Tendon Injuries

16

Kuno Weise

16.1 Basics

Fresh rupture or degenerative damage to large tendons is a clinical entity that is becoming increasingly common. This can be attributed to an increase in sport activity among older people in particular, and also to improved diagnosis and a greater degree of exposure to the systems that transfer muscle power to injury in professional life or in road traffic accidents. Substantial loss of function can result if the smaller tendons in the hand, for example, are severed as a result of direct blunt trauma or torn as a result of indirect injury mechanisms. Spontaneous tendon ruptures based on the indirect effects of force are often caused by more than one factor.

16.1.1 Anatomy

Tendons are made up of what is known as bradytrophic tissue (i.e., the blood supply is significantly lower compared to the muscles and ligaments). Nutrients are supplied to the tendon predominantly by small vessels from the peritendineum and to a lesser degree via the belly of the muscle attached to it. Tendons are made up of dense connective tissue that contains predominantly types I and III collagen fibers. Compared to the muscles, tendons are less receptive to training, which explains their tendency to strain injuries and spontaneous rupture.

16.1.2 Physiology and Pathophysiology

Tendons are part of the systems that transfer power (i.e., they transfer muscle contraction to the target organ, the bone, and its associated joints). They differ in length and configuration and show an appropriate adaptation in cross-section depending on strain and function. The reasons for gaps in the continuity of a tendon are direct trauma, such as cuts and stab wounds, and less frequently blunt trauma or spontaneous rupture resulting from indirect trauma. The latter is caused by a disparity between capacity and loading (e.g., when degenerative changes have occurred because of local circulatory disturbance and chronic overstrain). Local injections, metabolic disorders, and advanced age are further predisposing factors. Insufficient warm up and stretching, inadequate training, and unsatisfactory technique as well as poor conditions for sport activity are considered to be additional causes of these injuries.

16.1.3 Specific Causes of Tendon Injuries

Gaps in the continuity of the rotator cuff are predominantly the result of degenerative changes. The same applies to rupture of the long biceps tendon. Violent rupture of the rotator cuff requires special injury constellations that must involve a sudden change in length in excess of the resistance of the aponeurosis

K. Weise
Medizinisches Begutachtungsinstitut,
em. o. Prof. Eberhard Karls Universität Tübingen,
Forchenweg 7, 72076 Tübingen, Germany
e-mail: info@prof-weise.de

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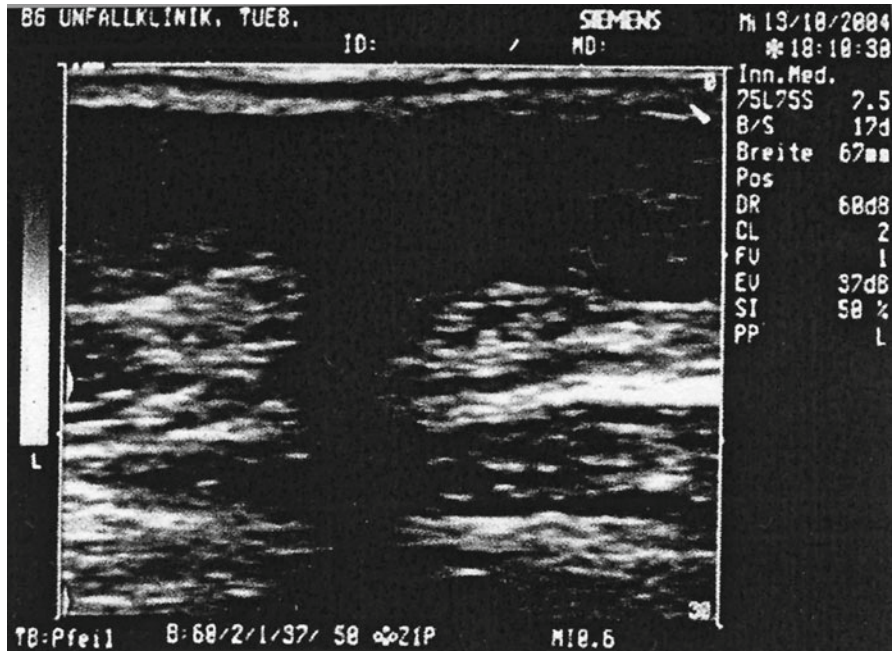


Fig. 16.1 Ultrasound image of a torn rotator cuff

(e.g., rupture of the supraspinatus tendon with anterior shoulder joint dislocation). Ruptures of the distal biceps tendon generally result from indirect trauma. The infrequent rupture of the triceps tendon is predominantly caused by direct injuries but can also occur after local cortisone injection. As a rule, tendon injuries to the forearm or hand are caused by direct trauma such as cuts.

At the lower extremity, in addition to the frequent spontaneous ruptures of the Achilles tendon ruptures of the tendons of the extensor system are the most common. The former frequently occurs in younger athletes, while ruptures of the quadriceps and patellar tendons are predominantly observed in older individuals. The remaining tendons of the lower extremity are less frequently involved. When the ankle and foot are affected it is generally because of straightforward severance.

16.1.4 Diagnosis

16.1.4.1 History and Clinical Examination

Swelling and hematoma, a palpable dimpling in the course of the tendon and impaired or reduced function, together with the patient's history, permit a tentative diagnosis.

16.1.5 Diagnosis by Imaging Procedures

16.1.5.1 Radiography

Native radiographs are used to exclude concomitant injury to the bone (e.g., a rupture injury to the tendon) or to demonstrate or exclude degenerative joint changes.

16.1.5.2 Ultrasound

Ultrasound imaging is the examination method of choice. It can supply accurate images of the gap in continuity and any concomitant edema or hematoma (Fig. 16.1).

16.1.6 Organ-Specific Imaging

16.1.6.1 Magnetic Resonance Imaging and Computed Tomography

In unclear cases it can be useful to obtain a magnetic resonance imaging (MRI) scan in order to reach a definitive diagnosis or for consideration of differential diagnosis (e.g., in cases of rotator cuff rupture). A distinction can be made between acute and chronic changes and an opinion formed on the issue of previous damage. Computed tomography (CT) for tendon injuries is the absolute exception.

16.2 Special Tendon Injuries and Damage to the Upper Extremity

- Rotator cuff
- Proximal/distal biceps tendon
- Triceps tendon
- Tendons in the muscles of forearm and hands

Tendon injuries to the upper extremity are relatively frequent and their cause becomes increasingly traumatic as we move in the proximal-distal direction. Tendon injuries in the forearm and hand region are generally caused by direct mechanisms, in particular by cuts. In contrast, the majority of the lesions of the rotator cuff and long biceps tendon results from degenerative changes caused by overstrain injuries (e.g., in individuals who undertake heavy, physical work).

Isolated traumatic ruptures to parts of the rotator cuff tend to be infrequent but can occur through mechanisms that suddenly increase the distance between the origin and insertion of the muscle belonging to it [1, 2]. This is feasible, for example, in anterior shoulder joint dislocation where a tear in the supraspinatus tendon or alternatively a bony rupture in the greater tubercle can occur. Rupture of the long biceps tendon, on the other hand, is caused almost exclusively by local wear with extensive degenerative changes in the region of the bicipital groove. In contrast, most ruptures of the distal biceps tendon are the result of indirect trauma. They regularly occur because of a violent force applied to the forearm when the elbow is bent and the biceps contracted. Rupture of the triceps tendon is rare (e.g., in power athletes and through indirect mechanisms after local cortisone injections or caused by direct blunt force trauma when the tendon is contracted).

Ruptures of the tendons in the forearm extensor and flexor muscles are caused either by local cuts, such as in the context of suicide attempts or, on occasions, by contusions with substantial soft-tissue damage or in the context of industrial or road traffic accidents. The latter typically involve different types of stab wounds or cuts to the hand. Rupture of the extensor tendon in the region of its insertion at the base of the distal phalanx of the middle finger and rupture of the extensor pollicis longus muscle in the thumb region are caused by degeneration.

