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(54) Title: ARTHROSCOPIC BONE TRANSPLANTING PROCEDURE, AND MEDICAL INSTRUMENTS USEFUL THEREIN

(57) Abstract: Described is an arthroscopic bone transplanting procedure for transplanting a section of a first bone to a second bone. The described procedure is particularly useful for the treatment an anterior shoulder instability, where the first bone is the coracoid and the second bone is the glenoid. Also described is a kit of medical instruments particularly useful in such a procedure.

ARTHROSCOPIC BONE TRANSPLANTING PROCEDURE, AND MEDICAL INSTRUMENTS USEFUL THEREIN

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to an arthroscopic bone transplanting procedure and to medical instruments useful in such a procedure as may be supplied in the form of a kit. The invention is particularly useful in the treatment of an anterior shoulder instability, where a section of the coracoid is transplanted to the glenoid, and is therefore described below with respect to said transplant.

The range of movements the human shoulder can make far exceeds any other joint in the body. The shoulder joint is a ball and socket joint, similar to the hip; however, the socket of the shoulder joint is extremely shallow, and thus inherently unstable. Muscles and tendons serve to keep the bones in approximation. In addition, in order to compensate for the shallow socket, the shoulder joint has a cuff of fibrous cartilage called a labrum that forms a cup for the head of the arm bone (humerus) to move within. This cuff of cartilage makes the shoulder joint much more stable, yet allows for a very wide range of movement. When the labrum of the shoulder joint is damaged, the stability of the shoulder joint is compromised, leading to subluxation and dislocation of the joint. Recurrent dislocations may cause damage to the bones of the joint –the humeral head and the glenoid. In particular, damage to the anterior–inferior part of the glenoid will cause a decrease in the area of contact with the humeral head.

When bone deficiencies associated with anterior shoulder instability are present, the prognostic factors for the success of soft tissue repair are poor. Current standards of success are predicated on the restoration of motion and strength and the return to full functional activities, including competitive athletics. Reestablishment of anterior shoulder stability requires the recognition and the treatment of osseous defects.

Several surgical procedures have been described for the management of osseous deficiencies in association with anterior shoulder instability, involving the transplantation of a portion of the coracoid process to the anterior–inferior section of the glenoid. The procedure described by Latarjet in 1954 involves the transplantation of a large section of the coracoid together with the conjoined tendon attached to it to

reinforce the glenoid fossa and create an antero–inferior musculotendinous sling. The procedure has been performed since its disclosure with positive results as an open surgical intervention.

However, up to the present, no minimally invasive technique for performing it has been developed.

OBJECTS AND BRIEF SUMMARY OF THE PRESENT INVENTION

An object of the present invention is to provide an arthroscopic bone transplanting procedure which is particularly useful in the treatment of anterior shoulder instability, but may be used in other procedures involving implanting of a section of a first bone to a second bone. A further object of the invention is to provide instruments, which may be supplied in kit form, particularly useful in such an arthroscopic procedure.

According to one aspect of the present invention, there is provided an arthroscopic procedure for transplanting a section of a first bone to a second bone, comprising the following steps: (a) making small incisions to open portals for the introduction of medical instruments; (b) drilling a threaded bore in said section of said first bone; (c) attaching a first cannula to said section of said first bone; (d) separating said section from said first bone; (e) positioning said separated section of said first bone on said second bone; (f) replacing said first cannula by a second cannula attached to said separated bone section by a cannulated device; (g) introducing a guide wire through the cannulated device; (h) removing the cannulated device; (i) drilling a bore into the second bone by a cannulated drill guided by said guide wire; (j) removing the guide wire; (k) and applying a bone screw through said bore in said separated section of the first bone and said bore in said second bone.

The preferred embodiment of the invention described below is particularly useful for the treatment of anterior shoulder instability, or other disorders where it is desired to use at least two bone screws for attaching a section of a first bone to a second bone. When such a procedure is used, in step (b), two threaded bores at a fixed distance from each other are drilled in said section of the first bone; in step (c), the first cannula is a T–handle cannula and is attached in said first bore by sutures or flexible wires; in step (f), the second cannula is a double cannula and is attached to said section of the first bone by two cannulated devices; in step (g), two guide wires are introduced through the two cannulated devices, which cannulated devices are then

removed in step (h); in step (i), two bores are drilled into the second bone by a cannulated drill guided by said guide wires; in step (j), the two guide wires are removed; and in step (k), two bone screws are applied through the two bones in the separated section of the first bone, and the two bores in the second bone.

