15 Wire, Screw and Plate Osteosynthesis of Patella Fractures

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15.1 Introduction

The aim of osteosynthesis of the patella is the step-free reconstruction and stable fixation of the fracture fragments. In this way, the congruence of the patellofemoral joint can be restored, and the function of the extensor mechanism can be maintained [1]. This is the best way to provide early functional follow-up treatment and avoid long-term movement restrictions due to immobilization damage. The osteosynthesis procedure must be selected according to the morphology of the fracture, the bone quality and the individual requirements of the patient.

The osteosynthesis must guarantee a high degree of stability. In its function of the sesamoid bone at the extensor apparatus of the knee joint, the patella is exposed to high axial tensile loads [2]. These forces have to be neutralized by the osteosynthesis material.

In addition to tried and tested K-wires and cannulated screws, anatomically preformed plates with stable-angle screw holes are now available for implants. These plates have proven to be effective especially in complex multi-fragmentary fractures and poor bone quality.

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15.2 Surgical Approach

The most common approach to the patella is the midline longitudinal incision directly above the patella, which is continued proximally and distally over the patella poles. If a McLaughlin cerclage is necessary, the incision can be widened further distal to the tibial tuberosity. Figure 15.1 shows the typical position of the described approach. The preparation on the patella is performed via a "full-thickness flap" medially and laterally [1]. The medial patellofemoral ligament (MPFL) should always be protected and not detached. Neurovascular structures like the ramus infrapatellaris of the saphenous nerve [3] as well as the nutritive vessels of the patella entering by inferior-medial aspect of the patella have to be handled with care [4]. A transverse horizontal approach has also been described in literature [5], but should not be used if possible in order not to interfere with a knee joint endoprosthesis that may become necessary in the further course. Exceptions may be indicated for open fractures and pre-existing wounds in the approach area.

To assess the retropatellar joint surface, a parapatellar lateral arthrotomy can be performed to gain insight into the patellofemoral joint in order to control a step-free reduction of the osteosynthesis. This allows the patella to be tilted laterally by up to 90° [6]. A medial arthrotomy should be avoided in order not to destabilize the MPFL and not to endanger the blood perfusion to the patella.

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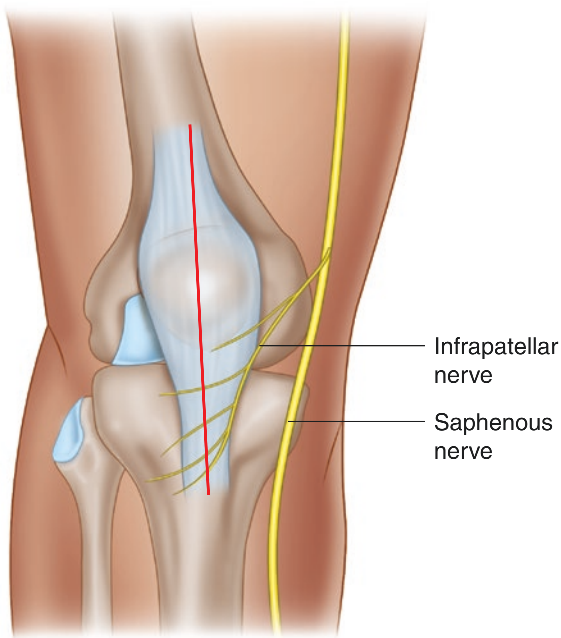

Fig. 15.1 Longitudinal approach to the patella

15.3 Osteosynthesis Procedures

15.3.1 K-Wires and Tension Wiring

The oldest and an established method of treating uncomplicated and horizontal fractures in particular is wire osteosynthesis with K-wires [7]. After initial procedures using simple wire spiking and circular cerclages, tension wiring has established itself as the most effective method [8]. Figure 15.2 shows the construct of the tension-wire osteosynthesis. If the AO technique is performed correctly, two axial K-wires 1.6–2.0-mm-thick are first inserted parallel to the upper pole of the patella across the fracture gap to the lower pole of the patella. Then two more wires in a "figure-of-8" form are placed around the wires protruding cranially and caudally and twisted on both ends. This is called modified anterior tension band wiring (MATB). Functional shortening of the wire length and compression on the fracture gap occur during intertwining. The axial wires protect the construct against translational displacement. On the other hand, the special arrangement of the wires transforms the tensile forces acting particularly on the anterior patella into compression forces on the articular side of the patella [5].