The symptoms of tendon rupture at the upper extremity range from the typical signs of a fresh lesion with swelling, hematoma, pain, and loss of function to a complete absence of these characteristic signs of injury. This applies to the creeping occurrence of a rotator cuff rupture and to tears of the long biceps tendon, symptoms of which many patients initially perceive as a kind of strain. Rupture of the distal biceps tendon behaves differently. It is accompanied by swelling, pain, and deterioration of function or lack of strength when the elbow joint is bent. Direct gaps in the course of the tendon in the distal forearm or region of the hand and fingers as a rule inevitably lead to loss of function in the dependent target organ, but are often not recognized in the primary diagnosis. Before initiating any treatment, it is important therefore to test the function carefully for all cut injuries in which depth and extent are unclear.

The threatening complication of re-rupture should be taken into account in all tendon injuries, whether conservatively or surgically treated. Re-rupture is caused by the reduced ability of bradytrophic tissue to heal and by degenerative changes that may be present. In the case of open tendon injuries to the hand and fingers, inflammation of the tendon sheath can develop. Finally, loss of function occurs regardless of correct and complete tendon reconstruction because of local scar tissue formation or long immobilization.

16.2.1 Diagnosis

16.2.1.1 Recommended Diagnostic Measures in Accordance with the European Standard

- Inspection: swelling, hematoma, impaired function, change in muscle contours
- Palpation: pain on pressure, gap in the continuity of the tendon

16.2.1.2 Further Useful Diagnostic Procedures

- Ultrasound: imaging of the localization, extent, and type of tendon rupture (acute/chronic, transverse/multilevel, complete/incomplete) and extent of edema/hematoma.
- Radiographs: to exclude bone involvement (bone rupture). To assess any concomitant joint damage (e.g., rotator cuff lesion, rupture of the long biceps tendon).
- MRI: with an unclear ultrasound diagnosis. Reproducible, gives more detailed information.
- CT: only in exceptional cases (e.g., in cases of concomitant bone injury at the joints).

16.2.2 Treatment

16.2.2.1 Conservative Treatment

Recommended Therapeutic Measures in Accordance with the European Standard

The more acute and fresh the injury to a tendon in the upper extremity, the more pressing is the indication for surgical care. Ruptures of the rotator cuff are treated conservatively because of advanced wear phenomena, especially in elderly patients and particularly if the opposite side exhibits similar changes (ultrasound). Ruptures of the long biceps tendon are also the domain of conservative treatment in older patients. This also applies to proximal ruptures of the biceps tendon, which are chronic or diagnosed late. Various studies comparing conservative and surgical therapy with appraisals of the criteria of pain, strength, and mobility demonstrate only slight superiority on the part of surgical treatment [1–3].

Rupture of the extensor tendon at the distal phalanx is regularly treated conservatively and successfully. Special finger splints are used that hold the distal phalanx in overextension for 6–8 weeks [1].

With partial rupture of the superficial layers of the rotator cuff and degeneration-induced tears in elderly patients with a low degree of activity and where the lesion is no longer fresh, conservative, early, functional therapy can yield good results. Conservative management of ruptures to the long biceps tendon likewise involves early functional therapy during which strong exertion should be avoided in the initial weeks. A conservative therapy regime for injuries to the extensor tendons of the finger using synthetic splints for 6–8 weeks requires them to be worn continually; otherwise partial healing of the tendon can occur with a residual decrease in extensibility.

16.2.2.2 Surgical Treatment

Recommended Therapeutic Measures in Accordance with the European Standard

Fresh, traumatic rotator cuff rupture is a clear indication for surgical reconstruction. A basic distinction is made between technically demanding arthroscopic refixation of the affected part of the tendon and the open procedure, known as “mini open repair” via a “lateral deltoid split”. If there is any doubt, open repair to restore continuity should be preferred. The affected part of the rotator cuff can be re-anchored to the insertion site of the aponeurosis at the greater tubercle either by the transosseous refixation, which is considered reliable or by means of what are known as suture anchors, which are fixed in the bone at the insertion site or somewhat medially of the insertion site. In older or chronic ruptures, the retracted tendon stumps are treated in the same way after mobilization. Special suturing techniques are used. It is important to perform refixation without tension being too great; possibly with medialization of the insertion region. Various graft replacements are used with significant defects or degeneration-induced massive ruptures, such as those involving the deltoid or latissimus dorsi muscle [1, 2]. After completion of all reconstructive measures, temporary immobilization and a physiotherapy program involving a defined increase in mobility and building up of the muscles is necessary (Figs. 16.2 and 16.3).

Ruptures of the long biceps tendon are managed for the given indication by using the keyhole technique (Fig. 16.4). The distal end of the tendon is located and used to form a knot that is secured with a suture. Subsequently, with the elbow joint at 90°, a hole about 8 mm in diameter is drilled in the bone of the upper arm after the tendon/muscle has been sufficiently tensed. The drill hole is extended distally to form a slot. The knotted tendon is fitted into this “keyhole” [3, 4]. Concomitant and follow-up management includes early mobilizing physiotherapy. Alternatively, the tendon stump can also be connected to the short head of the biceps using Kessler-type sutures or can be anchored at the coracoid process. Concomitant and follow-up treatment includes early functional rehabilitation.

Anatomical reinsertion is performed at the radial tuberosity in distal biceps tendon rupture. Transosseous reinsertion via V-shaped drill holes is time-consuming, and recently, the tendon has been re-anchored using suture anchors that were inserted into the tuberosity [5, 6]. Because of potential lesions of the superficial and deep branches of the radial nerve and the occasional development of heterotopic ossification with subsequent reduction in joint function, the complication rate for these interventions is not negligible. Adjuvant and follow-up treatment can be performed as early functional procedures when the tendon has been reliably fixed (Figs. 16.5 and 16.6).

Cut injuries with tendon involvement in the distal forearm, wrist, or in the hand or finger region are frequent and are treated according to the rules of tendon surgery using special suture techniques and a