Other aspects of the invention involve the construction of medical instruments, which may be supplied in a kit, particularly useful for the above–described bone transplanting procedures.

Further features of the invention will be apparent from the description below.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is herein described below, the reference to the accompanying drawings, wherein:

Fig. 1a is a schematic drawing of the gleno–humeral joint in the shoulder;

Fig. 1b is a schematic lateral view illustrating damage to the glenoid fossa;

Fig. 2a is a schematic anterior view of the bone reconstruction;

Fig. 2b is a transverse section through the reconstructed joint. and

Figs. 3–20 illustrate various medical instruments, which may be supplied in kit form, particularly useful in an arthroscopic bone transplanting procedure for reconstructing the shoulder joint in accordance with the present invention, in which:

Fig. 3 shows a standard Kirschner wire;

Fig. 4 is a cannulated bone drill;

Fig. 5 shows a drill guide for drilling a second bore at a pre–determined distance from a first bore;

Fig. 6 is a thread tapping tool;

Fig. 7a is a suture loader;

Fig. 7b is a suture retriever;

Fig. 8 shows a flexible wire;

Fig. 9 is a cannula with a T–handle;

Fig. 10 shows osteotomes, straight and curved;

Fig. 11 is a cannulator for a double cannula;

Fig. 12 is a double cannula;

Fig. 13 shows a suture hook;

Fig. 14 shows a cannulated device

Fig. 15 is a cannulated devicedriver;

Fig. 16 is a cannulated spike;

Figs. 17a and 17b are side and top views, respectively, of a clamping device for holding a transplanted bone section to the receiving site;

Fig. 18 shows cannulated bone drills;

Fig. 19 is a cannulated bone screw; and

Fig. 20 is a screwdriver with a long cannulated shaft for the bone screws.

THE CONSTRUCTION OF THE SHOULDER JOINT

Fig. 1a illustrates the bones of the shoulder joint. The head 1 of the upper arm bone, the humerus 2, forms a ball–and–socket joint with the shallow glenoid cavity 3. The glenoid is the lateral part of the shoulder blade scapula 4. Two hook–like projections of the scapula seen overhanging the glenoid are the acromion 5 and the coracoid process 6. A group of muscles collectively know as the Rotator Cuff originate on the scapula and insert on the humerus. These serve to stabilize the joint by keeping the humeral head in contact with the glenoid cavity. The clavicle 7 connects the acromion to the breastbone sternum. The glenoid labrum 8, which is a flexible fibrous ligament, surrounds the glenoid rim enlarging its area of contact with the humerus. When dislocations in the direction shown by the arrow occur, the anterior–inferior part of the labrum is torn away from the glenoid, causing instability of the joint. Recurring dislocations may lead to osseous lesions.

Fig. 1b illustrates the type of damage to the glenoid socket caused by such dislocations. The pear–shape of the intact glenoid is shown at "A"; while bone loss at the inferior, wider section "A", caused by a dislocation, is shown at "B" and results in an inverted pear shape narrower lower section as shown at "C". This causes a partial loss of contact with the humeral head.

Figs. 2a and 2b illustrate a bone reconstruction in accordance with the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

The description below describes a kit of instruments, and the method of their use, for performing coracoid transfer (Latarjet procedure) arthroscopically. The kit consists of various instruments, including drills, drill guides, osteotomes, cannulae, suture manipulators, screws, screwdrivers and others, specific for the purpose of the method disclosed by the invention.

The procedure consists of the following main steps:

- Opening portals (small incisions); introducing the arthroscope and instruments
- Preparation of the coracoid and glenoid surfaces
- Drilling and threading two holes in the coracoid at a fixed distance
- Passing sutures or flexible wires through the holes
- Attaching the coracoid by sutures or flexible wires to a cannula
- Separating the section of the coracoid to be transferred
- Positioning the graft on the glenoid
- Attaching a double cannula to the coracoid with a cannulated device
- Introducing K–wires through the cannulated device
- Removing the cannulated device
- Drilling into the glenoid with a cannulated drill over the K–wires
- Attaching the transplanted coracoid onto the glenoid with bone screws
- Removing the K–wires
- Final fixing of the transplant (tightening the screws)
- Removing the cannula.