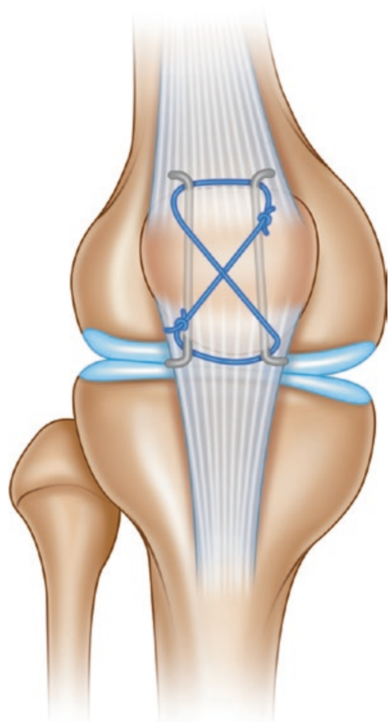

Fig. 15.2 Classic tension wiring technique

When correctly applied, this procedure delivers good clinical results with a success rate of more than 90% [9]. The advantages are the broad availability and cost efficiency of this process. Nevertheless, complications such as wire breakage, material dislocation, skin irritation, infection and secondary dislocation are often described in the literature with an incidence of 21–53% [10, 11].

15.3.2 Screw Osteosynthesis

An alternative to the tension belt is the treatment with screw osteosyntheses. The high bone density of the patella allows a good fit and strong compression of the fracture through the screw thread. If possible, the screws are inserted perpendicular to the fracture gap. Since the principle of tension wiring had proven to be successful, the technique was transferred to screw osteosynthesis. After screw osteosynthesis, a wire can be passed through the cannulated screws and, analogous to the MATB technique in a figure-of-8 form, placed anteriorly over the patella and twisted [12, 13]. Biomechanical tests have shown a superiority of cannulated screws over K-Wires in tension banding, as they allow more rigid stabilization [14]. Instead of a wire, resorbable or non-resorbable thread material such as braided polyester can be threaded through the cannulated screws and knotted to form a cerclage. Figure 15.3 shows the different types of screw osteosynthesis.

15.3.3 Plate Osteosynthesis

The latest development in osteosynthetic treatment of patella fractures are anatomically pre-shaped plates with locking screws. Biomechanical studies have shown that plate osteosyntheses can stabilize patella fractures more safely and for longer periods of time than tension belt osteosyntheses or cannulated lag screws [15]. Several observational studies report good clinical results with low complication rates [16–18]. Especially for complex fractures of osteoporotic bone, plate osteosynthesis is currently the method of choice. The approach for plate osteosynthesis equals the known longitudinal approach. Under X-ray control, the optimal position for the preformed plate can be found, and an overhang of the plate can be avoided. Drilling for the screws must be strictly monocortical to avoid damaging the retropatellar joint surface. The implant also has additional marginal holes to allow soft tissue fixation to the plate. In the case of avulsion fractures close to the patella poles, the patellar tendon or quadriceps tendon can be additionally fixed to the plate with sutures. The latest implants also have an extension similar to a hook plate, with which a dislocation of the patella poles is to be concealed. Two different shapes of plates are shown in Fig. 15.4.

