JIVS Journal of Istanbul Veterinary Sciences

Minimally invasive plate osteosynthesis (MIPO) in veterinary orthopedics

Çağıl Çokcoşkun Yılmaz[1], Cenk Yardımcı[2]

1. Minouvet Veterinary Clinic-İstanbul, Turkey. **2.** Department of Surgery, Faculty of Veterinary Medicine, Ondokuz Mayıs University, Samsun. Turkey.
Çokcoşkun Yılmaz Ç. ORCID: 0000-0001-5221-3663; Yardımcı C. ORCID: 0000-0001-6126-3603

Review Article
Volume: 6, Issue: 2
August 2022
Pages: 47-51

ABSTRACT

The current increase in the numbers of fracture treatment by plate osteosynthesis in veterinary medicine is leading to the production of specific plates for different types of fractures. Recent studies about fracture healing show that MIPO procedure is superior for faster union and healing by decreased contamination risk, faster return of function, lower complication rates and blood supply preservation. By now, indirect reduction technics are more valuable in preservation of the biological structure of bone than full anatomic reduction techniques. Day by day, MIPO becomes more popular in veterinary orthopedics. Basically the method is applying a plate without opening the fractured area to make a bridging between the proximal and distal metaphysis/diaphysis of the fragments. The success of the procedure relies on the type of the fracture and the fracture area. The procedure can be applied especially diaphyseal segmental fractures with success but to be avoided in articular fractures. The procedure has been being used usually in the diaphyseal tibial and radial fractures of the cats and dogs. But nowadays it has started to be used in femoral and humeral fractures as well. The disadvantages of the procedure is the difficulty of the application and the need of the intraoperative radiography or fluoroscopy for the correct positioning of the fractures.

Article History
Received: 24.04.2022
Accepted: 29.05.2022
Available online: 14.06.2022

Keywords: mio, mipo, fractures, plate osteosynthesis

DOI: https://doi.org/10.30704/http-www-jivs-net.1111320

To cite this article: Çokcoşkun Yılmaz, Ç., Yardımcı, C. (2022). Minimally invasive plate osteosynthesis (MIPO) in veterinary orthopedics. ***Journal of Istanbul Veterinary Sciences, 6*(2),** 47-51. **Abbreviated Title*:* J. İstanbul vet. sci.**

Introduction

Plate osteosynthesis, in addition to other orthopaedic procedures, has been widely employed in the treatment of fractures since the 1800s. The Arbeitsgemeinschaft für Osteosynthesefragen / Osteosynthesis working group, or ASIF (Internal fixation working group), was founded in 1958. The primary goal of this study group was to develop a healthy fracture management procedure that reduced pain and loss of function. This study has facilitated the development of novel osteosynthesis procedures and improved osteosynthesis results throughout the years by offering standardization. Surgical procedures have changed as a result of this process. First and foremost, indirect reduction took the role of anatomical reduction. The plate designs were reconstructed with biological osteosynthesis concepts in mind (Hudson et al., 2009) The primary goal of this modification was to retain the vascularization essential for bone regeneration.

These advancements also made the less invasive surgical method useful in the treatment of fractures. The fracture location is damaged by soft tissue trauma during anatomical reduction with an open approach, and fracture hematoma and extra-osseous blood

***Corresponding Author:** Çağıl Çokcoşkun Yılmaz
E-mail: lachail@gmail.com

circulation of the bone are also affected. This condition has been proven to result in iatrogenic damage and a delay in bone healing. In reality, in some circumstances, iatrogenic stress promotes necrosis in fracture fragments. When fracture fragments do not sustain iatrogenic damage as a result of trauma during surgery, they preserve their vitality. According to the principles of biological osteosynthesis, the fracture hematoma and vascularization of the area are preserved in the minimally intrusive technique. Fracture pieces are not anatomically firmly positioned. Hulse's connections with soft tissue, on the other hand, are kept without being damaged by the indirect reduction approach based on the idea of "open but don't touch." (Aron 1995; Perione et al.2020). As a result, while environmental tissue damage is reduced, bone fragment vascularization is conserved (Johnson, 2003).

Another advantage of biological osteosynthesis is that it reduces the time required for surgery when compared to open reduction treatments (Johnson, 1998). This minimizes the possibility of infection (Eugster, 2004). By avoiding often observed difficulties, it is assured that the fracture heals before infection arises, reducing the requirement for grafts and the danger of non-union. Internal fixations based on biological osteosynthesis principles eliminate any difficulties associated with external fixation. Because the plates are applied from a more distant region, rather than immediately over the fracture area, the fracture area is not exposed, and tissue damage is decreased. Simultaneously, the fracture hematoma is maintained. This procedure is known as wig plate application or minimally invasive plate osteosynthesis (MIPO) (Perione et al.2020; Witsberger et al., 2010).