In the reconstruction of the shoulder joint according to the present invention illustrated in Figs. 2a and 2b, 20 indicates the glenoid, 21 illustrates the coracoid graft implanted thereto by a pair of cannulated devices 22 and 23, 24 indicates the humeral head, and 25 indicates the conjoined tendon.

A Bone Transplantation Procedure and the Medical Instruments Used Therein

Figs. 3–20 illustrate the various medical instruments, preferably supplied in kit form, for performing an arthroscopic bone transplanting procedure in accordance with the present invention.

Portals (small incisions) are first made for introducing the arthroscope and instruments and for preparing the coracoid and glenoid surfaces, leaving the conjoined tendon (shown in Fig. 2b) attached to the coracoid. Two threaded holes are drilled in the coracoid process, using the bone drill shown at 32 in Fig. 4 with a diameter of about 3 mm. A Kirschner wire 31 (Fig. 3) is inserted at a safe distance from the lateral tip of the process for guiding the bone drill, and the first hole is drilled. For placing the second hole, the drill is inserted through the drill guide shown at 33 in Fig. 5. A guide pin 33a fixed at distance "d" from the center of the drill nut 33b ensures a predetermined distance of about 9 mm from the first hole. Both holes are

threaded now with the elongated tap shown at 34 in Fig. 6. For safeguarding the integrity of the transplant, inserts may be implanted in the holes.

Suture strands or flexible wires are now attached to the coracoid process for securing during separation by threading them through the holes. A suture loader 35, Fig. 7a, and a suture retriever 36, in Fig. 7b are provided in the kit for manipulating the sutures. An alternative flexible wire 37 is shown in Fig. 8. The sutures/wires are drawn out through the shaft of a T–handle cannula shown at 38 in Fig. 9 and are fixed at the proximal, handle section of the cannula for holding the coracoid graft during separation and transfer to the receiving site. Osteotomes, such as those shown at 39a, 39b in Fig. 10, serve to separate the lateral section of the coracoid. At least one osteotome is provided in the kit.

Preparing for the transfer of the separated section of the coracoid, the subscapularis muscle is dissected and split to allow for transferring the T–handle cannula 38 with the coracoid transplant to the anterior–inferior, damaged section of the glenoid. The cannulator shown at 40 in Fig. 11 is used to dissect tissue and to free a passage to the receiving site. A double cannula shown at 41 in Fig. 12 is inserted through the passage freed by the cannulator.

The two tubes "t" of the double cannula 41 are fixed, so that the distance of their centerlines "d" is identical to that of the drill guide 33 in Fig. 5. Handle "h" attached to the tube is offset at an angle "a" relative to the axis of the tubes and is formed to provide a firm grip. Angle "a" should be of an order of 40 to 65 degrees to allow maneuvering without obstructing the field of vision, and the length of the tubes measured from the handle should be about 150mm. A window "w" is cut in each of the tubes near the distal end to enable observation of the interior of the two tubes, and the position of an instrument introduced into the tubes.

When the double cannula has been inserted to face the coracoid transplant, the T–handle cannula 38 is released from the sutures/wires attached to the graft and is withdrawn. Using a suture hook shown at 42 in Fig. 13, the sutures/wires are drawn through the tubes of the double cannula and an elongated cannulated holding device such as screws 43 shown in Fig. 14 are inserted over them into the tubes of the cannula. The screws are driven into the coracoid using a suitable instrument, such as the screw driver shown at 44 in Fig. 15 until the coracoid is firmly attached to the cannula. An alternative device for holding the separated coracoid bone transplant to

the double cannula is shown at 45 in Fig. 16. The distal section of the spike in Fig. 16 is expandable to hold the device to the walls of the bores of the graft.

The sutures/wires holding the coracoid can now be removed. The exact positioning on the glenoid may be assisted by using a suitable instrument, such as the clamping device shown at 46 in Figs. 17a and 17b. Once the transplant is in the correct position on the glenoid, Kirschner wires (31, Fig. 3) are driven into the glenoid through the cannulated devices holding the coracoid. The devices are now removed using the screwdriver 44, Fig. 15, or by releasing the spike 45.