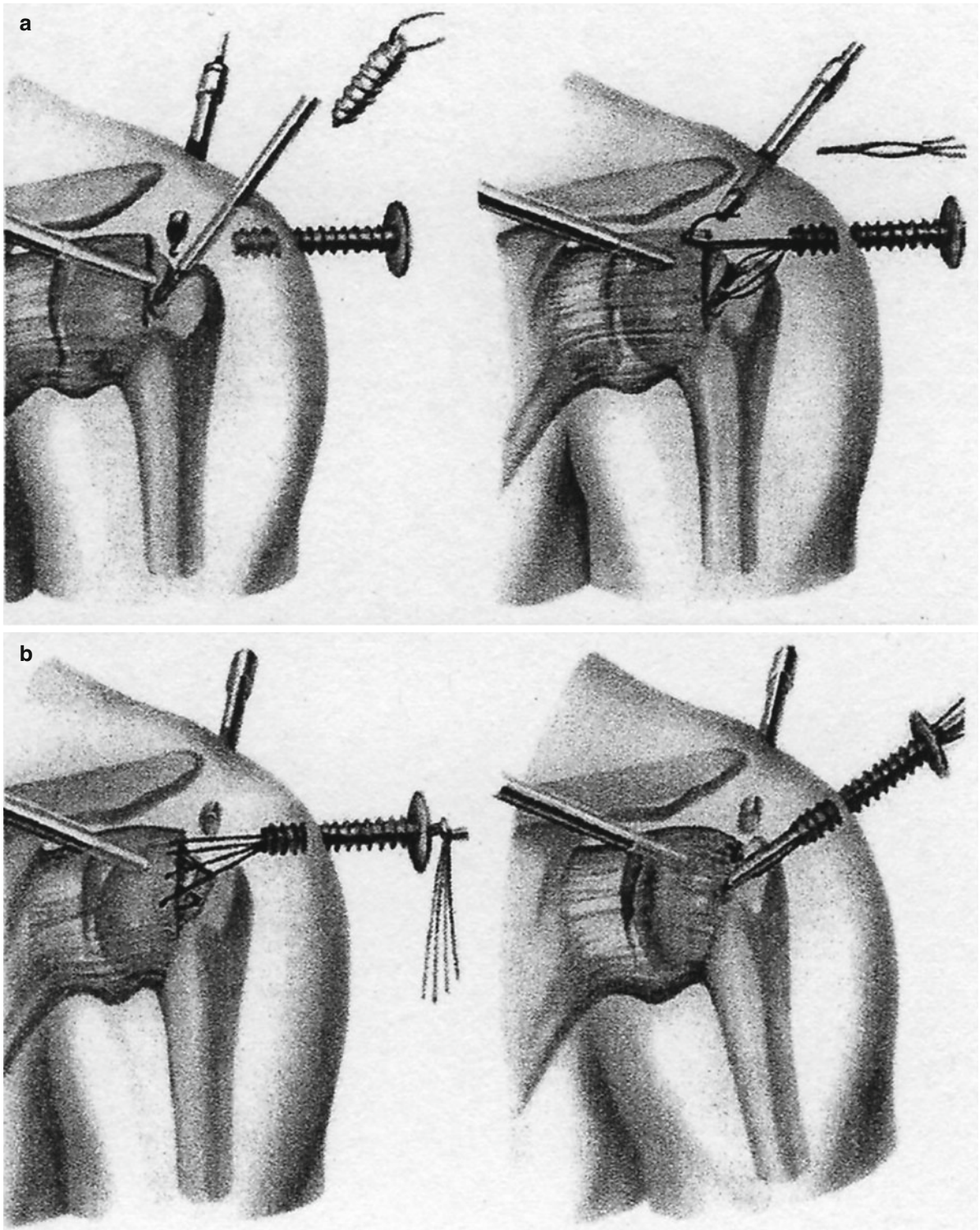


Fig. 16.2 (**a**, **b**) Arthroscopic technique of transosseous suture in rotator cuff tears

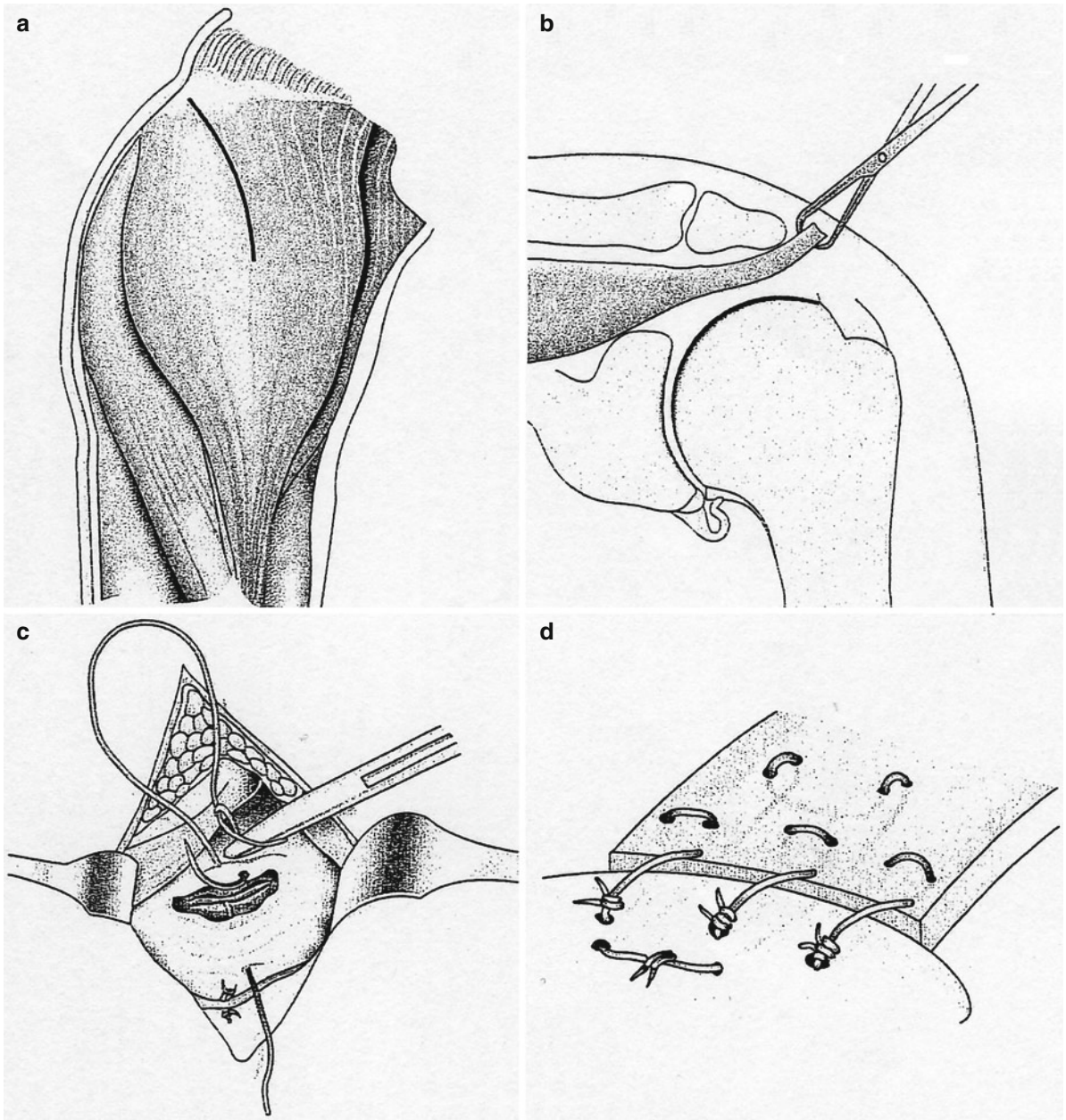


Fig. 16.3 Transosseous fixation of the torn rotator cuff at the site of the greater tubercle. (**a**) Incision. (**b**) Mobilization of the tendon. (**c**, **d**) Transosseous fixation

differentiated adjuvant and follow-up treatment using special functional splints. For loss of substance, tendon grafts or transfers are performed. Rupture injuries to the bone, such as to the extensor tendons, from a certain size and degree of dislocation are refixed using tension band fixation or small screws. Ruptures of the tendon of the extensor pollicis longus muscle, either on the basis of degenerative changes in chronic fractures or iatrogenic fractures of the distal radius occurring on reconstruction, are treated by using an extensor indicis proprius graft.

Additional Useful Surgical Measures

With degenerative-induced rotator cuff ruptures where the head of the upper arm has moved up and there are signs and symptoms of impingement, reconstruction of

the aponeurosis is combined with a subacromial decompression. Degenerative changes in the long biceps tendon are accompanied by biceps tendon tenodesis. The reconstruction of the relatively infrequent ruptures of the triceps tendon is performed surgically by end-to-end suture of the tendon stumps using U-shaped sutures. Functional adjuvant and follow-up treatment after refixation of the long and distal biceps tendon or triceps tendon can be undertaken after provision of splints with individually adjustable mobile joints.

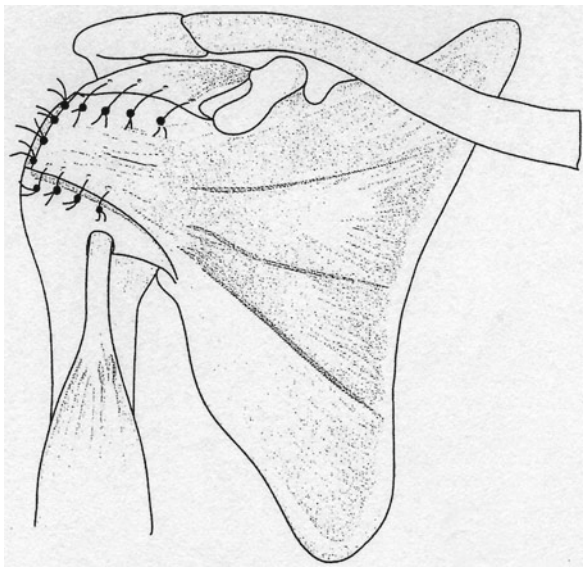


Fig. 16.4 Transfer of a m. subscapularis flap into the defect of the rotator cuff

16.2.3 Differential Diagnosis

Differentiating between traumatic rotator cuff ruptures and those induced by degenerative changes is significant, not least because of the need for expert opinions related to insurance claims. This differentiation also has an impact on the type and timing of treatment as well as on prognosis. Tears of the long biceps tendon as well as those of the distal biceps tendon are often overlooked initially because no change in the muscle contours can be seen on the flexor side of the upper arm. If there are grounds for suspecting cut injuries of the flexor and extensor tendons at the wrist, hand, and fingers, the precise functional tests, or under certain circumstances, surgical exploration are indicated in order to establish the actual extent of the injury.