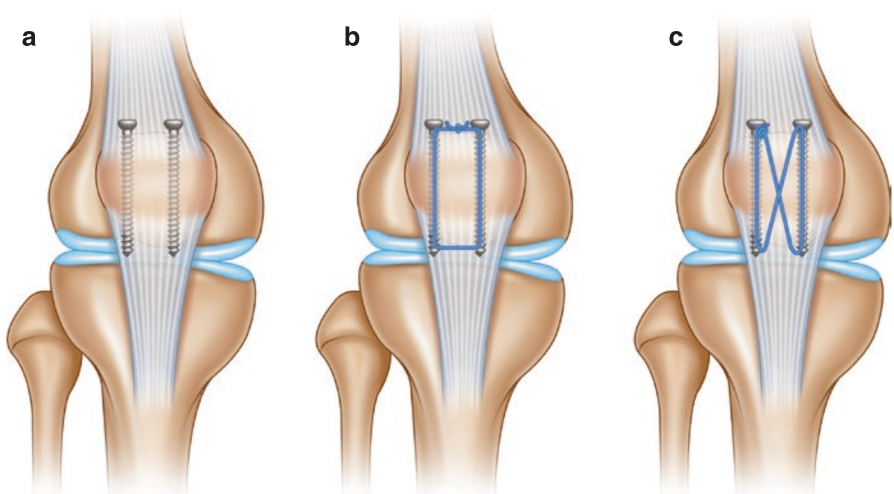

Fig. 15.3 (**a**) Simple screw osteosynthesis; (**b**) screw osteosynthesis with box-shaped tension band; (**c**) screw osteosynthesis with vertical figure-of-8-shaped tension band

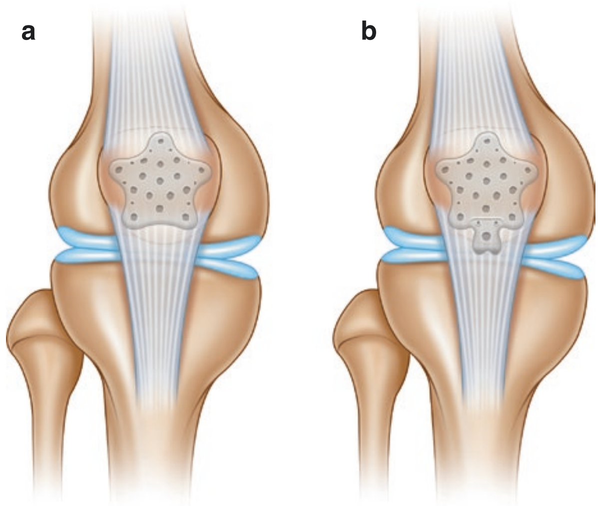

Fig. 15.4 (**a**) Locking plate osteosynthesis; (**b**) locking plate with hook extension

15.4 Augmentation Techniques

Despite the steady improvement in osteosynthesis techniques, complications due to secondary fractures or material dislocations still occur often [19]. To achieve maximum stability of the osteosynthesis, a precise analysis of the fracture morphology is necessary. A combination of different methods may also be useful, especially in the case of multi-fragmental comminuted fractures. For example, plate osteosynthesis can be supported by individual longitudinal, transverse or oblique screw osteosyntheses. However, especially with small marginal fragments, it can be difficult to address these fragments with one or more screws. In fractures of the proximal or distal pole of the patella, the osteosynthesis must be protected from the distracting forces of the extensor muscles. After reduction and completion of osteosynthesis, an equatorial cerclage can be applied circularly around the patella [17]. Alternatively, a McLaughlin cerclage can be applied, especially in cases of critical stability of the inferior patellar pole [20]. It is a patellofemoral cerclage, which is circularly attached from the upper pole of the patella to the tuberosity tibiae. The proximal cerclage can either be transosseously guided in a drill channel or transtendinously punctured through the tendon. Distally, the cerclage is always guided transosseously through the tibia in a transverse drill channel below the tibial tuberosity. The cerclage provides tension relief of the patella and the patellar tendon and therefore protects the osteosynthesis. Care should be taken not to overcorrect the tension of the quadriceps tendon. Otherwise, this can result in an iatrogenic patella baja. The Insall-Salvati Index should be determined on the lateral X-ray and compared to the contralateral side to ensure a symmetrical height of the patella. The different types of augmentative cerclages are shown in Fig. 15.5.

15.4.1 Alternative Materials for Cerclages and Tension Wiring

Braided polyester material can also be used for both the classic tension wiring techniques and augmentation techniques such as McLaughlin cerclage or equatorial cerclage. Studies have demonstrated comparable stability of the construct [21], with fewer implant-associated soft tissue irritations and fewer revision surgeries being performed on the polyester sutures [22].