The double cannula serves as a drill guide. With a cannulated drill 47a, Fig. 18, inserted over one of the Kirschner wires, a first hole is drilled into the glenoid. Leaving the first drill in position, the other drill 47b in Fig. 18, with the longer shaft, is used to drill a second hole over the second Kirschner wire.

After removing the drills, cannulated bone screws 48, Fig. 19, are inserted over the K–wires into the coracoid graft and are screwed part–way into the glenoid using the cannulated device driver with a long shaft 49, Fig. 20, for use with the cannulated bone screws.

The K–wires can now be pulled out and the optional bone clamping device is removed. The bone screws 48 are drawn tight and the double cannula is withdrawn to conclude the procedure.

While the invention has been described with respect to a preferred embodiment, it will be appreciated that this is set forth merely for purposes of example, and that many other variations, modifications and applications of the invention may be made.

What is claimed is:

1. An arthroscopic procedure for transplanting a section of a first bone to a second bone, comprising the following steps:

(a) making small incisions to open portals for the introduction of medical instruments; (b) drilling a threaded bore in said section of said first bone; (c) attaching a first cannula to said section of said first bone; (d) separating said section from said first bone; (e) positioning said separated section of said first bone on said second bone; (f) replacing said first cannula by a second cannula attached to said separated bone section by a cannulated device; (g) introducing a guide wire through the cannulated device; (h) removing the cannulated device; (i) drilling a bore into the second bone by a cannulated drill guided by said guide wire; (j) removing the guide wire; (k) and applying a bone screw through said bore in said separated section of the first bone and said bore in said second bone.

2. The procedure according to Claim 1, wherein when such a procedure is used, in step (b), two threaded bores at a fixed distance from each other are drilled in said section of the first bone; in step (c), the first cannula is a T–handle cannula and is attached in said first bore by sutures or flexible wires; in step (f), the second cannula is a double cannula and is attached to said section of the first bone by two cannulated devices; in step (g), two guide wires are introduced through the two cannulated devices, which cannulated devices are then removed in step (h); in step (i), two bores are drilled into the second bone by a cannulated drill guided by said guide wires; in step (j), the two guide wires are removed; and in step (k), two bone screws are applied through the two bones in the separated section of the first bone, and the two bores in the second bone.

3. The method according to Claim 2, wherein in step (b), two threaded bores are drilled at a fixed distance from each other in said section of the first bone by:

drilling a first bore;

inserting into the first bore a pin carried on a drill guide instrument having a drill guide member at said fixed distance from said pin;

drilling said second threaded bore guided by said drill guide member; and

removing said drill guide instrument.

4. The method according to Claim 2, wherein said double cannula is attached to said section of the first bone by a double cannula instrument having a distal end

including two parallel tubes at a fixed distance from each other, and a proximal end serving as a handle.

5. The method according to Claim 4, wherein the axis of said handle is at an angle of 40–65° to the axis of the two tubes.

6. The method according to Claim 4, wherein the distal ends of the two tubes are formed with windows to enable observation of their interiors.

7. The method according to Claim 1, wherein, after step (j), a clamping device is applied through said bores in said section of the first bone and in said second bone; said clamping device including a proximal end having a handle, a distal end formed with a hook engageable with the distal side of the second bone, and a displaceable finger piece carried by said proximal end of the clamping device for displacing said hook towards or away from said handle.

8. The method according to Claim 7, wherein said handle is fixed to a shaft, and said hook is carried at the distal end of a rod which is displaceable within said shaft towards and away from said handle by said finger piece.

9. The method according to Claim 8, wherein said clamping device further includes a nut threaded on said handle and engageable with said finger piece to move same axially of said handle by threading said nut in one or the other direction with respect to said handle.

10. The method according to Claim 8, wherein said handle is formed with an axial slot in which the finger piece is axially movable with respect to the handle.

11. The method according to Claim 1, wherein the arthroscopic procedure is for the treatment of an anterior shoulder instability, wherein said first bone is the coracoid, and the second bone is the glenoid.

