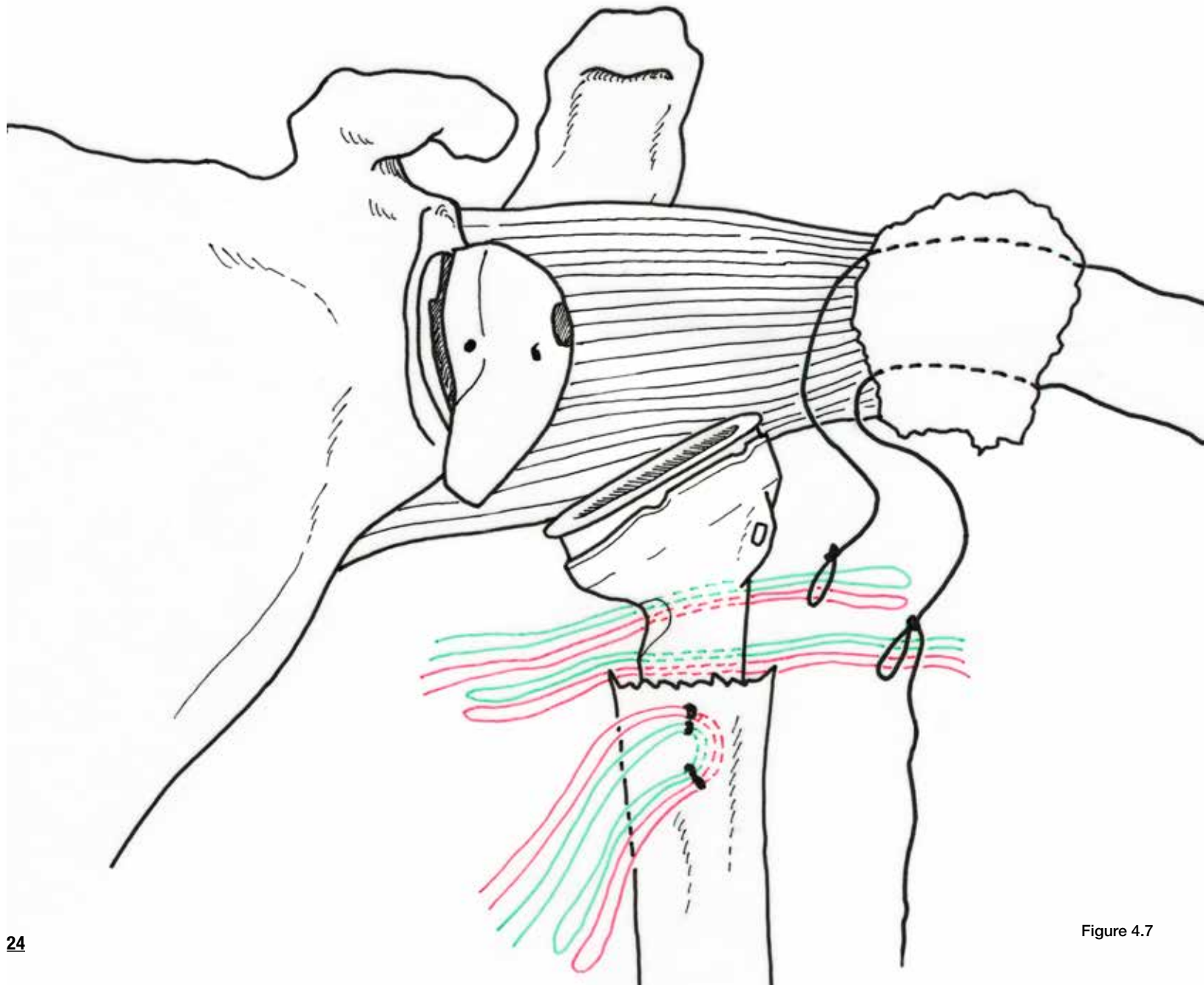


FINAL IMPLANT POSITIONING

Implant the definitive glenosphere, then the definitive humeral component according to the chosen height and version.

If the surgeon is concerned about iatrogenic fracturing of the diaphysis, a prophylactic cerclage suture or wire can be placed around the proximal diaphysis prior to insertion of the humeral prosthesis.

