Ogurtan intramedullary decompressional and antirotational device (OIDAD)
A Descriptive Report

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SUMMARY
The aim of this study was to describe the use of Ogurtan Intramedullary Decompressional and Antirotational Device (OIDAD) used on a variety of long bone fractures in dog and man. Lateral approach was used to expose the femoral shaft, and OIDAD was applied lateromedially. The use of the OIDAD with short and long proximal parts and long distal part is presented. It is possible to apply the OIDAD causing unlimited complete interfragmental compression 360° around the fracture line along with complete antirotational effect in the femur. Although the femur of the dogs has a curvature anatomically it was possible to bring the fractured segments together circumferentially. Because femur of the man straight compared to that of dog, the use of OIDAD should be a lot easier in man than in dogs.

KEY-WORDS : dog - intramedullar - femur.

RÉSUMÉ
Dispositif intramédullaire de compression et antirotatoire d’OGURTAN (OIDAD). Un rapport descriptif. Par Z. OGURTAN, C. IZCI et C. CEYLAN

Le but de cette étude était de présenter le dispositif intramédullaire de compression antirotatoire interfragmente droit d’OGURTAN (OIDAD) utilisable sur d’autres fractures des os longs chez le chien et l’homme. Un abord latéral a été employé pour exposer le fémur, et OIDAD a été appliqué latéro-médiatement. L’utilisation de l’OIDAD avec les pièces proximales courtes et longues et distales ont été présentées. Il est possible d’appliquer l’OIDAD engendrant une compression interfragmente directe de 360° autour du trait de fracture avec un effet antirotatoire. Bien que le fémur des chiens ait une courbure anatomique, il a été possible de réunir les fragments. Puisque le fémur d’homme réglé comparé à celui du chien, l’utilisation de l’OIDAD devrait être beaucoup plus facile que chez les chiens.

MOTS-CLÉS : chien - intramédullaire - fémur.

Introduction

Closed reduction with external support, internal fixation and internal fixation with secondary external auxiliary support are three categories by which fracture repair is achieved. Kirschner-Ehmer external skeletal fixators [2], bone plates [3, 4], lag screws [12], intramedullary (IM) pins [3, 11] have received wide acceptance in the treatment of certain types of fractures.

Plate and screw fixation provide maximum stability compared to IM fixation, but are technically demanding and expensive surgery.

Although close approximation and rigid fixation are the primary goals of the plate fixation, that is not taken into consideration in the treatment of IM nailing as in the plate fixation. When the fragments are fixed closely and held in place rigidly by compression, resorption occurs at the ends of the fracture fragments and bone healing occurs without callus formation [6]. This is called primary or direct bone healing. This was confirmed by experimental studies done in sheep with compression plates [6]. If there is motion at an interface, bone undergoes resorption at the surface [8].

Adverse effects associated with plate function include decreased mineralization, maximum angle of rotation, and energy absorption, reduction in maximum torque capacity,
cancellous transformation, weakening of bone, cortical thinning, increased bone porosity [1, 5, 13] and blockade of efferent vascular circulation [9]. Plate fixation leads to weakening of the bone causing refracture [13] due to osteopenia in the cortex directly underlying the plate, reduction of the cortical caliber, lack of lamellar arrangement of new bone [13]. Rotational instability and fracture shortening are the major complications associated with IM fixation which may become predisposed to pin migration leading to non-union or malunion and infection.

The OIDAD is an interlocking device which rules out this amplification by 1) automatic IM pin length adjustment eliminating the necessity of having and using different IM pins in length prior to compression of the fracture line, 2) avoiding second surgery for the removal of all parts, 3) providing interfragmental compression along with maintenance of axial alignment, prevent rotation and avoid adverse effects of plate fixation.

**Materials and methods**

OIDAD consists of an IM pin (Fig. 1), a reverse (left) threaded round nut (Figs. 1c, 7c, 8c), a long proximal part (LPP) (Figs. 2a, 5a), a long distal part (LDP) (Figs. 2b, 5b), a short proximal part (SPP) (Figs. 3a, 6a), a short distal part (SDP) (Figs. 3b, 6b), side intramedullary (SIM) pins (Figs. 4, 7g), side plates (Figs. 8g) and screws (Fig. 8h).