Basic principles of minimally invasive plate osteosyntesis (MIPO): Stabilization is performed using a plate implanted through a soft tissue tunnel in the form of a bridge between two minor incision lines far from the fracture line in MIPO, which has recently been employed in veterinary medicine. MIPO is used in a wide range of fracture types. The use is successful with an indirect reduction without the necessity for anatomical reduction, especially in diaphyseal fractures. The creation of calluses, which develops quickly as a result of the adhesion of the fracture components to the neighboring soft tissues, is essential for bone repair. The "blind" stability of bone fragments is the most difficult aspect of indirect reduction employed in MIPO applications. Fracture fragments are attempted to be aligned by manipulating from the outside prior to and during the surgery. Fluoroscopy is also employed to regulate this positioning. It is advanced by regulating with fluoroscopy at every step before stabilizing in place of the plate in order to preserve bone length throughout the surgery and to manage the right placement of bone fragments. The purpose of this entire procedure is not to expose the fracture line and so protect the soft tissue and expedite recovery (Perione et al., 2020; Chao et al., 2012).

Surgical approach: Because the critical neurovascular structures in the area cannot be fully visualised, the surgical approach must be undertaken with extreme caution. The incision line is 2 to 4 cm long and extends to the proximal and distal regions of the area where the plate will be put (Wagner and Frigg, 2006). In extreme instances, a third observation portal with MIPO and IM pin combinations can be used (Perione e al., 2020). Following the formation of the incision line, an epiperiosteal tunnel is opened between the proximal and distal incisions using a periosteum elevator or blunt-tipped soft-tissue scissors.

Figure 1. Application of MIPO in a comminuted femoral fracture of a dog; application of an epiperiosteal tunnel for the insertion of a compression plate locked from the distal to the proximal (Hudson et al., 2009).

Plates of several varieties can be used. The plate is applied to the fracture region by changing the epiperiostal tube from distal to proximal. Fluoroscopy is then used to ensure proper positioning. Screws are put on the proximal and distal sections of the plate using the proximal and distal incision lines. The screws are stabilized once they have been checked for accurate insertion. The surgeon's knowledge of MIPO procedures significantly reduces the surgery time (Schmokel et al., 2007). Since open reduction cannot be used for placement, fluoroscopy is used to confirm the precision of the location at each stage of the application. After fluoroscopy confirms proper implantation, the MIPO plate is fully adhered to the bone.