The chosen definitive reverse liner is then implanted (*Figure 4.6*).



FIXATION OF THE TUBEROSITIES

Cerclage sutures

Four horizontal doubled sutures are required: one pair superior and one pair inferior, each pair with 2 sutures of a different color (red and green wires in the image). They will be used for the reattachment of the tuberosities.

These sutures are placed around the medial notch of the reverse humeral body before reduction.

The reverse shoulder prosthesis is then reduced.

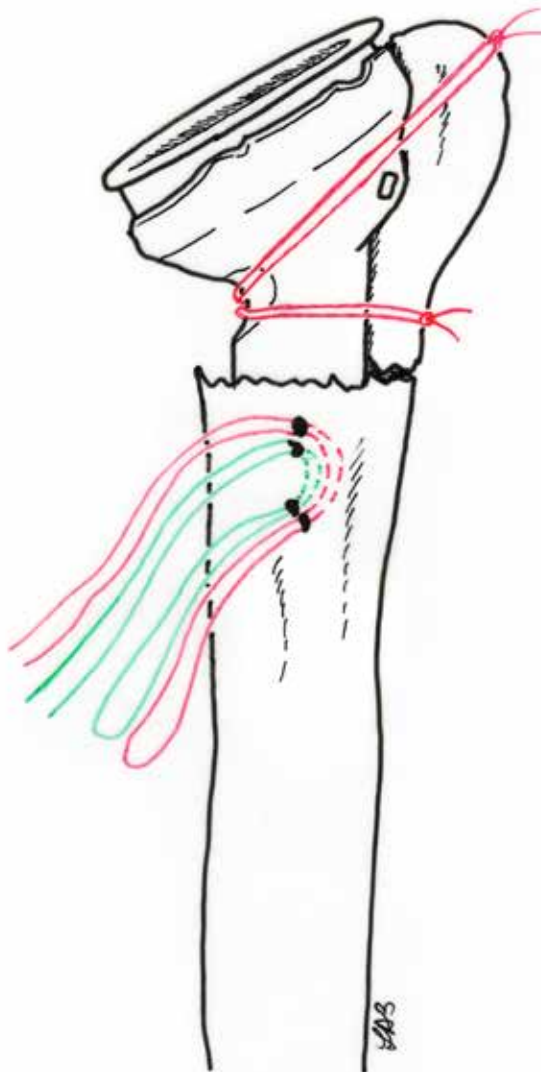
Fixation of the greater tuberosity

Position the patient's forearm in neutral rotation.

Firstly repair the Greater Tuberosity.

Each traction suture around the Greater Tuberosity is used to relay both pair of cerclage sutures that have been placed around the humeral prosthesis (*Figure 4.7*).

Grab the GT fragment with an Ellis forceps and pull it forwards and downwards to the correct position. Slight External rotation of the humerus can aid reduction of the GT.