IM pin (Fig. 1) is right threaded in the distal (Figs. 1a, 7a, 8a) and left threaded in the proximal (Figs. 1b, 7b, 8b) to which the left threaded round nut (Figs. 1c, 7c, 8c) is inserted. There is a nonthreaded part (Figs. 1d, 7d, 8d) between the left and right threaded parts of the IM pin.

The LPP (Fig. 2a) and SPP (Fig. 3a) have three vertical holes. One of these holes is on the center (Figs. 2a-1, 3a-1) and the other two is on the right (Figs. 2a-2, 3a-2) and left (Figs. 2a-3, 3a-3) sides of the LPP and SPP. The vertical holes of the LPP and SPP on the center (Figs. 2a-1 and 3a-1), right (Figs. 2a-2 and 3a-2) and left (Figs. 2a-3 and 3a-3) have no threads.

The LDP (Fig. 2b) and SDP (Fig. 3b) have three vertical holes. The vertical holes of the LDP and SDP on the center (Figs. 2b-1, 3b-1), right (Figs. 2b-2, 3b-2) and left (Figs. 2b-3, 3b-3) have right threads. The SIM pins (Figs. 4, 7g) are right threaded. The size (in length) of the proximal and distal parts to be used with SIM pins for the SDP and SPP is 3 cm., and 9 cm. for the LDP and LPP.

The system can also be utilized with the use of two side plates (Fig. 8g) instead of two SIM pins in which LPP (Fig. 5a), SPP (Fig. 6a), LDP (Fig. 5b) and SDP (Fig. 6b) have right threaded horizontal holes (Figs. 5a-2 and 5a-3; 6a-2 and 6a-3; 5b-2 and 5b-3; 6b-2 and 6b-3) on each side. The size (in length) of the proximal and distal parts to be used with side plates for the SDP and SPP is 2 cm., and 9 cm. for the LDP and LPP. The sizes of the (proximal and distal parts), IM pin and left threaded round nut used was 6, 4 and 5 mm in diameter, respectively.

The proximal parts regardless of being long or short have always a vertical nonthreaded hole (Figs. 2a-1, 3a-1; 5a-1, 6a-1) and distal parts have always a vertical right threaded hole (Figs. 2b-1, 3b-1; 5b-1, 6b-1) on the center.

A standard lateral approach to the femoral shaft of dogs was used and 6 cadaver dogs were used.

Application of OIDAD was carried out using LPP and LDP (Fig. 9.) and SPP and SDP (Fig. 10) on transversal femoral fractures.

**Results**

The system was used in the treatment of experimentally induced transversal diaphyseal long bone fractures. The principals and technique of the system were as follows.

Application of the system to the transversal mid-femoral fractures in the dog is shown in Figure 9 utilizing the SPP and SDP (Fig. 6), and in Figure 10 utilizing the LPP and LDP (Fig. 5). Figures 7 and 8 shows the schematic presentation of the system.

First, short or long proximal parts (SPP-LPP) (Figs. 7e, 8e) and short or long distal parts (SDP-LDP) (Figs. 7f, 8f) parts of the system were placed perpendicular to the bone above and below the fracture line, respectively, after drilling the holes lateromedially.

Second, the length (j) (Figs. 7j and 8j) between the bottom line of the left threaded round nut (Figs. 7c, 8c) and the upper line of the LPP or SPP (Figs. 7e, 8e) was adjusted to be equal to the length (I) (Fig 71, 81) between the bottom line of the LDP or SDP (Figs. 7f, 8f) and the tip of the IM pin. Adjustment was done corresponding to this length by turning the left threaded round nut either clockwise going up or anticlockwise going down the left threaded part of the IM pin (Figs. 1b, 7b, 8b) which provided automatic IM pin length adjustment prior to compression of the fracture line, based on where fracture occurred. This adjustment provides the desired length of the IM pin to be seated between the bottom line of the LDP or SDP and the distal end of the bone where IM pin is supposed to be located. This must be done before the IM pin is introduced into the medullary canal through the nonthreaded vertical hole of the LPP or SPP (Figs. 2a-1, 3a-1, 5a-1 6a-1) and the right threaded vertical hole of the LDP or SDP (Figs. 2b-1, 3b-1, 5b-1, 6b-1). It would be impossible without the moving part (left threaded round nut) to make the IM pin length adjustment to seat the IM pin on the deserved part of the distal part of the bone and it would cause to prepare different IM pins to which a nut is fixed permanently at different locations in the proximal part of the IM pin depending on where fracture occurred. This moving part (left threaded round nut) inserted into the left threaded part of the IM pin eliminates this problem.

