Parts of Ilizarov-Type External Fixators

3

Melih Cıvan

3.1 Rings

3.1.1 Full Rings

Because of the difficulties in the application, whole rings were removed from standard Ilizarov sets (Fig. 3.1). Today, two half rings are used to make a whole ring.

3.1.2 Half Rings

Half rings are the main components of the Ilizarov system (Fig. 3.2). The internal diameter of the rings varies between 80 and 240 mm. The holes were rare in the early years. Today we use half rings with 8 mm-wide holes, 4 mm apart.

The rods that cross the rings are 6 mm wide, which allows 15° of angulation between the perpendicular line to the ring and rods. Besides using a whole ring, half rings can be used to make alternative structures. Today, radiolucent "carbon fiber" rings that visualize joints more clearly in X-rays are used (Fig. 3.3).

3.1.3 5/8 Rings

These partial rings are used to obtain a space for dressing or surgery and even for more joint movement (Fig. 3.4). For example, in the knee joint, these rings allow full flexion when positioned anteriorly.

3.1.4 Omega Rings

These rings are especially used in the shoulder to allow patient's joint movement (Fig. 3.5).

3.1.5 Arches

The original Ilizarov set contained 290 and 300 mm arches; today we have 80 to 260 mm arches. These arches are wider and thicker than normal rings and have grooves with holes. These are especially used in the pelvic region with Schanz screws. The combination of Schanz screws with the system was originally used by R. Cattaneo et al. who reduced the risk of vessel and nerve injury because of the K-wires. Arches also make patients more comfortable while resting in the supine position (Figs. 3.6, 3.7, and 3.8).

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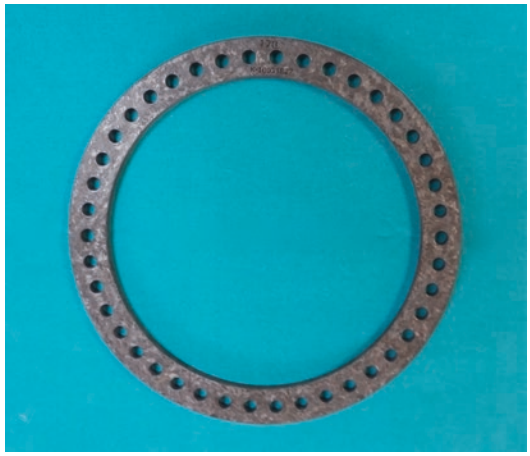