16.2.4 Prognosis

In terms of prognosis, rotator cuff ruptures depend on the way they occurred, previous injury, the timing and quality of diagnosis and treatment, the extent of the defect, and last but by no means least, on an appropriate concomitant and follow-up treatment. The outcome after treatment of ruptures of the long biceps tendon is only marginally different under conservative or surgical regimes. Surgically treated ruptures of the distal biceps tendon are not infrequently accompanied by deterioration of elbow joint function and the rotatory movements of the forearm, particularly when heterotopic

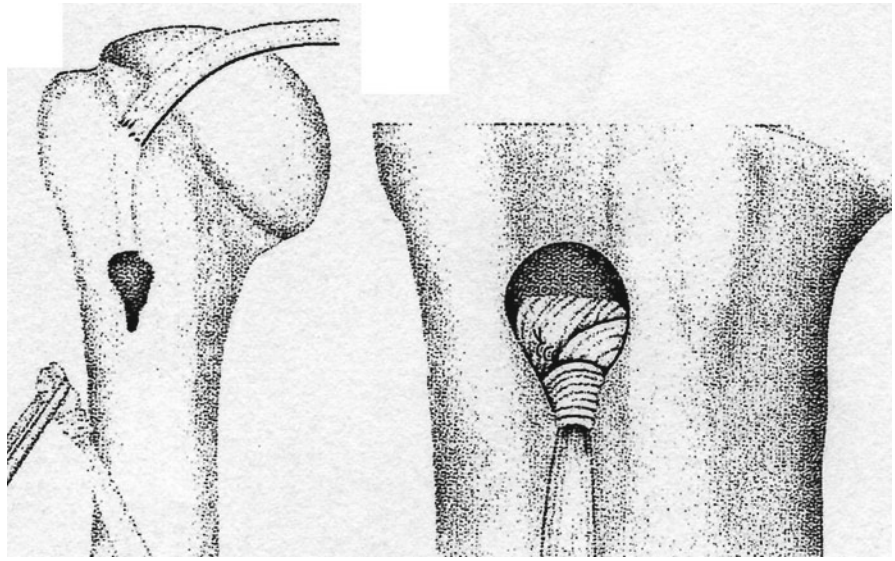


Fig. 16.5 Keyhole technique for re-fixation of the long biceps tendon

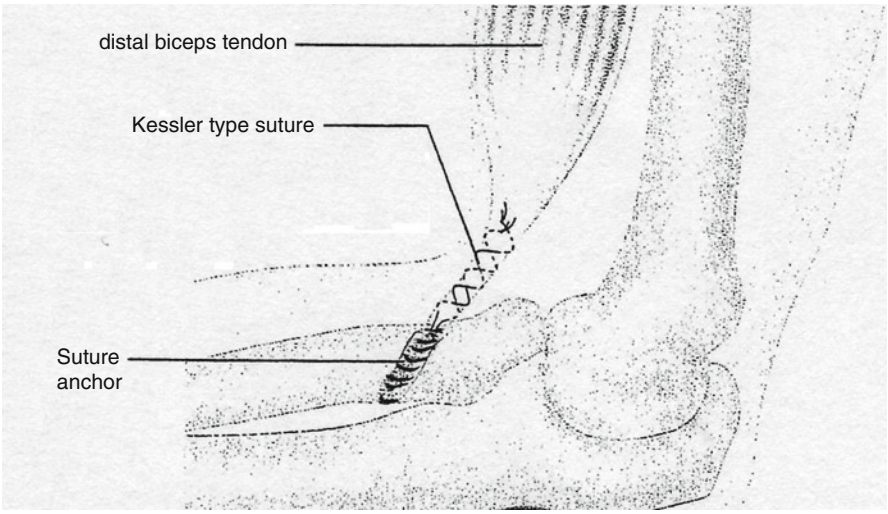


Fig. 16.6 Reinsertion of a distal biceps tendon rupture using suture anchors

ossification occurs. Lesions of the sensory and motor branch of the radial nerve leave a legacy of symptoms and marked abnormalities in function. The reconstruction of cut injuries of the flexor and extensor tendon or of tendon avulsion and ruptures in the hand can also be followed by residual impairment in function.

16.2.5 Examples of Surgical Procedures

16.2.5.1 Procedure 1

Recent traumatic rupture of the supraspinatus tendon in young, active patients is reconstructed surgically. The procedure can be performed using an open procedure or arthroscopically. The technique most frequently performed is open reinsertion via a lateral deltoid split with the patient in the beach chair position. After splitting the deltoid muscle, inserting a protective suture to protect the axillary nerve and carrying out subacromial decompression, the edges of the tendon are identified and débrided, as is the insertion site of the rotator cuff at the greater tubercle. After creating drill channels the tendon edges are reunited and tension-free and U-shaped absorbable sutures are inserted. Alternatively, suture anchors can be used.

16.2.5.2 Procedure 2

A rupture of the biceps tendon, for which there is clinical and ultrasound evidence, must be refixed surgically. An S-shaped, curved incision is made over the elbow, the radial nerve is identified and protected, and access is gained to deeper levels as far as the tuberosity of the radius. The ruptured tendon is located in the proximal region of the wound. With the elbow joint at 90°, 1–2 suture anchors are screwed into the tubercle, after which the tendon is sutured with Kessler-type sutures. These can be used to fasten the tendon stump to its insertion site. An alternative technique is transosseous refixation by means of a U-shaped drill hole at the tuberosity of the radius [5, 6].

16.2.6 Special Remarks

Tendon injuries and damage to the upper extremity occur frequently and are caused either by direct or traumatic external force or by advanced degenerative changes. A differentiation based on these etiological factors has direct impact on the appropriate therapy, adjuvant or follow-up treatment, as well as prognosis.

Most tendon injuries to the upper extremity result from sport activities or industrial accidents. Intensive preventative measures are needed to reduce the incidence of this kind of injury.

16.3 Tendon Injuries to the Pelvis and Lower Extremity

- Apophyseal avulsion fractures of the pelvis
- Tendon ruptures to the knee extensor system (quadriceps tendon, patellar ligament)
- Achilles tendon rupture
- Tendon injuries of the lower leg and foot muscles

In the case of tendon injuries to the lower extremity, it is clear that in numerical terms, Achilles tendon rupture dominates, followed by generally