Third, after the adjustment done, the IM pin was inserted from the greater trochanter with a pin chuck into the medullary canal and the vertical nonthreaded hole (Figs. 2a-1, 3a-1, 5a-1 and 6a-1) on the center of the proximal part and turned clockwise to catch the right threaded vertical hole (Figs. 2b-1, 3b-1, 5b-1, 6b-1) of the distal part. It should be noticed that

OGURTAN INTRAMEDULLARY DECOMPRESSIONAL AND ANTIROTATIONAL DEVICE

FIGURE 1. — Proximally left threaded (B) and distally right threaded (A) IM pin. A left threaded round nut (C) is inserted to the left threaded part of the IM pin. IM pin has also a nonthreaded part (D).

FIGURE 2. — Long proximal part (LPP) (A) with right threaded vertical holes (A-1) on the center, (A-2) on the right and (A-3) on the left. Long distal part (LDP) (B) with nonthreaded vertical holes (B-1) on the center, (B-2) on the right and (B-3) on the left.

FIGURE 3. — Short proximal part (SPP) (A) and short distal part (SDP) (B), corresponding to Figure 2.

FIGURE 4. — Right threaded side intramedullary (SIM) pin.

FIGURE 5. — Long proximal part (LPP) (A) with right threaded vertical hole (A-1) on the center and right threaded horizontal holes (A-2) on the right, and (A-3) on the left. Long distal part (LDP) (B) with nonthreaded vertical hole (B-1) on the center, and right threaded horizontal holes (B-2) on the right and (B-3) on the left.

FIGURE 6. — Short proximal part (SPP) (A) and short distal part (SDP) (B) corresponding to Figure 5.
FIGURES 7 and 8. — Schematic representation of the application of the OIDAD. Fig. 7 is on the left and Fig. 8 is on the right. Left threaded (A), right threaded (B) parts of the IM pin, left threaded round nut (C), nonthreaded part of the IM pin (D), short or long proximal parts (LPP or SPP) (E), short or long distal parts (LDP or SDP) (F), SIM pins (7g) and side plates (8g), and screws (H). The distance between the bottom line of the LDP or SDP and the tip of the IM pin (I).

FIGURE 9. — Mediolateral appearance of a transversal fracture of the femur, fixed with OIDAD utilizing LPP and LDP with bilateral side plates. Note the complete compression of the fractured segments and drilled tubes above the round threaded nut. Left threaded round nut (thin arrow), metal tubes (thick arrow) placed above the left threaded round nut.

FIGURE 10. — Mediolateral appearance of a transversal fracture of the femur, fixed with OIDAD utilizing SPP and SDP with a unilateral side plate. Note the complete compression of the fracture line. There is a small gap between the fractured segments due to the uneven fracture surfaces resulted from making the fracture with gigli wire. Left threaded round nut (arrow).
the right threaded distal part of the IM pin (Figs. 1a, 7a, 8a) remains below the fracture line, and engages the right threaded vertical hole on the center of the distal parts (Figs. 2b-1, 3b-1, 5b-1, 6b-1). When the left threaded round nut (Figs. 1c, 7c, 8c) contacts against the proximal part, the IM pin starts to compress the fracture line. When continued, the system completely compress the fracture line 360° circumferentially. No compression takes place if the proximal part of the IM pin (Figs. 1b, 7b, 8b) and left threaded round nut (Figs. 1c, 7c, 8c) are made right threaded. In addition to this; if the vertical hole of the proximal part on the center is left threaded instead of nonthreaded, compression occurs, but this cause difficulties during the IM pin removal, because it results in distraction of the fracture lines. Therefore the vertical hole of the proximal part on the center has to be nonthreaded.