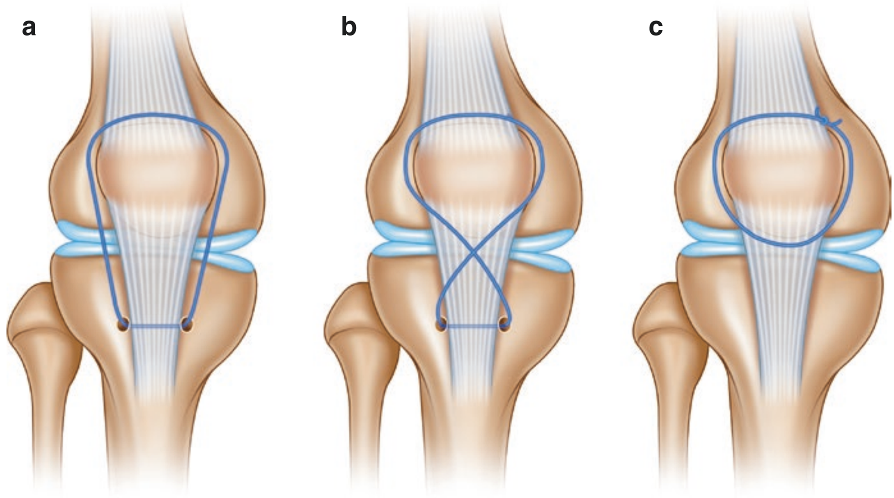

Fig. 15.5 (**a**) McLaughlin cerclage box-shaped; (**b**) McLaughlin cerclage, figure-of-8-shaped; (**c**) equatorial cerclage

Table. 15.1 Therapeutic algorithm for the treatment of displaced patella fractures

		Fracture pattern	
		Simple fracture	comminuted
Bone quality	good	Screw osteosynthesis and/or tension wiring	Plate osteosynthesis
	poor	Plate osteosynthesis	Plate osteosynthesis + augmentation*

*Mc-Lauglin cerclage, equatorial cerclage

15.5 Partial Patellectomy and Total Patellectomy

If a fracture lies very far cranially or caudally and close to the patellar margin, the fragments may be very small in individual cases. In such cases, the quadriceps tendon or patellar tendon is torn functionally. If these fragments are too small to be grasped by screws or cerclages, a partial patellectomy may be necessary [23]. In these cases, the tendon must then be refixed to the patella using suture anchors or transosseous sutures [1].

Total patellectomy has become a rarity due to improved reconstructive methods. However, in cases of extensive bone defects or infections such as osteomyelitis of the patella, the patella can be completely resected as the ultima ratio. The quadriceps- and patella-tendon must then be adapted end-to-end. The functional results after total patellectomy are poor [24].

15.6 Therapeutic Algorithm

In order to make a profound therapeutic decision regarding the optimal osteosynthesis procedure, it is essential to be able to assess both the fracture morphology and the bone quality of the patient. In many cases CT imaging is helpful for this.

In our recommendation, only uncomplicated fractures with good bone quality should be treated using conventional tension wiring osteosynthesis and preferably with cannulated screws. Fractures of higher complexity, either comminuted fractures or insufficient bone density, should be treated with plate osteosynthesis. Especially in geriatric patients with osteoporotic bone structure, angular stable plate osteosynthesis should become the future gold standard. Table 15.1 shows a graphic overview of the suggested procedure for different fracture types.

15.7 Aftercare

The permitted postoperative load and range of motion are determined by the surgeon based on the intraoperative findings. At the end of each operation, the knee should be bent to 90° and the integrity of the osteosynthesis should be observed. We also recommend documentation by X-ray in 90° flexion position.

If sufficient stability is achieved, we recommend early functional aftercare of the injury. The knee should be immobilized in a hard frame brace with a limited range of motion. The maximum flexion should, for example, be limited as follows: 1–2 postoperative week, 30°; 3–4 postoperative week, 60°; and 5–6 postoperative week, 90°. Full axial load in 0° stretched position is permitted. When walking, crutches should be used for 6 weeks with partial loading of the leg.

15.8 Case Reports

15.8.1 Case 1

A 33-year-old patient presented with a severely comminuted fracture of the left patella after a bicycle accident with a fall and direct impact on the knee. Resulting from our therapeutic algorithm plate osteosynthesis was performed. The postoperative results show a good reconstruction of the retropatellar joint surface. Figure 15.6 shows the radiographic documentation of the case.