Fig. 3.1 A whole ring

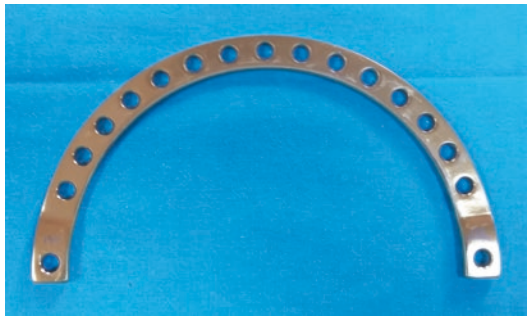

Fig. 3.2 Half ring

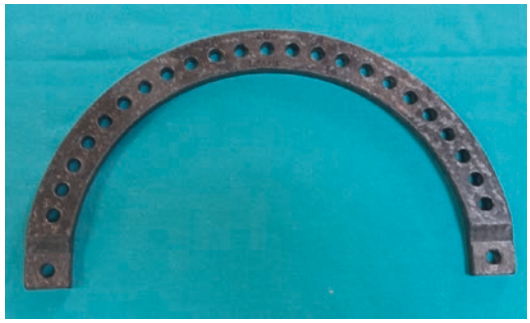

Fig. 3.3 Carbon fiber half ring

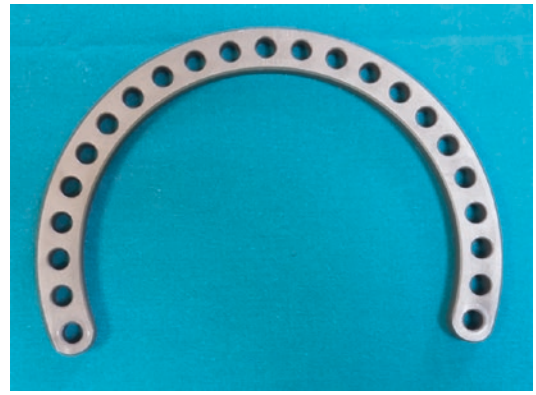

Fig. 3.4 5/8 ring

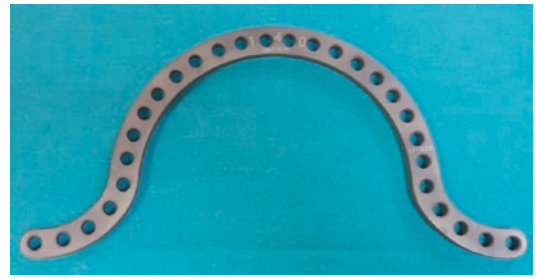

Fig. 3.5 Omega rings

Fig. 3.6 Italian femoral arch

Fig. 3.7 Carbon fiber Italian femoral arches in different sizes

Fig. 3.8 Foot half rings are easy to apply to the hindfoot

3.2 Connection Parts

3.2.1 Rods

As mentioned before, rods are threaded bar-type connection parts, 6 mm in diameter. Length of the rods varied from 60 to 400 mm in the original Ilizarov set. Every thread is 1 mm long.

Rods are not only for connection but also they can allow compression or distraction. If three rods are going to be used, there must be 120° of angle between them. If four rods are to be used, there must be 90° of angle between them. Especially when proper rods are selected with wide rings, four rods must be used. Thus, resistance for stretching can be strengthened. Rods can be threaded, cannulated, or slotted (Fig. 3.9). For slotted rods, thin K-wires can be crossed inside for distraction of the bones in various directions.

3.2.2 Telescopic Rods

Telescopic rods are used for increasing the endurance of the system during lengthening. A new type of telescopic rod has allowed us to determine lengthening speed and amount (Fig. 3.10).

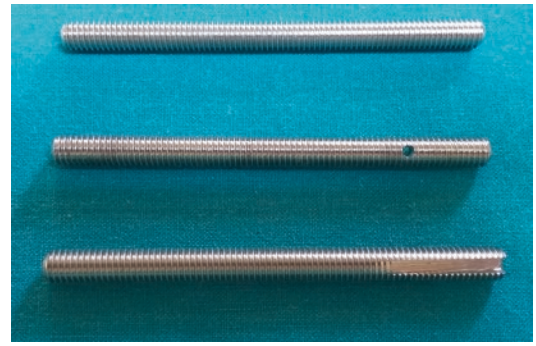

Fig. 3.9 Top-to-bottom threaded, cannulated, and slotted rods

Fig. 3.10 Graduated type telescopic rod

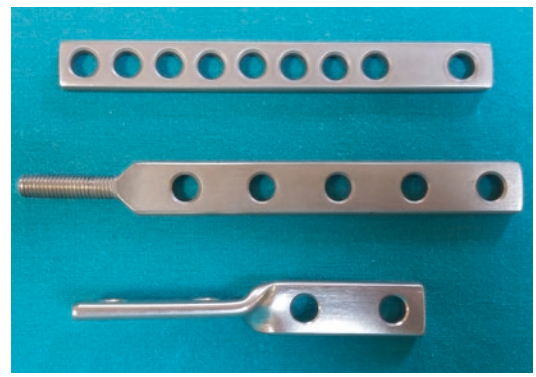

Fig. 3.11 Top-to-bottom flat, long connection plate, connection plate with threaded end, and twisted plate

These graduated types of telescopic rods are added to the set by ASAMI. In the original Ilizarov set, there were 130, 170, and 210 mm-long telescopic rods.

Plates are used for the connection of different-sized rings, which increases the stability of the system, making intervention rings or foot components. Holes in the plates differ between 2 and 10 mm. These connection plates have three types: flat, twisted, and curved plates (Figs. 3.11 and 3.12). Flat connection plates are used for the connection

Fig. 3.12 Curved plate

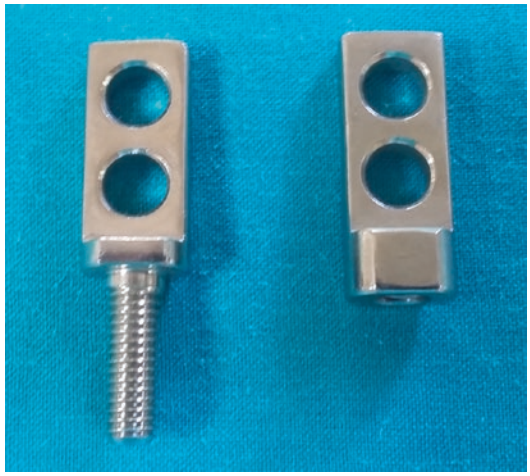

Fig. 3.13 A male (*top*) and a female post

in the same plane, whereas twisted plates are used for connections in the perpendicular plane. Curved plates are used to extend half-ring connections.