After all the procedures 1 through 3 were completed, metal tubes (Fig. 9) were placed above the left threaded round nut (Figs. 1c, 7c, 8c, 9) for easy removal of the IM pin, otherwise bone production occurring above the left threaded round nut within the medullary canal interferes with the removal of the IM pin. Therefore the left threaded round nut has to extend along the proximal part of the IM pin (Fig. 1b). If the left threaded round nut extends through out of the bone, the use of metal tube/tubes and a left threaded round set nut becomes unnecessary. If the left threaded round nut remains within the medullary canal as in Figures 1c and 10, metal tube/tubes (Fig. 9) are placed above the left threaded round nut and a left threaded set nut is placed over the metal tube/tubes to fix and maintain the position of the tube/tubes. We were unable to make the left threaded round nut long enough due to technical difficulties to extend along the proximal part of the IM pin and bone. Therefore, metal tubes were used.

After the complete compression of the fracture line, the metal or plastic plates (Figs. 8g, 9, 10) were placed over the proximal and distal parts. The plates were fixed with screws (Fig. 8h) through the right threaded horizontal holes of the proximal and distal parts after drilling the holes on the plates. The excessive parts of the plates were cut off before they were fixed. When the system is to be used with SIM pins (Figs. 4, 7g); they are placed through the nonthreaded vertical holes on the right and left sides of the proximal part and through the right threaded vertical holes on the right and left sides of the distal part. When the side plates and SIM pins are applied, the fractured segments become resistant to rotational forces. In other words, while the side plates and SIM pins provide complete anterotational effect, IM pin provides complete interfargmental compression. The SIM pins and side plates never touch the bone. At the end of the procedure, the excessive parts of the SIM pins are cut off distally and IM pin is cut off proximally. Application of this system with SIM pins was not carried out, therefore it was not presented.

When the system was used with LPP and LDP (Fig. 9), they remained out of the skin to be used with either SIM pins or side plates. The advantage of LPP and LDP is that after the complete healing of the fracture, the patient does not need to undergo second surgery for the removal of the IM pin, proximal and distal parts, and SIM pins, and metal or polymeric plates. After the healing of the fracture, first IM pin has to be removed, followed by SIM pins or side plates, proximal and distal parts.

**Discussion**

The application of the OIDAD with long (Fig. 9) and short (Fig. 10) proximal and distal parts on transversal fractures of the femur in dogs were presented.

An electrical chemical reaction taking place through the corrosion of metals in biological fluids results in the release of metal ions into the surrounding aqueous electrolyte. Corrosion resistance of the stainless steel is provided by chromium, nickel and molybdenum. The passive film of chromium content ~ 40 Å in thickness is responsible for the formation of a protective chromium oxide surface layer. This so-called passive film protects the stainless steel against general corrosion [7] through the retardation of the anodic dissolution of the metal cations [10]. Damage to the passivating layer such as wear, may bring about accelerated focal corrosion and failure [10]. Regarding this, it was beyond our capabilities to manufacture this device for follow up studies of OIDAD because of technical difficulties to meet the specified implant manufacturing requirements. Therefore this study was carried out only in cadavers.

The advantage of the OIDAD is to overcome the adverse effects of plate fixation, because there would be no device contact to the outer part of the bone, eliminating the adverse effects of the plate fixation. In addition to this, the number of the holes necessary for plate fixation is lowered to only 2 holes with this device along with complete compression and anterotational effect. The compression provided with plate fixation is limited, and occurs only on the cortex underneath the plate. OIDAD provides unlimited complete interfargmental compression 360° around the fracture line along with complete anterotational effect. The OIDAD device can also be used for lengthening procedures. In this case the holes of the side plates must be slotted longitudinally to allow the adjustments to be made. Although the femur of the dogs has a curvature anatomically it was possible to bring the fractured segments together in the middiaphyseal part. Because femur of the man straigth compared to that of dog, its use should be a lot easier than in dogs.

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**References**