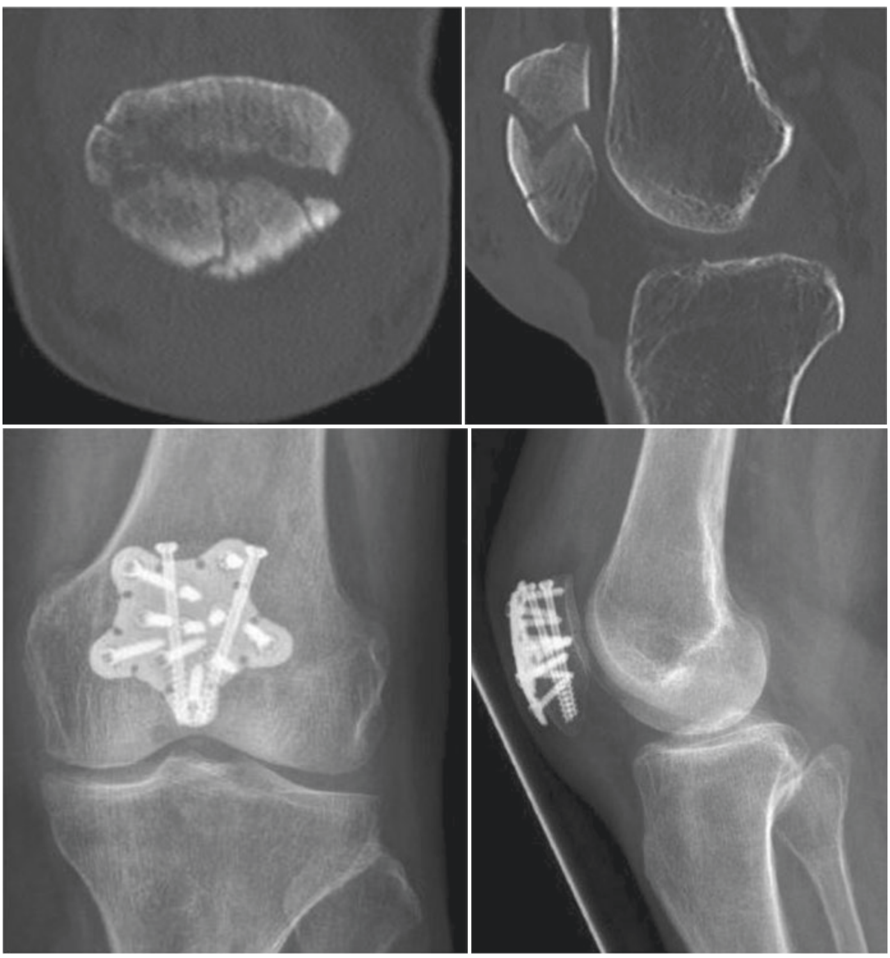

Fig. 15.6 Preoperative CT scan and postoperative X-ray of a comminuted patella fracture

15.8.2 Case 2

A 40-year-old female patient with high functional demand suffered a horizontal split fracture of the patella type AO34C1.1 from a bicycle accident The two-part fracture pattern as well as the good bone quality of this young patient lead to the decision to perform a classic tension wiring osteosynthesis. Figure 15.7 shows the X-ray documentation and intraoperative photo documentation.