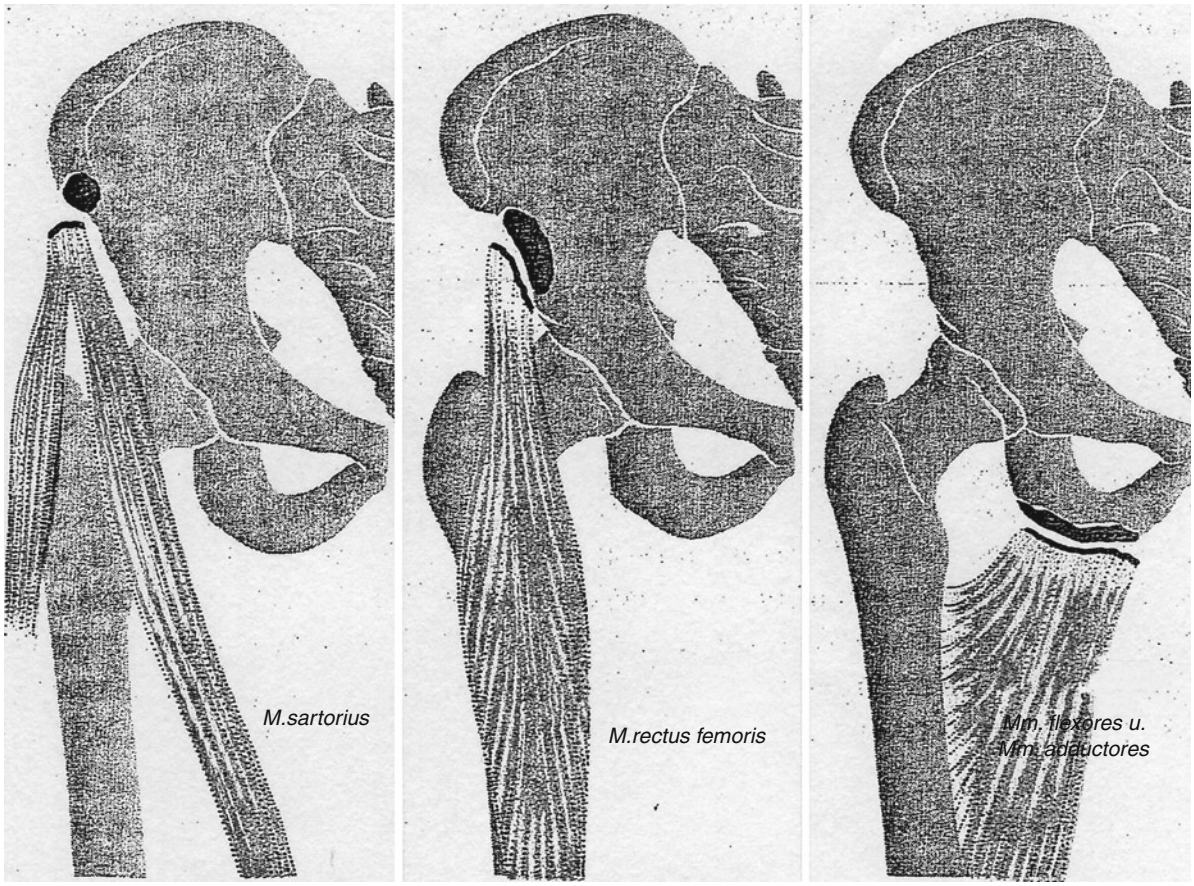


Fig. 16.7 Several types of epiphyseal avulsion fractures

degeneration-induced rupture injuries to the knee extensor system. While apophyseal avulsion fractures of the pelvis are generally seen in young people and result from sudden movements (e.g., starting, jumping), tendon injuries in the ankle and foot region tend to be caused by direct trauma (i.e., cuts, stab wounds) (Fig. 16.7).

The characteristic symptoms of tendon injuries to the lower extremity are substantial loss of function in the neighboring joints, such as loss of the knee extensor mechanism in ruptures of the quadriceps or patellar tendons, or patient inability to stand on their toes with Achilles tendon rupture. Apophyseal pelvic injuries have few symptoms; direct ruptures of ankle and foot tendons are accompanied by equivalent injuries and a dependent loss of function at the periphery.

The most serious and frequent complication of tendon injuries to the lower extremity is re-rupture, particularly where there are pronounced degenerative changes, an inadequate suturing technique, or premature loading.

16.3.1 Diagnosis

16.3.1.1 Recommended Diagnostic Measures in Accordance with the European Standard

- Inspection: possible swelling and hematoma at the pelvis as well as antalgic posture. In quadriceps or patellar tendon ruptures, changes in contours with swelling, hematoma, and loss of extensor mechanism. Open wounds in the case of cuts or stab injuries in the ankle or foot.
- Palpation: pain on pressure in the region of the pelvic apophyses and dimpling. Quadriceps/patellar

tendon, high-riding patella in patellar tendon rupture. In tendon ruptures to the ankle joint and foot the tendons are not palpable at typical localizations.

16.3.1.2 Further Useful Diagnostic Procedures

- Ultrasound: imaging technique of choice in all large tendon injuries, (e.g., knee extensor system, Achilles tendon, and the long tendons of the lower leg muscles).
- Radiography to confirm apophyseal avulsion fractures of the pelvis or to exclude concomitant bone lesions (e.g., rupture injuries to the bone at the patellar tendon/Achilles tendon, the tibial tuberosity, or calcaneal tuberosity).
- MRI/CT: MRI is used where findings are unclear and/or concomitant injury to adjacent joints is suspected, but is normally superfluous. The same applies to CT [1, 7].

16.3.2 Treatment

16.3.2.1 Conservative Treatment

Recommended Therapeutic Measures in Accordance with the European Standard

As a rule, apophyseal avulsion fractures of the pelvis in young people are treated conservatively. Only pronounced dislocations of larger fragments are an indication for surgical refixation in individual cases [1, 2].

Conservative measures in ruptures of the extensor system are considered only in infrequent cases of incomplete or partial ruptures. In the case of complete ruptures, without surgery, an extensor insufficiency will remain [8–10].

Achilles tendon rupture where ultrasound shows that the ends of the tendon are in contact when the foot is in plantar flexion can be successfully treated without surgery. A prerequisite for this is wearing a special boot continuously for about 8 weeks as plantar flexion is gradually reintroduced on full weight bearing. The shoe is used for about 1–2 weeks after the trauma following initial immobilization in plaster. Ultrasound follow-up assessments are recommended at regular intervals. After removing the shoe, a 2–2.5 cm raised heel must be worn for 4–6 weeks as part of the patient's ready-to-wear shoe [9, 11–13].

Acute ruptures of the ankle joint and foot tendons are not suitable for conservative treatment.

Additional Useful Therapy Options

Bed rest of 2–3 weeks duration with therapeutic positioning of the affected part is recommended for the treatment of apophyseal avulsions or pelvic rim fracture. In avulsion fractures at the ischial tuberosity, the patient is in the extended position; if these affect the anterior superior iliac spine then the hip joint is flexed. Conservative treatment of Achilles tendon rupture needs strict monitoring, on the one hand, and appropriate compliance on the part of the patient on the other. During treatment using the special boot, a defined physiotherapeutic adjuvant and follow-up treatment is necessary as well as regular ultrasound assessments. Rupture injuries to the Achilles tendon that are very distal and close to the insertion site or involve the bone are unsuitable for conservative therapy.

16.3.2.2 Operative Treatment

Recommended Therapeutic Measures in Accordance with the European Standard

Avulsion fractures of the large pelvic tendons are refixed in selected cases using screws or tension band fixation.

Ruptures of the tendons of the knee extensor system generally occur right at the tendon origin or insertion (i.e., at the upper or lower patellar pole or at the tibial tuberosity). Ruptures in the tendon that are caused by indirect trauma tend to be infrequent. They may result from direct blunt force trauma, such as through cut or stab wounds. Additional augmentation using cerclage wire or absorbable cord is required as well as suturing because of the poor healing ability. Tendon ruptures directly at the upper or lower patellar pole are fixed in a transosseous fashion, at best using U-shaped sutures through the tendon stump or longitudinal 2 mm channels drilled at the knee cap. Augmentation follows with the insertion of a framework of cerclage wire or a 2.00 mm Polydioxanon (PDS) cord positioned across the patella and proximal to the rupture site of the quadriceps tendon and through the latter. In the case of patellar injuries, they are placed through a horizontal drill hole at the level of the tibial tuberosity. After suture and augmentation the knee joint is moved through at least 60° of flexion in order to test whether the construct is reliable and to guarantee functional adjuvant and follow-up treatment [1, 2, 8, 10].