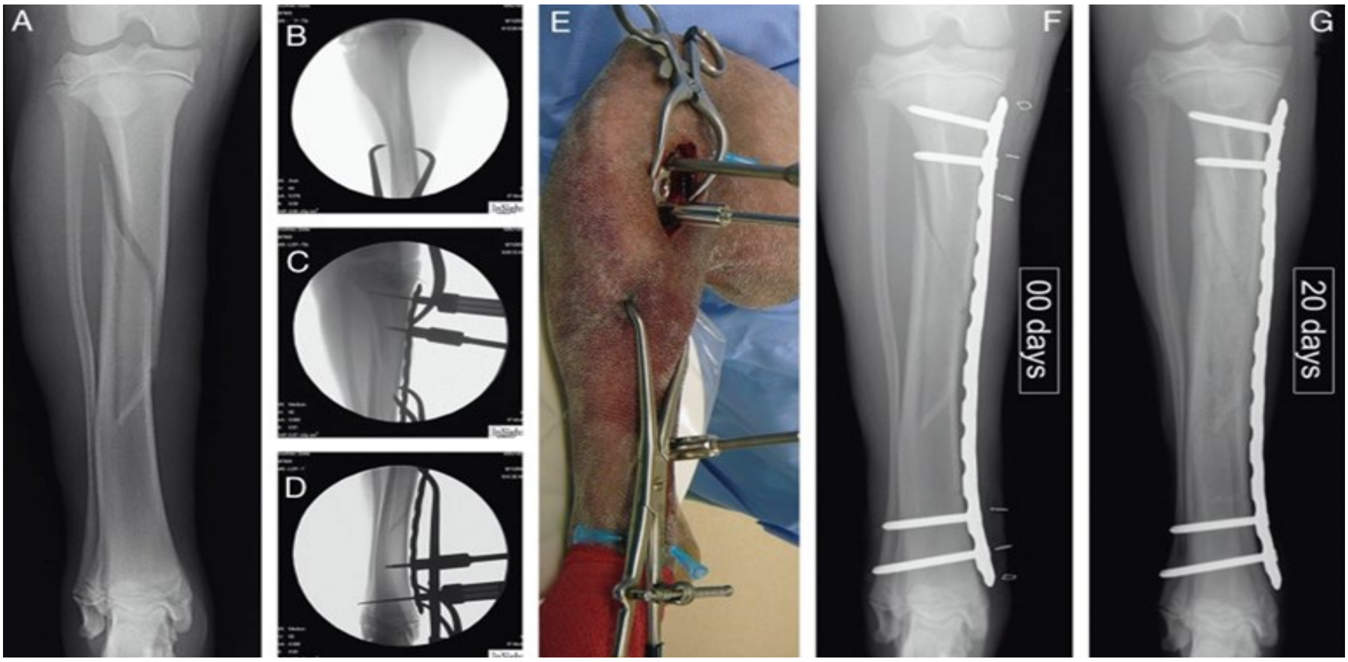

Figure 2- A spiral diaphyseal tibia fracture in a 6-month-old German Shepherd weighing 28 kg. During the operation, alignment was achieved by using bone reduction forceps (B-E). 13-hole 3.5mm LCP plate is placed. (C-E). A small number of screws were used to encourage secondary bone healing, cause minimum harm to the fracture site, and to provide flexible fixation (D-E). Hypodermic needles were placed to see and protect the growth plates of the tibia (E). At the end of 20 days, postoperative imaging showed continued growth (G). (Guiot and Dejarden, 2011)

Pre-operative planning: Adequate preoperative planning is essential in MIPO applications, as it is in any surgical method (Hudson et al., 2009; Hudson et al., 2020) A thorough preoperative planning is very crucial in this approach, where the application differs from conventional procedures, in order to decrease the surgery time and accomplish indirect reduction without any complications. MIPO can be utilized on a wide range of bones and fractures. It does, however, need a more careful approach in neuro-vascularly hazardous locations. It is critical to plan the implant selection and placement in detail during the preoperative phase, based on the patient's radiological results. Despite the fact that long plates aid in fracture stabilisation in implants, smaller plates are preferable owing to mechanical limitations (Hudson et al., 2020).

Implant selection: Preoperative planning must pay special attention to implant selection (Hudson et al., 2020). The weight of the patient, the position of the fracture fragments, the kind of fracture, and the stress to be imposed on the fracture are the primary parameters in this respect (Hudson et al., 2009). MIPO is frequently used in conjunction with normal locked bone plates (Hudson et al., 2020). Locking plates offer effective fixing because they prevent fracture section location from being altered during screw tightening (Hudson et al., 2009). Conventional plates may also be selected to assure alignment on the sagittal axis depending on the state of the case. This decision is largely dependent on the type of fracture (Hudson et al., 2020). Although locking plates are favoured because they give stability without touching the bone surface, they are not appropriate for every MIPO situation. Dynamic compression plates (DCP), limited contact dynamic compression plates (LC-DCP), and locking compression plates are utilized in MIPO applications (Johnson, 2003; Wagner and Frigg, 2006). MIPO applications can also be combined with IM pins or ESFs (Hudson et al., 2009).

Traction application or hanging the extremity: Since the bone fragments cannot be relocated with an open reduction, it is critical in MIPO applications to restore the decreased limb length caused by the patient's present muscle contraction in the preoperative period. Traction applications are chosen for this purpose. During the preoperative planning of the procedure, the traction process is initiated to both stretch the reduced limb length and assure proper posture. Traction tables designed specifically for veterinary medical applications can be utilised. In the absence of them, adequate pressure can be applied by suspending the extremities from a point during preparations. The stretching force created by the present weight of the patient's leg also assists to arrange the fracture pieces appropriately in tractions done by hanging this sort of extremity. Before the procedure, fluoroscopy or portable radiography can be used to manage preoperative and intraoperative placement (Perione et al., 2020).