3.2.3 Posts

Posts are used for crossing additional wires close to the rings for improving the stability of the system. There are two subtypes of posts with either a threaded end or threaded hole. The lengths of the posts vary between single and four holes (Figs. 3.13 and 3.14).

For more easily hinged movement, there are also thinner posts.

3.2.4 Universal Socket (U-Type Hinges)

These recently invented hinges add hinge movement for an additional plane (Fig. 3.15).

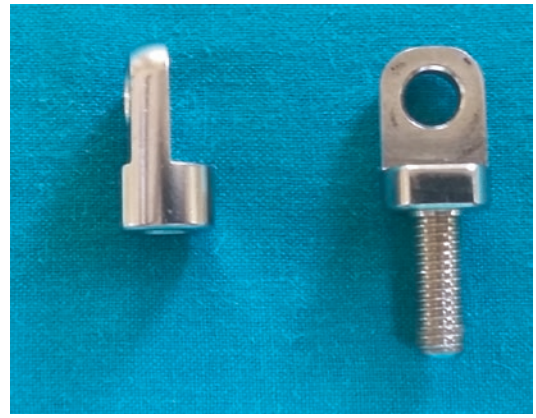

Fig. 3.14 Thinner female (*left*) and male (*right*) hinges

Fig. 3.15 U-type hinges

3.2.5 Wire Fixation Bolts

There are two types of wire fixation bolt with centered or lateral positioned holes. Bolts with lateral positioned holes are used for fixation of the wire to the ring without displacement and obtaining the tension. In the Ilizarov set, these apparatus allow 200–300 kg tension to the wires. Besides these, there are more types of pin fixation bolts (Figs. 3.16, 3.17, and 3.18).

3.2.6 Connection Bolts and Nuts

These apparatus are used for fixation of the rings with rods or fixation of the threaded sockets and making whole rings from half rings. These are 6 mm in width and 10, 16, or 30 mm in length (Figs. 3.19, 3.20, 3.21, and 3.22).

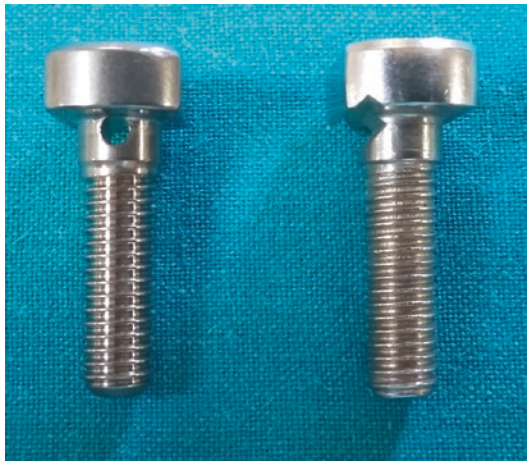

Fig. 3.16 Wire fixation bolts with centered (*left*) and lateral-positioned (*right*) holes