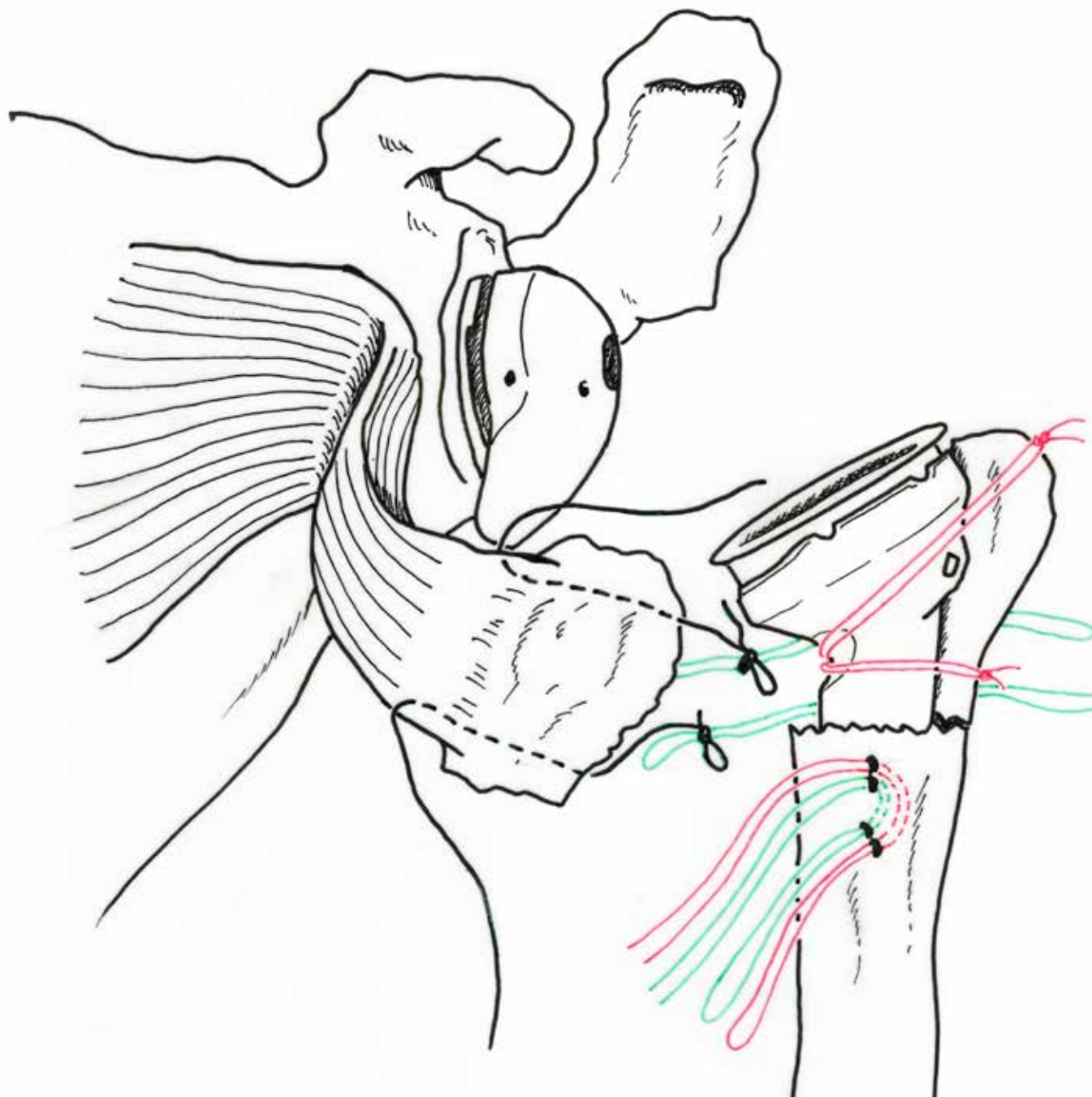
Positioning of the greater tuberosity

The top of the GT should be aligned with the top of the reverse body. Check that when the Lesser Tuberosity is reduced to the GT, the bicipital groove should be positioned anteriorly, in line with the flexed and supinated forearm (*Figure 4.8*).