Surgical reconstruction of the Achilles tendon is indicated for athletic patients and if there is marked residual tendon diastasis, even with the foot in plantar

flexion. Recently, a percutaneous suture technique has prevailed that uses two 1.3 PDS cords inserted in opposite directions through stab incisions that are knotted, with the foot in plantar flexion, at the level of the rupture site medially and laterally of the tendon and through which adaptation of the tendon stumps is achieved. Alternatively, open suturing (e.g., the Kirchmayr technique, fibrin glue and suturing in combination with a primary turn-down flap) have been recommended. The latter is useful in pronounced degenerative changes and marked diastasis of the tendon stumps [11–15].

Transosseous fixation is used for fixation of tendon ruptures at the calcaneal tuberosity involving bone fragments and the suture is protected by augmentation.

Reconstruction of the course of the tendon after direct injury to the tendons of the lower leg and foot muscles is performed using the suture techniques usually used in tendon surgery, such as the Kirchmayr technique. The aim is reliable restoration of the continuity of the tendon, possibly accompanied by temporary tenodesis using Kirschner wire and subsequent immobilization (Fig. 16.8).

Additional Useful Surgical Measures

Chronic ruptures of the extensor tendons at the knee joint or secondary suture insufficiency require syndesmoplasty. Turn-up X-, Y-, or Z-shaped grafts can be used for the quadriceps tendon. Augmentation is always necessary to protect this grafting procedure. Immobilization lasts for 3–4 weeks.

Insufficiencies or chronic defects in the region of the Achilles tendon can be restored through re-adaption of the débrided tendon stumps, combined with a turn-up plasty, and in the case of defects that cannot be directly bridged, X- or Y-shaped grafts or plantaris tendon graft or grafts using the tendon of the peroneus brevis or the flexor hallucis longus muscle.

Revision is indicated in achillodynia and after unsuccessful conservative therapy. After oval excision of the thickened section of the tendon, bridging using a stitched turn-up graft is indicated.

16.3.3 Differential Diagnosis

Surprisingly, many ruptures of the extensor system, or more precisely of the Achilles tendon, are not primarily diagnosed despite the patient consulting a doctor (between 10 % and 20 % of cases according to publications in the literature). In cases of doubt, an MRI should be performed as a reproducible diagnostic procedure. Partial ruptures diagnosed clinically on both sides or by ultrasound are generally found to be complete ruptures during surgical revision.

16.3.4 Prognosis

Residual damage and symptoms should not be expected in young people after conservative treatment of apophyseal avulsions of the pelvis. Only larger dislocations and increased callus formation can cause regional mechanical problems.

On the other hand, the prognosis after surgical reconstruction of ruptures of the knee extensor system must be more tentative. Impairments of knee joint function as well as the risk of re-rupture are observed in a certain percentage of patients.

The outcome after conservative or surgical treatment of Achilles tendon rupture depends to a great extent on establishing the correct indication for the procedure in question, performing it correctly, undisturbed wound healing, and a gradual building up of strength while avoiding re-rupture. After complications occur, prognosis becomes appreciably less favorable. Residual impairments of function, loss of strength in the calf muscles, and impaired athletic ability can be long-term results. The reconstruction of severed tendons in the ankle and foot depends, as far as outcome is concerned, both on correct surgical technique and carefully monitored adjuvant and follow-up treatment.

16.3.5 Examples of Surgical Procedures

16.3.5.1 Procedure 1

Longitudinal parapatellar incisions extended proximally or distally are a suitable approach to reconstruction of ruptures of the knee extensor system. After identification and débridement of the tendon ends and biopsying for cellular examination, 2 mm channels are drilled, in accordance with the type of rupture, at the upper and lower patellar pole, through which the U-shaped sutures on the stump of the quadriceps or patellar tendon are directed and knotted at the end. A transverse hole drilled through the patella for augmentation and for passage proximally through the quadriceps tendon and distally, by means of a further drill hole, through the tibial tuberosity, makes it

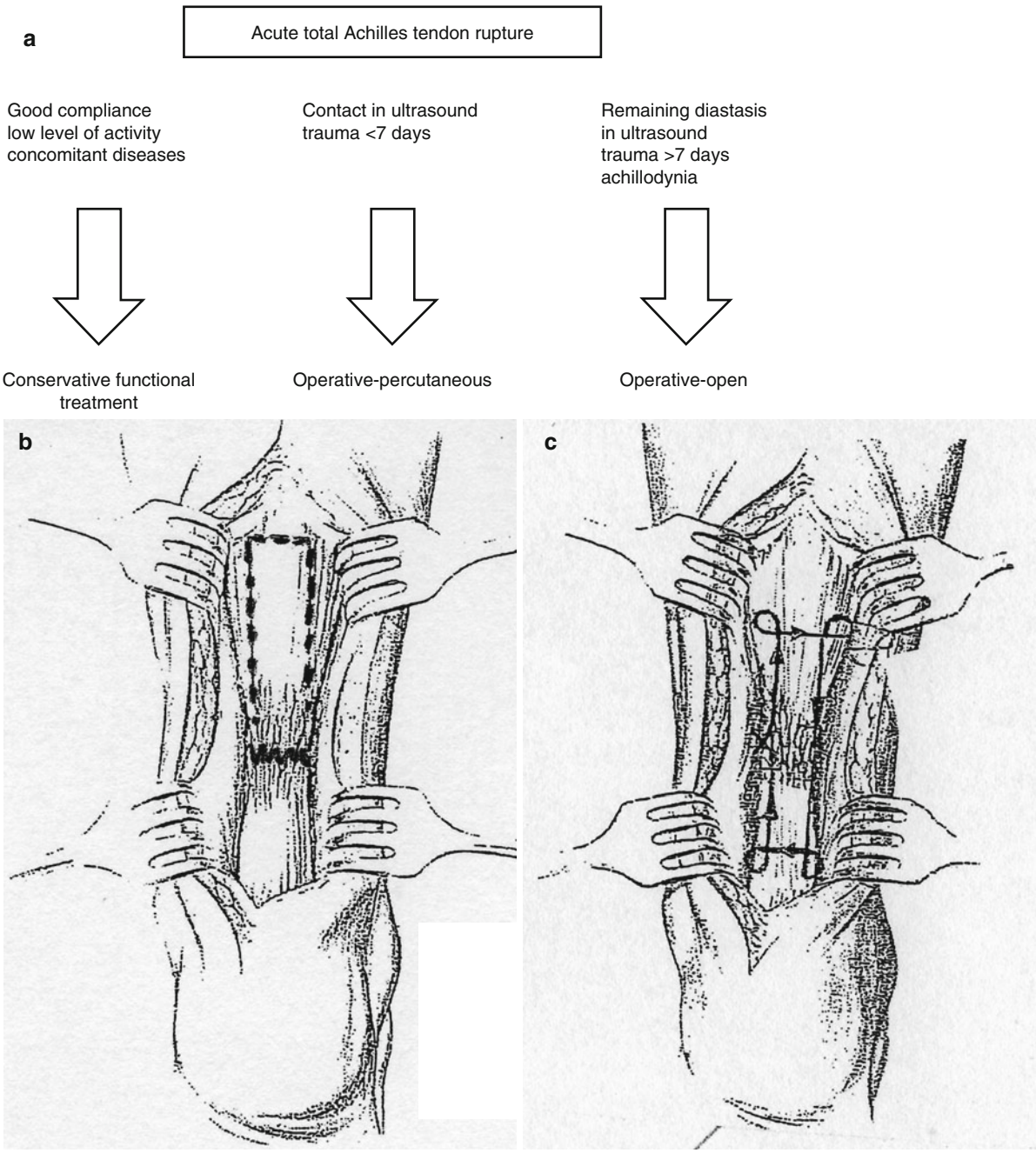
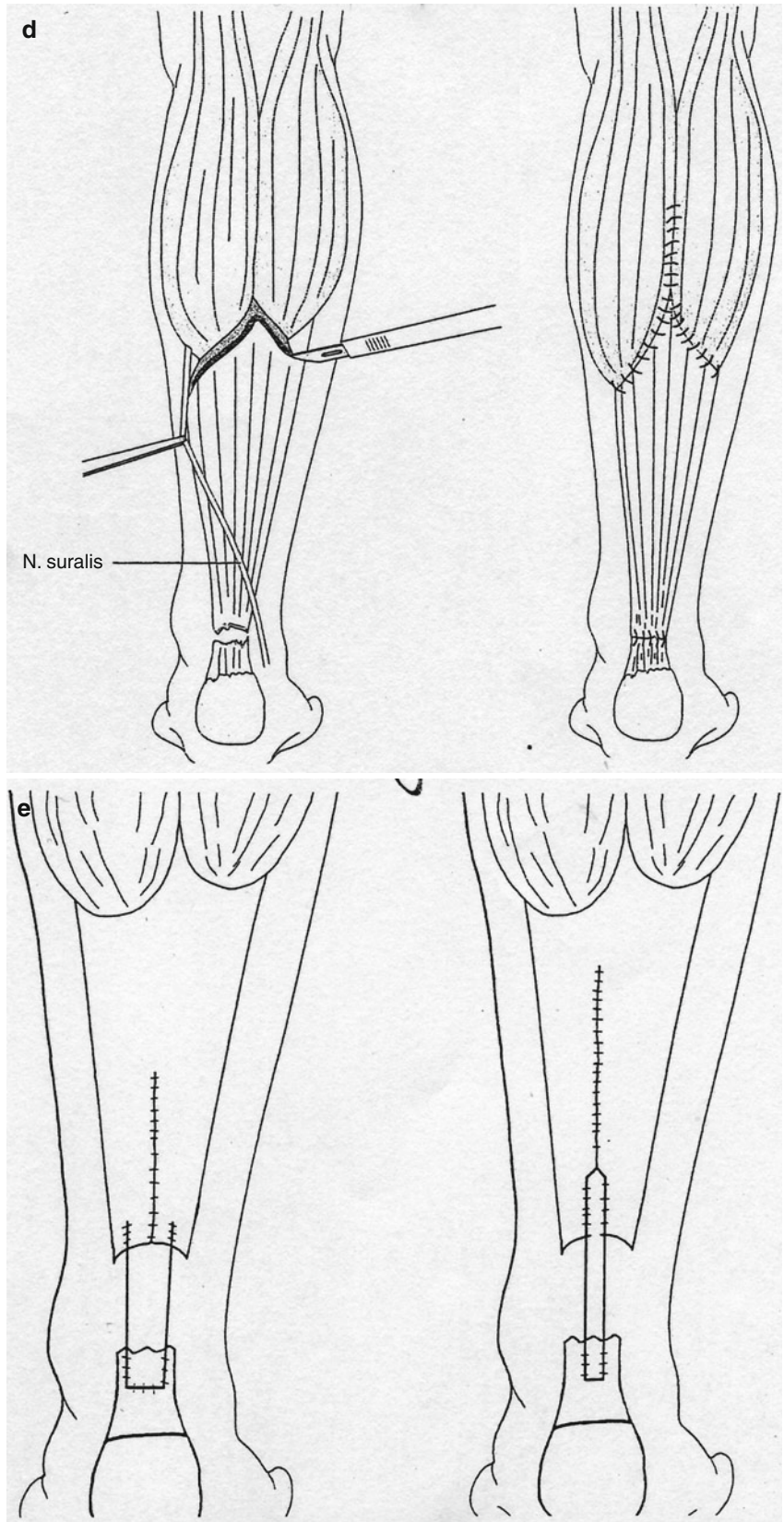