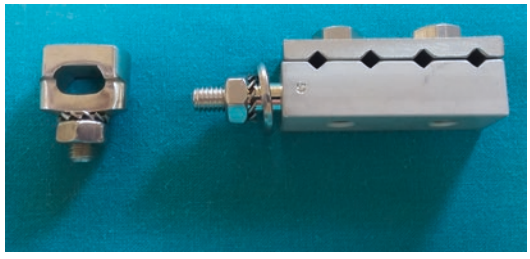

Fig. 3.17 Single and multiple-pin fixation bolts

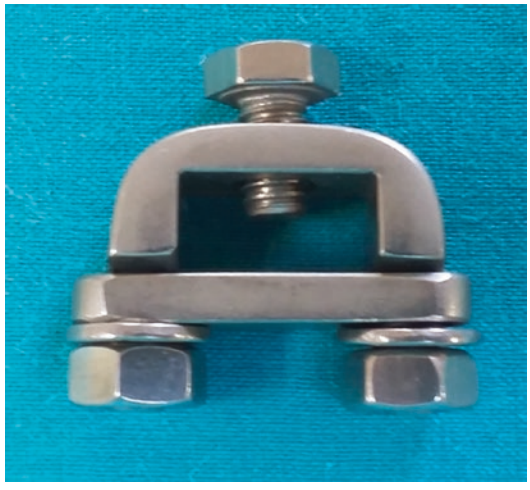

Fig. 3.18 Open-frame (or solid-frame) clamps

Fig. 3.19 Different sizes of bolts

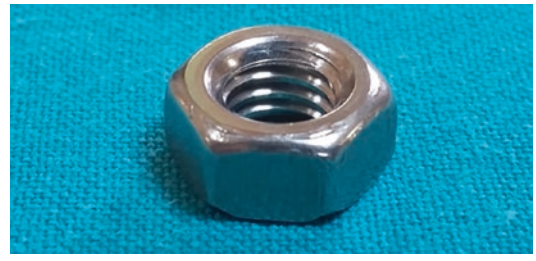

Fig. 3.20 A nut

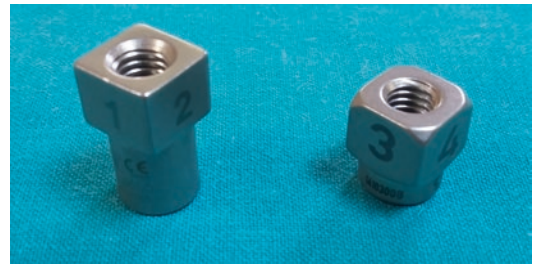

Fig. 3.21 Square nut

Fig. 3.22 Nylon-insert nut (nyloc nut)

Fig. 3.23 Threaded socket

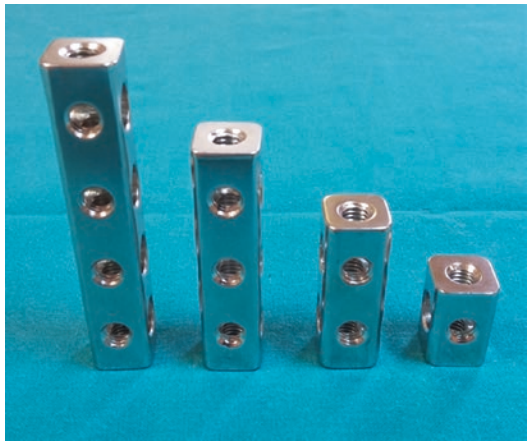

Fig. 3.24 Different size of square sockets

3.2.7 Threaded Socket

These apparatus were used to connect rings instead of short rods (Fig. 3.23). We are now using square sockets.

3.2.8 Square Sockets (Wrenchoqube)

Today we use these square sockets instead of the classic threaded socket (Fig. 3.24). They can transform into pin clamps with additional sleeves. There are four alternative sizes with holes. Schanz screws are fixated to the Wrenchoqubes with sleeves and set screws (Figs. 3.25 and 3.26). We use straight and 90° screwdrivers for this procedure (Fig. 3.27).