Case selection for MIPO

Not every fracture method is appropriate for every patient. As a result, selecting the appropriate treatment strategy for the condition becomes increasingly important in each case. MIPO is not appropriate for every fracture. They are particularly useful in metaphyseal fractures and, in instances when anatomical reduction is not required, in fractures of the long bones of the extremity (Hudson et al., 2009; Wagner and Frigg, 2006). MIPO plates operate as a bridge over the fracture line, reducing strain on the fracture fragments (Wagner and Frigg, 2006).As a consequence of the research, we now aware that MIPO is effective in the stabilization of tibial fractures in people, cats, and dogs (Schmokel et al., 2007; Guiot and Dejardin 2011). However, in recent years, it has also been employed in fractures of the radius, humerus, and femur, as well as in certain investigations of metacarpal bone fractures. MIPO is effectively used in diaphyseal fractures, especially because the fracture pieces allow enough margin for fixing both distally and proximally (Hudson et al., 2009). As a result, fractures in the joint area are not desired in joint fractures because they do not give adequate room for the proximal and distal halves of the plate to be placed. Another concern is the presence of essential nerve and circulatory structures along fracture lines. When the neurovascular anatomy in the area must be maintained, open reduction is a better option. In such cases, MIPO is not recommended.

Another key consideration is the amount of time that has passed after the fracture. MIPO's success rate is unquestionably higher in emergency situations (Hudson et al., 2020).

In MIPO applications, the approach to the surgical site is critical for minimizing soft tissue injury. Although radius-ulna and tibia fractures are anatomically suited for MIPO applications, the approach in humerus and femur fractures is fairly problematic due to the anatomical nature of the bone and the neurovascular organization of the region. The method's main drawback is its difficulty in applying to humeral and femoral fractures, both neurovascularly and owing to the anatomical features of the bones and the bonding point of several muscle groups. Nonetheless, studies show that the procedure is effective in treating humeral fractures and has several advantages (Maritato and Rovesti, 2020).

Advantages and disadvantages of the method

This procedure, like any other surgical approach, has advantages and disadvantages. Many comparison research on ORIF and MIPO have been conducted. Internal fixation (ORIF) and MIPO treatments with open reduction were evaluated in a retrospective investigation on diaphyseal tibia fractures in dogs. As a consequence, whereas dogs treated with MIPO recovered quickly and without difficulties, dogs treated with ORIF recovered slowly and with repeated issues (Baroncelli et al., 2012).

MIPO treatments have been effectively employed in humeral, radial, ulnar, and femoral fractures in cats, according to research (Aron et al., 1995; Perione et al., 2020; Hudson et al., 2019; Schmierer and Pozzi, 2017; Maritato and Rovesti, 2020). In practise, anatomical approach challenges, as well as anatomical and neurovascular structural obstacles for the humerus, should be taken into account.

The most prominent advantages of MIPO treatments are the decrease of microbial contamination and tissue damage, the great acceleration of healing as a result of these, and the reduction of the time to restore the function of the broken limb. The method's main drawback is that visual control of the area can only be performed by fluoroscopy. Fluoroscopy is an imaging method that exposes the entire place to radiation exposure. During MIPO application, it is required to employ highly intense fluoroscopy. At each level of the application, imaging should be undertaken for control reasons. The fluoroscope is both costly and dangerous owing to significant radiation emissions. Simultaneously, visual control of the region's neuro-vascular anatomy cannot be accomplished as clearly as in open reduction throughout the surgery. As a result, despite its many advantages, MIPO is a tough treatment to use and necessitates extensive surgical knowledge with technological equipment.

Conclusion

MIPO has begun to be used in our country in recent years, but it is still a procedure that is not widely used in clinical practise. The utilization of this approach, which is often used in veterinary colleges and animal hospitals, is expanding in orthopaedic problems on a daily basis. In practice, it was discovered that the use of MIPO greatly reduced the operation time in tibial fractures, but in femur and humeral fractures, the abundant muscle tissue anatomically produced some application issues. Because of this structure, it has been difficult to access the periosteum and decrease fractures (İstim and Arıcan, 2020)

Minimally invasive procedures are becoming more popular all around the world. This circumstance has also resulted in the recent proliferation of MIPO practices. Especially in certain research comparing ORIF with MIPO, it is a striking outcome that MIPO achieves an improvement without problem (Baroncelli et al., 2012). A survey of veterinary surgeons, members and diplomats of the American College of Veterinary Surgery, the European College of Veterinary Surgery, and the veterinary orthopaedics community was conducted in 2018. 62 percent of the 256 veterinary surgeons who took part in this study said they wished to do more MIO and MIPO in the near future (Robinson et al. 2020).