Add morcelized bone graft –harvested from the humeral head– between the prosthesis and the GT and between the GT and diaphysis

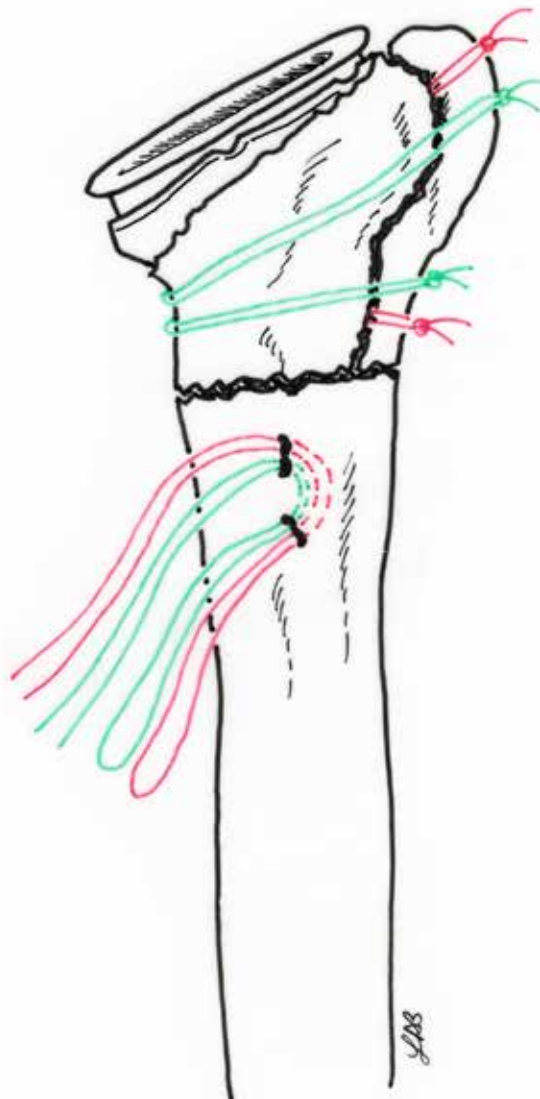
The fins of the SMR Finned Reverse Humeral Body can aid in supporting the GT.