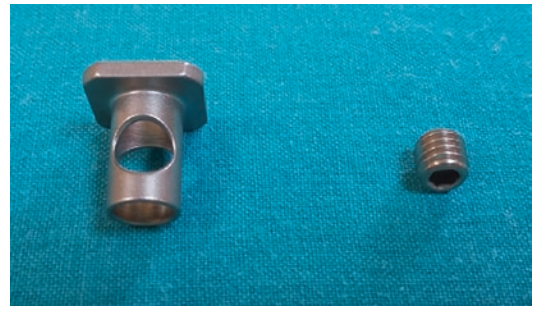

Fig. 3.25 Sleeves and set screws for Schanz screw fixation

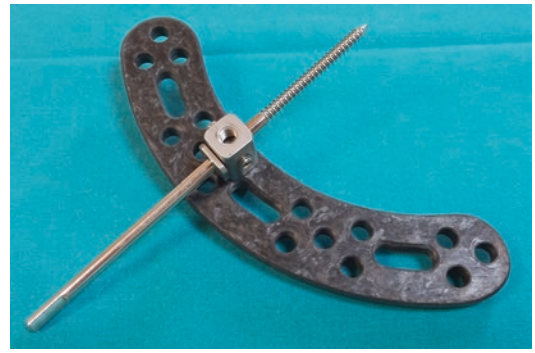

Fig. 3.26 Square sockets used for Schanz screw fixation

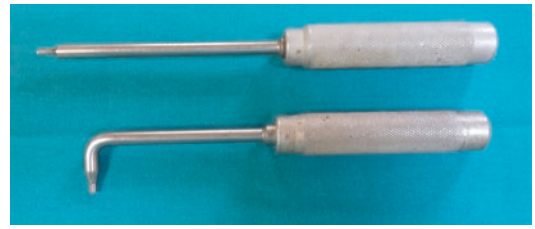

Fig. 3.27 Straight and 90° screwdrivers for set screws

3.2.9 Bushes and Washers

These parts adjust the surfaces of fixation. There are flat-sided, oval, conical, star, and slotted washers. Slotted washers are used for fixation of wires. Conical washers are used to obtain angulations with the frame and rods and can tolerate 7.5° of angulation. Oval washers allow for two holes to be used at the same time (Figs. 3.28 and 3.29).

Bushes are used for spacers in hinges (Fig. 3.30).

Fig. 3.28 From left to right; flat-sided washer, star washer, and slotted washer

Fig. 3.29 Male (*left*) and female (*middle*) conical washers and an oval washer

Fig. 3.30 A bush

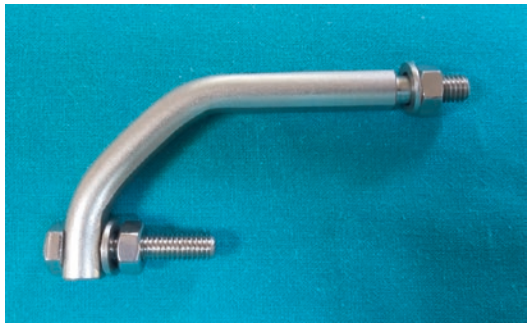

Fig. 3.31 Oblique support connectors

3.2.10 L-Type Connectors

These connectors are also called *oblique support connectors*. They are used for connecting the circular system to the semicircular or unilateral system (Fig. 3.31).

3.3 Wires and Screws

3.3.1 Kirschner Wire

K-wires are used for trans-osseous fixation. The thickness of the wires varies between 0.5 and 2 mm. The 0.5 and 1 mm wires are used in short bones. Trocar-pointed and bayonet-pointed wires are the two types of wires available. Trocar-pointed wires are used in cancellous bone and pass the metaphysis more safely. Bayonet-pointed wires prevent the abrasion of the cortical bone and osteonecrosis.

There are also K-wires with olives, which are used for traction or fixation of bone fragments. These wires prevent the system from sliding on the bone. Furthermore, compression or reduction of the fragments is possible with these wires. Stop wires can be constructed with cross formation of standard K-wires. The other end of the wires must be blunt for safe use (Fig. 3.32).

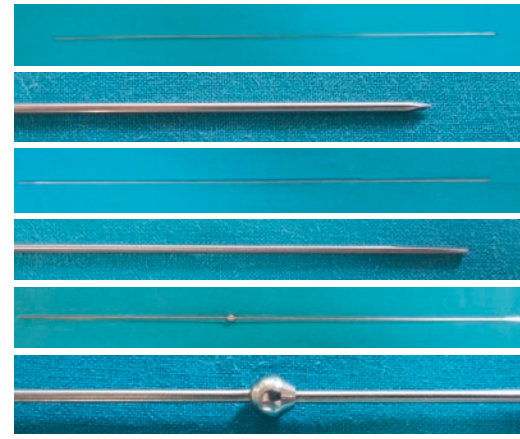

Fig. 3.32 Top-to-bottom, trocar-pointed, bayonet-pointed, and olive K-wires

Fig. 3.33 Schanz screw

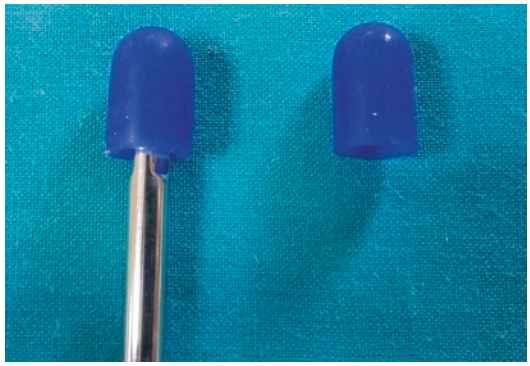

Fig. 3.34 Plastic caps

3.3.2 Schanz Screws

These screws were added to the system later for safe unilateral or semicircular use in proximal regions, especially when there is a risk for vessel and nerve damage. There are various types of Schanz wires regarding thickness and length. These screws are self-tapping and do not require drilling. Deeper threads are used for cancellous bone. There are two cut types for Schanz screws: cylindrical and conical. For pediatric use, there are shorter and thinner screws, 4.5 mm in diameter.