Fig. 16.8 (**a**) Kessler-Kirchmayr technique for suture in Achilles tendon rupture. (**b**) Augmentation for Achilles tendon rupture in Silverskjöld technique; preparation of the tendon flap. (**c**) Augmentation after bridging the rupture site by means of tendon flaps. (**d**) V-Y-plasty in Achilles tendon rupture with remaining defect. (**e**) Different types of Achilles tendon arthroplasties: Lindholm's arthroplasty, Lange's arthroplasty

Fig. 16.8 (continued)



possible to construct a frame-shaped augmentation using either tension band wire fixation or PDS cord to suit the type of rupture in question. PDS cord has the advantage of being biodegradable and does not, therefore, involve removal of implants. The disadvantage is the higher rate of irritation and inflammatory conditions. The correct height adjustment of the patella is highly significant, such as avoiding patella alta or baja through too tight adduction of the augmentation frame [8, 10]. Checks of the reconstructed tendon should be made intraoperatively to ensure the treatment carried out is stable up to at least 60° flexion of the knee joint (Fig. 16.9).

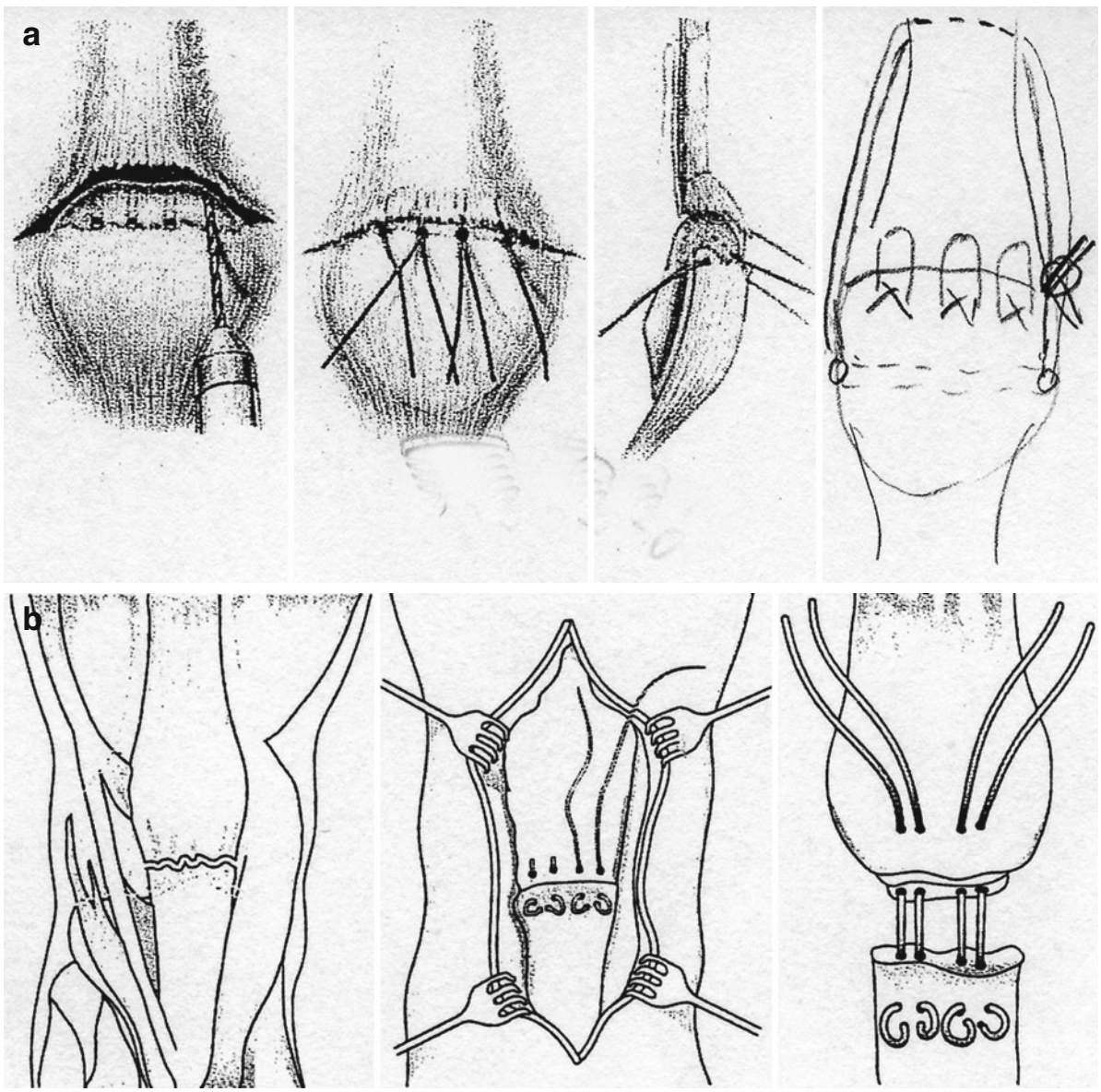


Fig. 16.9 (**a**) Transosseous re-fixation of a quadriceps tendon rupture. (**b**) Suture technique and transosseous re-fixation of a patellar tendon rupture. (**c**) Augmentation of the sutures by tension band wire of PDS cord