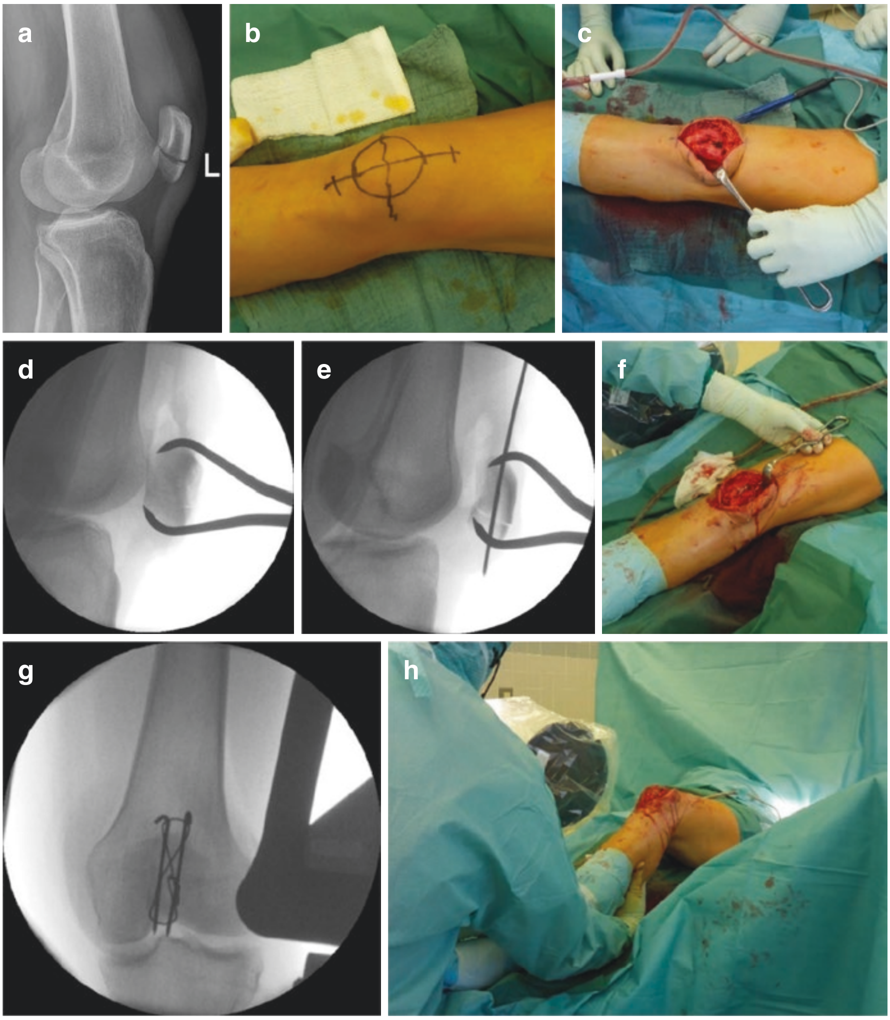

Fig. 15.7 (**a**) Preoperative X-ray; (**b**) intraoperative approach; (**c**) intraoperative: after debridement and preparation of the bursa; (**d**) reduction using Weber clamp; (**e**) temporary fixation using K-wire; (**f**) final fixation using tension banding; (**g**) intraoperative control; (**h**) intraoperative stability test if McLaughlin required; (**i**, **j**) postoperative X-rays; (**k**) after implant removal

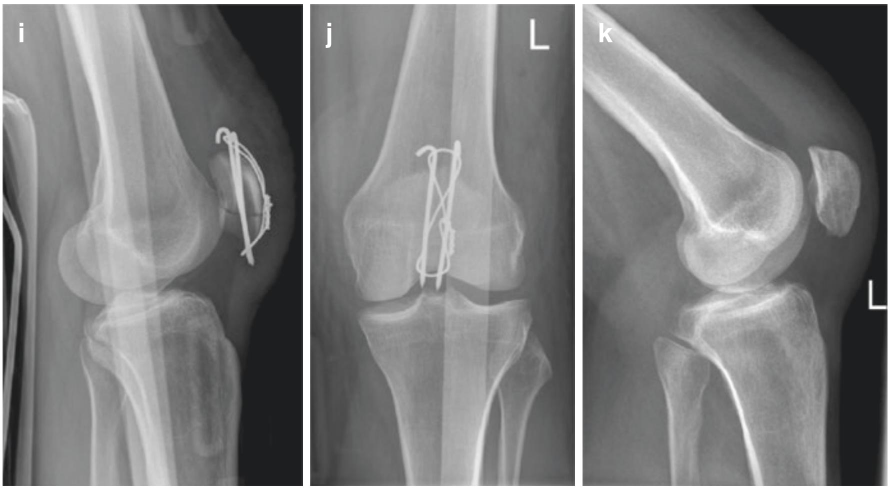

Fig. 15.7 (continued)

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