After the application of the Schanz screws, surplus length must be shortened with scissors. After cutting, plastic caps are used (Figs. 3.33 and 3.34).

3.4 Other Parts

3.4.1 Translation Rotation Device

These devices allow translation or rotation between two frames and were invented by Dr. Dror Paley (Fig. 3.35).

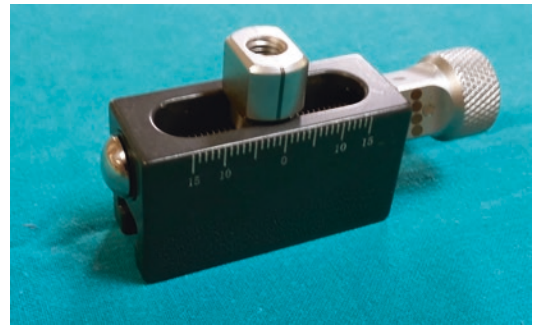

Fig. 3.35 Translation rotation device

Fig. 3.36 Top-to-bottom wrench with two open ends, wrench with open-circular end and adjustable wrench

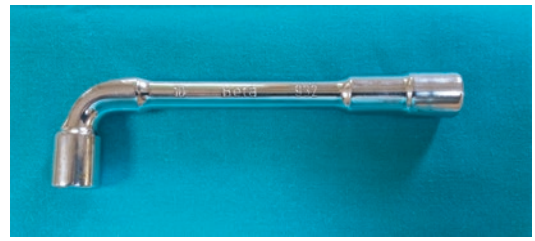

Fig. 3.37 Double-ended offset socket wrench

3.4.2 Wrenches

No. 10–14 wrenches are used for the whole system. There are various types of wrenches (Figs. 3.36 and 3.37).

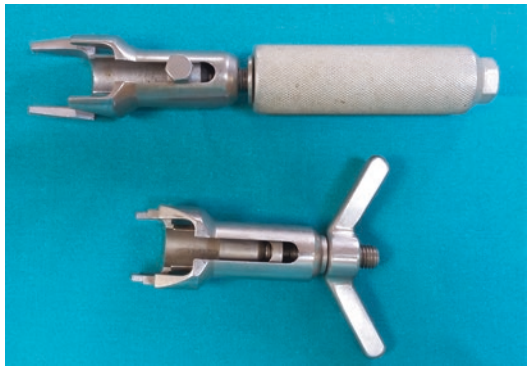

Fig. 3.38 Old wire tensioners

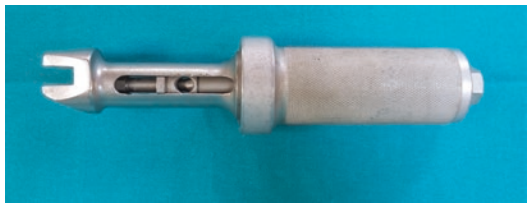

Fig. 3.39 New wire tensioners

3.4.3 Wire Tensioner

Various types of wire tensioners have been invented over time (Fig. 3.38). In practice, the sound of the wire is used because the original wire tensioner does not have the capability to measure the amount of tension. New tensioners have the capability to measure tension (Fig. 3.39).

3.4.4 Gigli Wire

This wire is used in procedures of mini-open corticotomy or for cutting carbon fiber rings (Fig. 3.40).

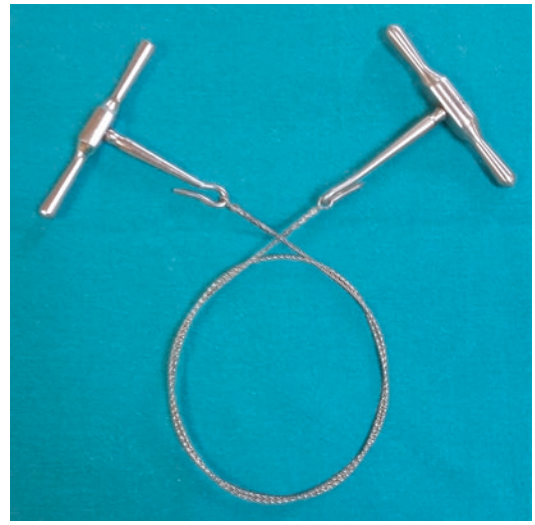

Fig. 3.40 Gigli wire

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