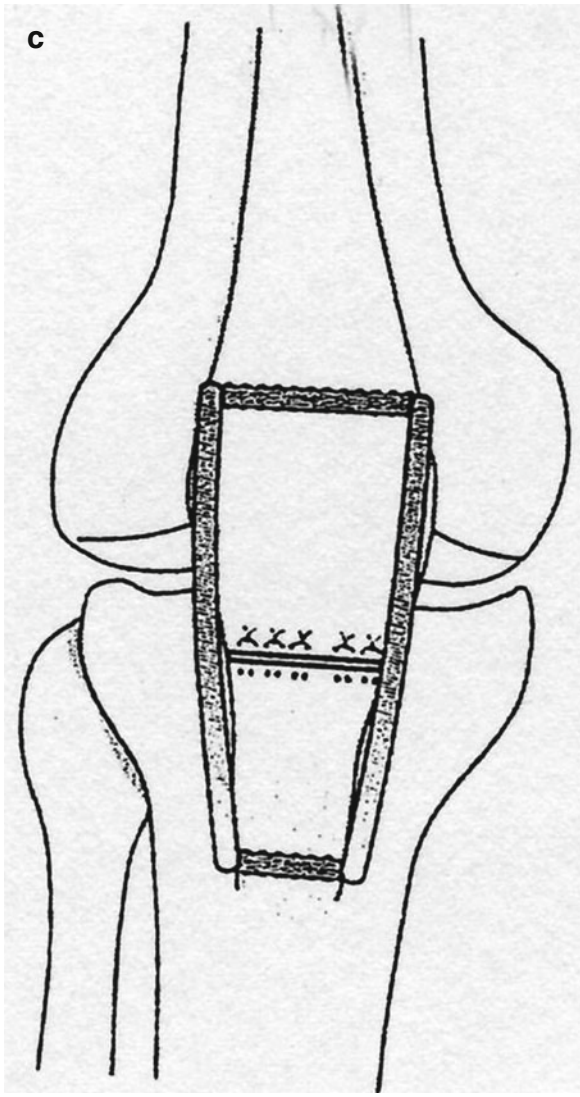


Fig. 16.9 (continued)

16.3.5.2 Procedure 2

Percutaneous suturing is suitable in Achilles tendon ruptures as an alternative to conservative therapy, which may be somewhat complicated, and will protect the contact between the tendon stumps when the foot is in plantar flexion. After ultrasound examination to exclude too great a diastasis between the tendon stumps, six stab incisions are marked in the prone position, which are made medially and laterally at the level of the rupture or 5 cm proximally or distally to it. It is essential to take the course of the sural lateral nerve into account. Using 1 × 1.3 mm PDS cord with reinforcement at both ends threaded through a straight needle, the tendon is perforated transversely proximally and distally, and the thread guided through the transverse point of exit via the stab incision at the level of the rupture (Fig. 16.10). Subsequently, knots are tied on both sides of the proximal and distal leg with the foot in plantar flexion and supplemented by a protective suture [11, 14]. Adjuvant and follow-up treatment is carried out with the patient wearing a special boot for 3 weeks in both plantar flexion and the neutral positions. Afterward, a raised heel of 2–2.5 cm is prescribed for 4–6 weeks.

16.3.6 Special Remarks

Tendon injuries to the lower extremity are frequent, caused to a great extent by previous degenerative damage. They generally require surgical reconstruction with temporary postoperative immobilization that should however, be kept as short as possible. Tendon injuries caused by direct traumatic external force resulting from cuts, stabs, or blows also need surgical repair to restore continuity. In such cases the patient needs to rest for a short time and then receive early functional follow-up treatment.

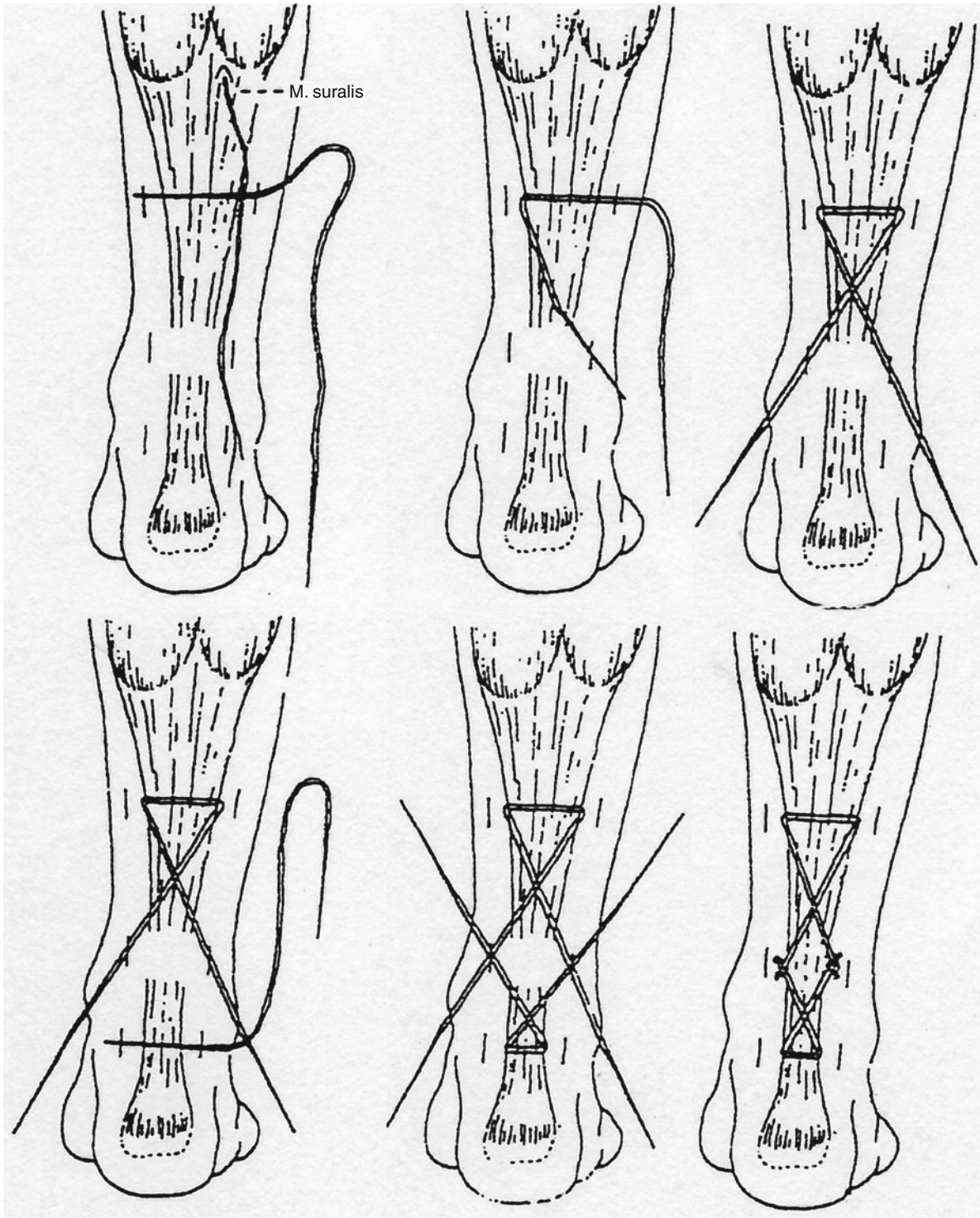


Fig. 16.10 Percutaneous suturing of Achilles tendon rupture

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