Despite its technical problems MIPO (İstim and Arıcan, 2020; Bedizci and Kurum, 2020) which has been effectively applied in our country, is projected to be a favored approach among orthopaedists in the next years by finding more space in practice.

References

Aron D.N., Palmer R. H., & Johnson A. L. (1995) Biologic Strategies and a balanced concept for repair highly comminuted long bone fractures. *Compendium on Continuing Education for the Practicing Veterinarian*. *17*, 35-47.

Baroncelli A. B., Perione, B., Winter, M. D., Reese, D. J., & Pozzi, A. (2012) Retrospective comparison between minimally invasive plate osteosynthesis and open plating for tibial fractures in dogs. *Veterinary and Comparative Orthopaedics and Traumatology, 25*, 410-417.

Bedizci M. Ö., & Kurum, B. (2020). Minimal invasive plate osteosynthesis (MIPO) applications in long bone fractures of dogs and cats. *International Journal of Veterinary and Animal Research 3*(3), 58-63.

Chao P., Lewis D. D. , Kowaleski M.P., & Pozzi, A. (2012) Biomechanical concepts applicable to minimally invasive fracture repair in small animal. *Veterinary Clinics of North America: Small Animal Practice*, 42, 853-872.

Eugster S., Schawalder P., Gaschen F., & Boerlin P. (2004) A prospective study of postoperative surgical site infections in dogs and cats. *Veterinary Surgery, 33*, 542-550.

Guiot, L. P., Dejardin, L. M. (2011) Prospective evaluation of minimally invasive Plate Osteosynthesis in 36 nonarticular tibial fractures in dogs and cats. *Veterinary Surgery, 40*, 171-182.

Hudson C. C., Lewis D. D. , Pozzi A. (2020) Minimal İnvasive Plate Osteosynthesis /Radius and Ulna. *Veterinary Clinics of North America: Small Animal Practice, 50-51*, 135-153.

Hudson C. C., Pozzi A., & Lewis D. D. (2009) Minimally invasive plate osteosynthesis: Applications and techniques in dogs and cats. *Veterinary and Comparative Orthopaedics and Traumatology, 3*, 22. 175-182.

Istim C., & Arıcan M. (2020) Köpeklerin uzun ekstremite kırıklarında minimal invaziv plak osteosentez (MIPO) yönteminin klinik ve radyografik olarak değerlendirilmesi. *Eurasian Journal of Veterinary Sciences 36*(3), 172-179.

Johnson A. L. (2003) Current concepts in fracture reduction. *Veterinary and Comparative Orthopaedics and Traumatology,16*,59-66.

Johnson A. L., Smith C. W., & Schaeffer D. J. (1998) Fragment recontration and bone plate fixation versus bringing plate fixation for treating highly comminuted femoral fractures : 35 cases. *Journal of the American Veterinary Medical Association . 213*,1157-1161.

Maritato K. C., & Rovesti G. L. (2020) Minimal invasive Osyeosynthesis Techniques for Humerus Fractures. *Veterinary Clinics of North America: Small Animal Practice, 50-51*, 123-134.

Peirone B., Rovesti G. L., Baroncelli A. B., & Piras L.A. (2020) Minimally invasive plate osteosynthesis fracture reduction techniques in small animals. *Veterinary Clinics of North America: Small Animal Practice 50*(1), 23-47.

Robinson, W. P., Knowles, T. G., Barthelemy, N. P., & Parson, K. J. (2020) Perceptions of minimally invasive osteosynthesis: A 2018 survey of orthopedic surgeons. *Veterinary Surgery, 49,* O163-O170.

Schmierer P.A., Pozzi A. (2017) Guidelines for surgical approaches for minimal invasive plate osteosynthesis in cats. *Veterinary and Comparative Orthopaedics and Traumatology, 30*, 272-278.

Schmokel H. G., Stein, S., Radke, H., Hurter, K., & Schawalder, P. (2007) Treatment of tibial fractures with plates using minimally invasive percuteneous osteosynthesis in dogs and cats. *Journal of Small Animal Practice, 48*, 157-160.

Wagner, M., & Frigg, R. (2006) AO Manual of fracture management, internal fixators: concepts and cases using LCP and LISS. Clavadelerstrasse: *AO Publishing,* 1-57.

Witsberger T. H., Hulse D. A., Kerwin S. C., & Saunders W. B. (2010) Minimally invasive application of a radial plate following placement of an ulnar rod in treating antebrachial fractures. Veterinary and Comparative Orthopaedics and Traumatology, 6/2010, 23, 459-467.