12. A medical kit of instruments for transplanting a section of a first bone to a second bone in accordance with the method of Claim 2, said kit comprising:

a first cannula having a T–shaped handle; and a double cannula having two tubes extending parallel to each other and having axes at a precise distance from each other; said double cannula having a proximal end carrying a handle, and a distal end formed with a window in each of said tubes to enable observing the interior of the respective tubes.

13. The medical kit according to Claim 12, wherein said handle of the double cannula is at an axis of 40–65° of said two tubes.

14. The medical kit according to Claim 12, wherein said kit further comprises a clamping device including a proximal end having a handle, a distal end formed with a hook engageable with the distal side of the second bone, and a displaceable finger piece carried by said proximal end of the clamping device for displacing said hook towards or away from said handle.

15. A medical kit according to Claim 14, wherein said handle is fixed to a shaft, and said hook is carried at the distal end of a rod which is displaceable within said shaft towards and away from said handle by said finger piece.

16. A medical kit of instruments useful in transplanting a section of a first bone to a second bone in accordance with the method of Claim 2, comprising:

a drill for producing two bores through the section of the first bone at a precise distance from each other;

said drill including a drill bit for producing one of said bores, and a drill guide having an axis parallel to, and a precise distance from, the axis of the drill bit for use in drilling the second bore at said distance.

17. A medical instrument useful in transplanting a section of a first bone to a second bone, comprising:

a double cannula having two tubes extending parallel to each other and having axes at a precise distance from each other;

said double cannula having a proximal end carrying a handle, and a distal end formed with a window in each of said tubes to enable observing the interiors of said tubes.

18. The instrument according to Claim 17, wherein said handle is at an axis of 40–65° of said two tubes.

19. A medical instrument comprising a clamping device including a proximal end having a handle, a distal end formed with a hook engageable with the distal side of the second bone, and a displaceable finger piece carried by said proximal end of the clamping device for displacing said hook towards or away from said handle.

20. The medical instrument according to Claim 19, wherein said handle is a fixed to a shaft, and said hook is carried at the distal end of a rod which is displaceable within said shaft towards and away from said handle by said finger piece.

21. The medical instrument according to Claim 20, wherein said clamping device further includes a nut threaded on said handle and engageable with said finger

piece to move same axially of said handle by threading said nut in one or the other direction with respect to said handle.