A superior and inferior horizontal cerclage suture (red wires in the image) is then tied, securing the GT to the prosthesis. Each have been doubled over to allow the surgeon to tie a “Nice Knot”.^[21]



Fixation of the lesser tuberosity

The 2 traction sutures around the LT are used to relay the remaining superior and inferior horizontal cerclage sutures (inferior and superior green wires) (*Figure 4.9*).



Positioning of the lesser tuberosity

As previously performed for the GT, some bone graft is placed between the prosthesis and the LT, and between the LT and diaphysis.

Use a combination of traction on the LT by pulling on the horizontal cerclage sutures or using an Ellis forceps and internal rotation of the humerus to reduce the LT to the GT and diaphysis (*Figure 4.10*).

Once a good reduction of the LT is achieved, the two horizontal cerclage sutures are tied to secure the LT to the humeral prosthesis. The sutures have been doubled over to allow the surgeon to tie a “Nice Knot”.^[21]

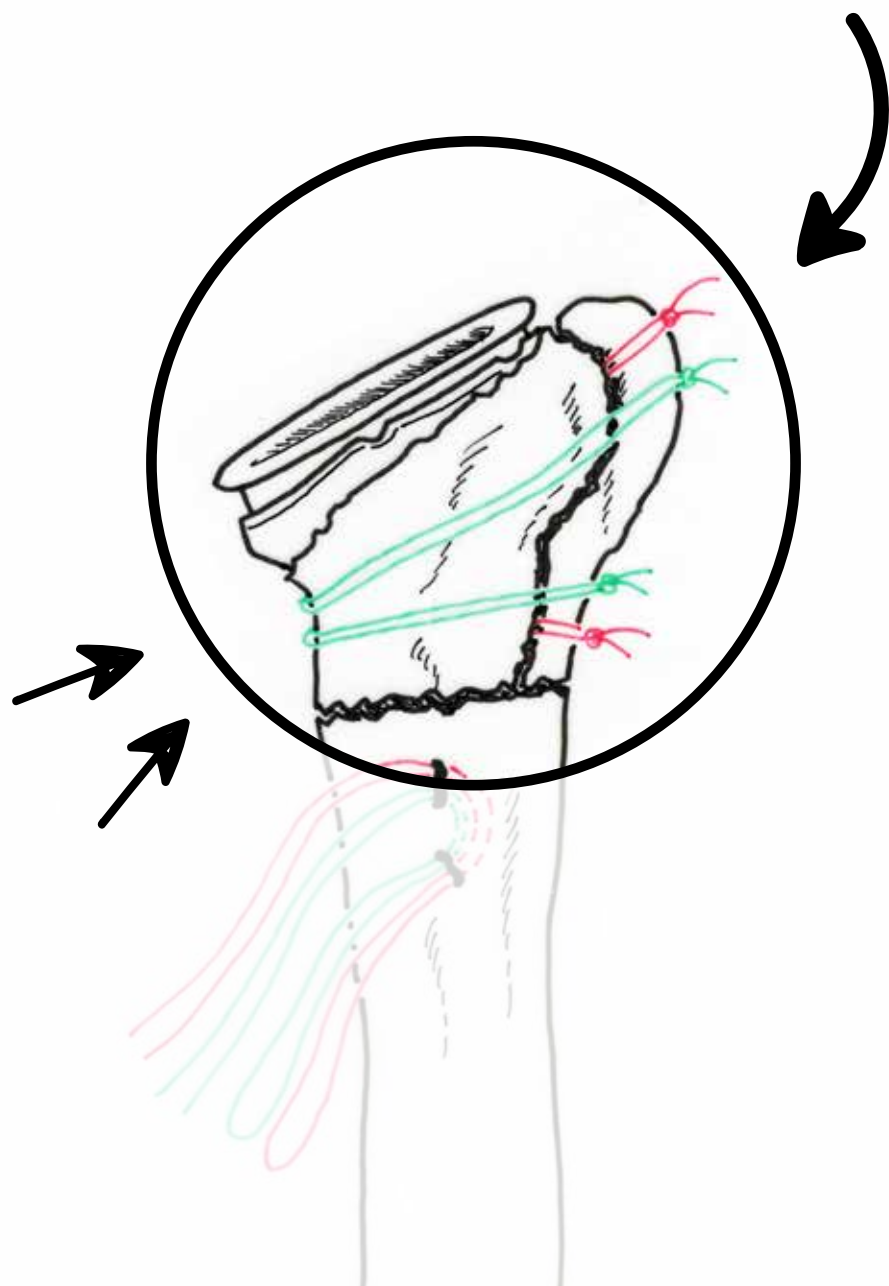


Figure 4.11

The last surgical steps have just shown the placement of 4 horizontal double stranded cerclage sutures

- 2 around the GT and the Reverse Humeral Body (red)
- 2 around GT, LT and the Reverse Humeral Body (green)

These cerclage sutures compress and provide lateral stability to the tuberosities. (*Figure 4.11*)

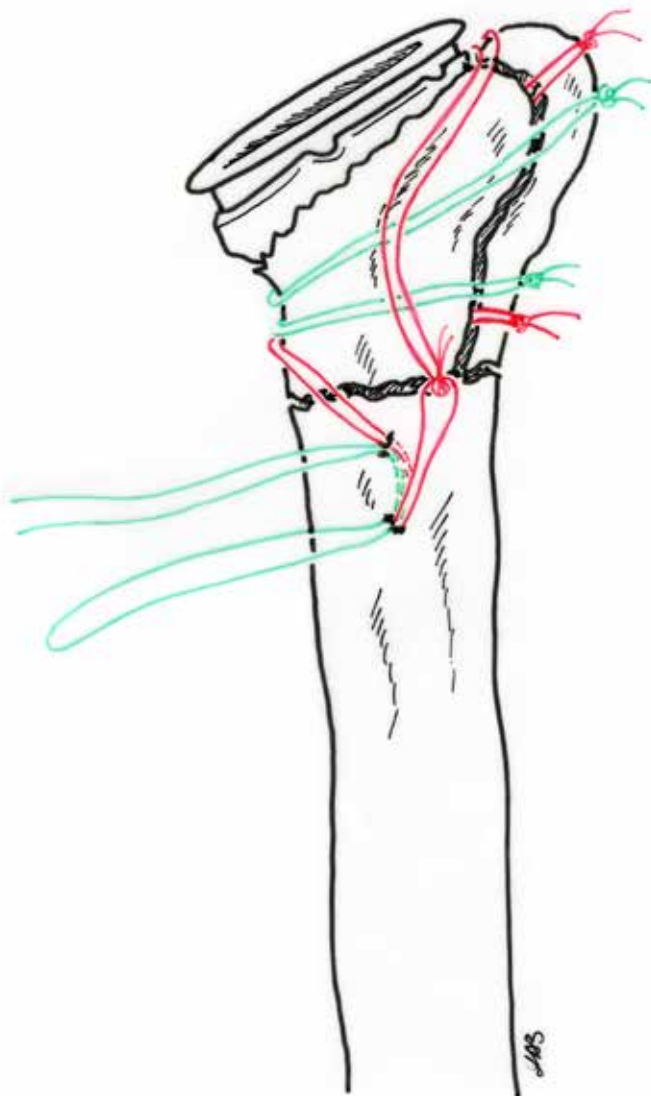


Figure 4.12

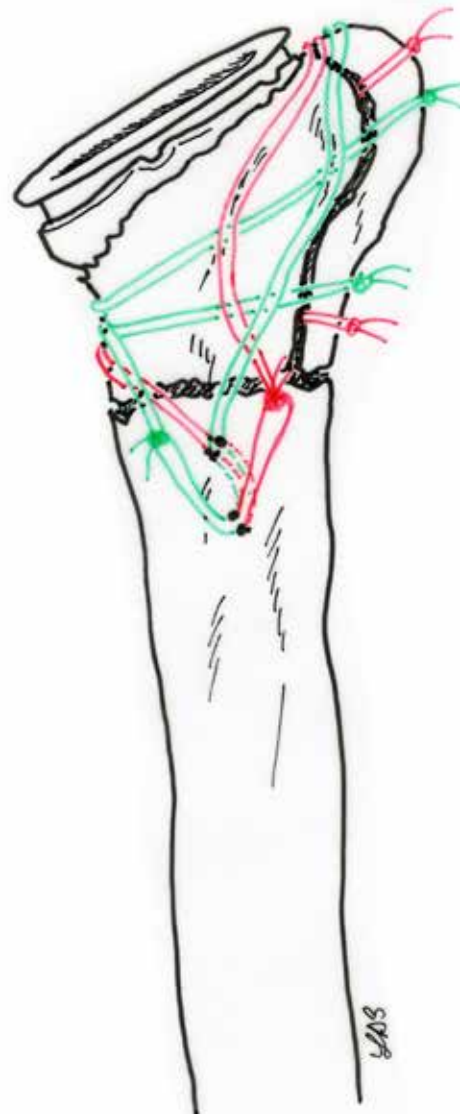


Figure 4.13

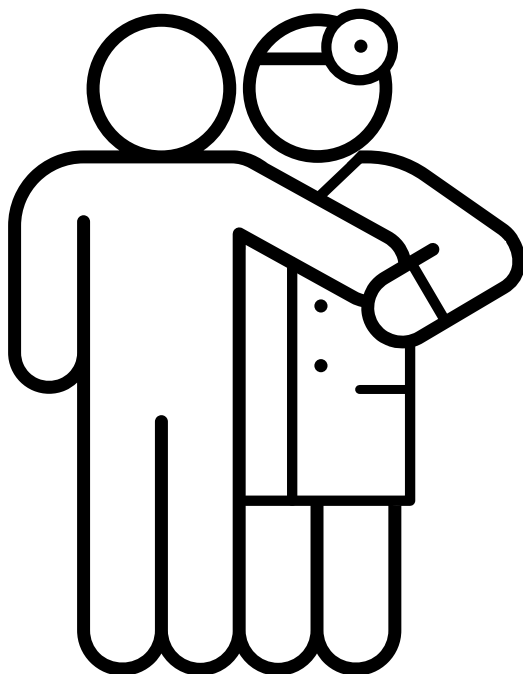
Final sutures

The diaphyseal sutures are used to provide a vertical support and should be passed around the repaired tuberosities.

Use a large Mayo needle to pass one doubled suture (the red wire in the image) anti clockwise through the infraspinatus, supraspinatus and upper subscapularis tendon (*Figure 4.12*). The other doubled suture (green) is passed clockwise through the lower subscapularis, upper subscapularis and supraspinatus tendon (*Figure 4.13*).

Each suture is then tied: the wires have been doubled over to allow the surgeon to tie a “Nice Knot”.^[21]

The above suturing technique should provide a reproducible and secure fixation of the tuberosities onto the prosthesis and diaphysis.



5.

REHABILITATION

The surgeon should individualize the postoperative rehabilitation depending on the stability of the prosthesis and fixation of the tuberosities.