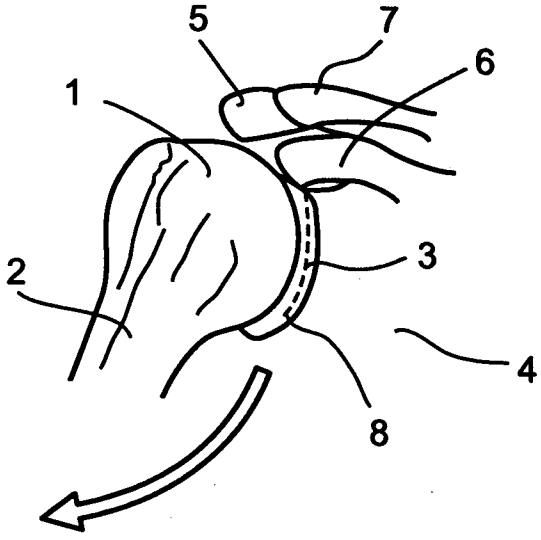

Fig. 1a

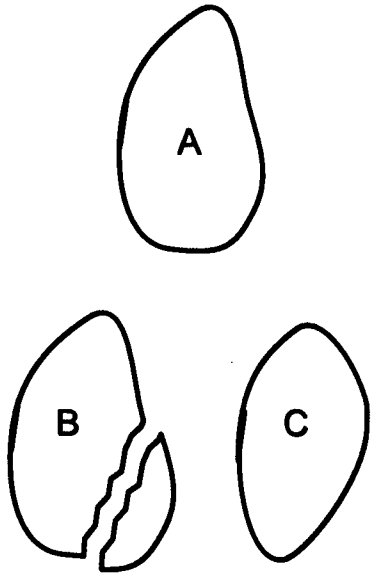

Fig. 1b

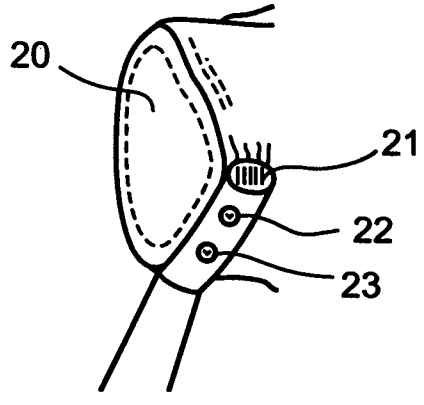

Fig. 2a

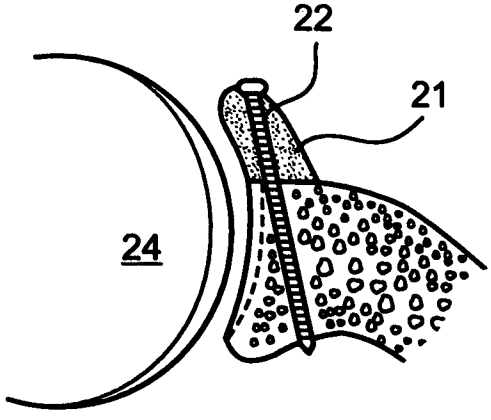

Fig. 2b

Fig. 3

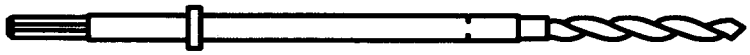

Fig. 4

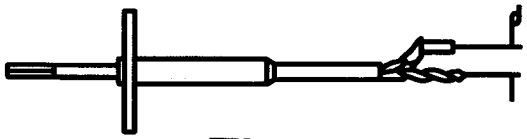

Fig. 5

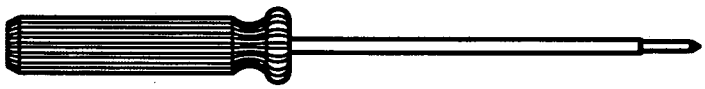

Fig. 6

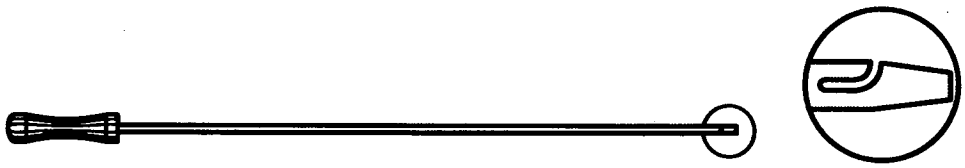

Fig. 7a

Fig. 7b

Fig. 8

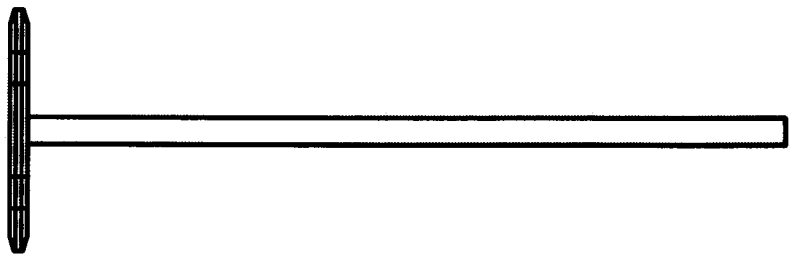

Fig. 9

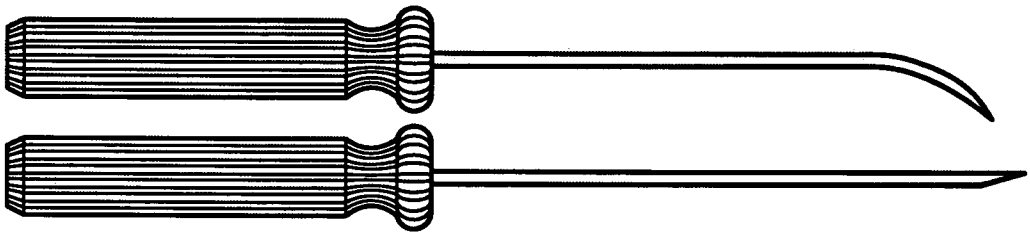