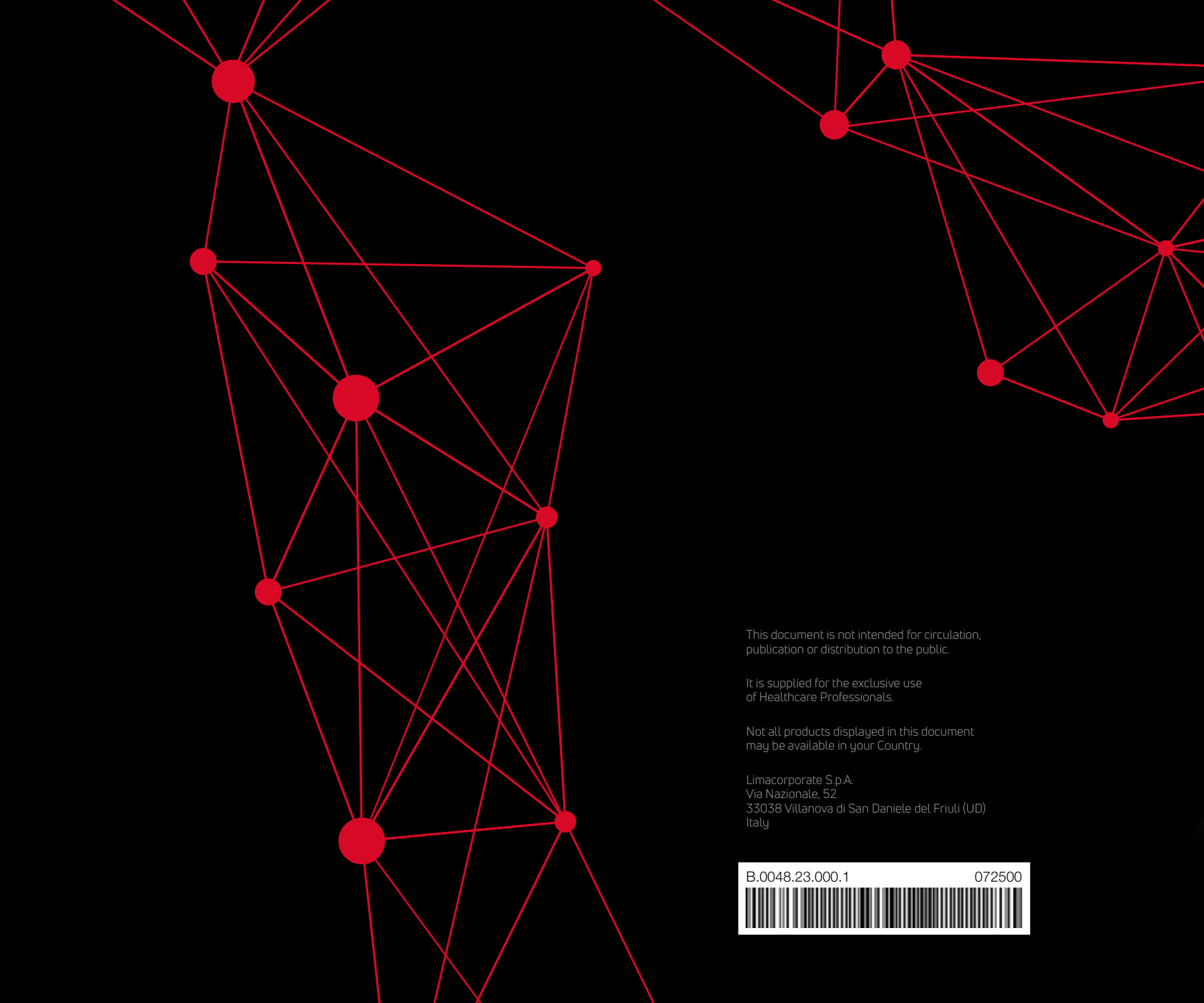
Usually, an accelerated post operative rehabilitation can be commenced immediately after the surgery.

When not performing rehabilitation exercises (pendulum and assisted active range of motion exercises) the arm can be rested in a sling for 6 weeks with the arm in external rotation (approximately 30 degrees) to reduce tension on the repair of the Greater Tuberosity.

After 6 weeks, the patient is usually allowed to use the arm for all light activities of daily living and allowed to drive. Strengthening is usually commenced 3 months post operative.

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