Fig. 10

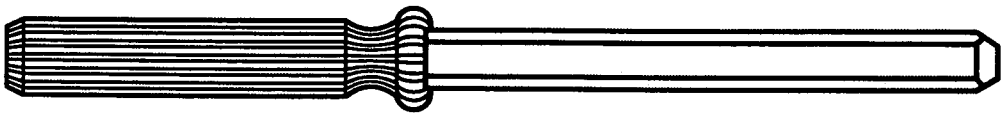

Fig. 11

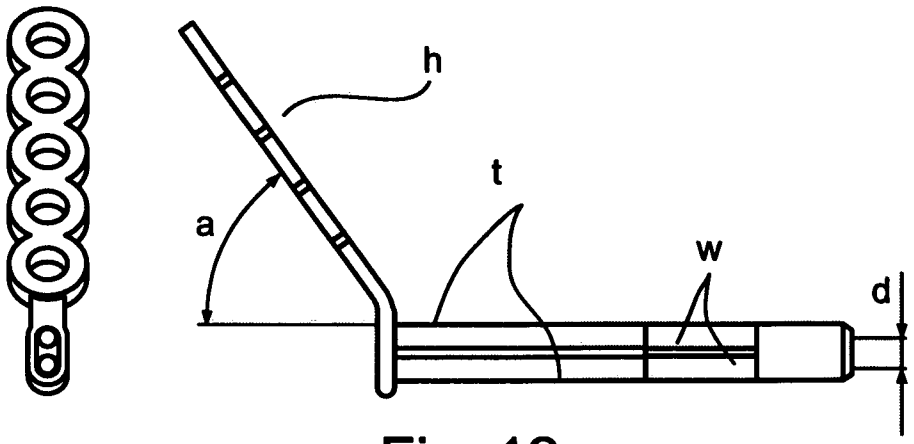

Fig. 12

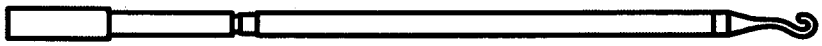

Fig. 13

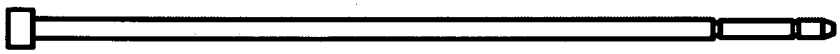

Fig. 14

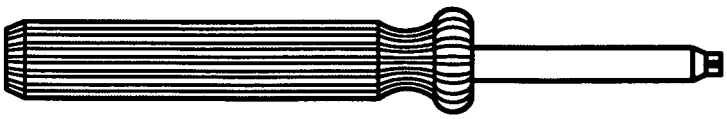

Fig. 15

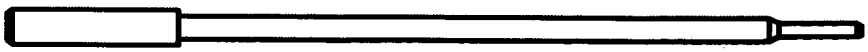

Fig. 16

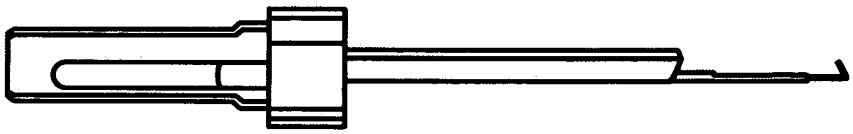

Fig. 17a

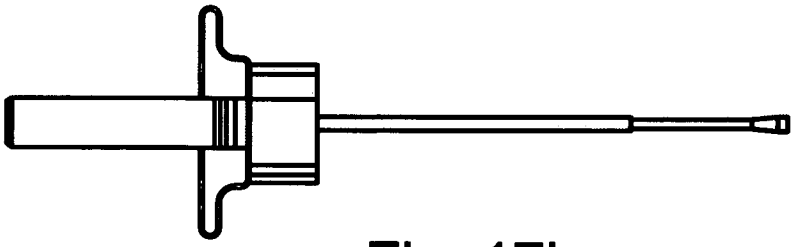

Fig. 17b

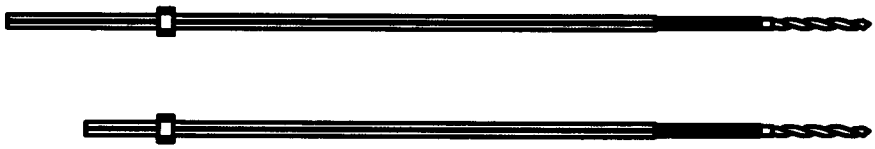

Fig. 18

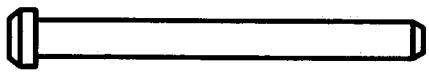

Fig. 19

Fig. 20