International Journal of Healthcare Sciences ISSN 2348-5728 (Online)
Vol. 4, Issue 2, pp: (1686-1692), Month: October 2016 - March 2017, Available at: www.researchpublish.com

Overview of Minimally Invasive Percutaneous Plate Osteosynthsis

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Abstract: **This review focuses in reviewing the evidence based on various aspects of application of minimally invasive plate osteosynthesis (MIPO) technique used in commonly indicated fractures, along with factors influencing its mechanical stability. We intended to overview also the consideration for these procedures. Comprehensive search was conducted through; PubMed/Medline, and Embase databases, searching literature concerning minimally invasive plate osteosynthesis (MIPO), we searched studies published until end of 2016, Restricted our search to English language articles. This has led to development of minimally intrusive plate osteosynthesis. This strategy if used when suggested leads to many advantages such as greater rates of union with decreased surgical time, blood loss, post-operative pain, infection rates and specific other postoperative issues. This strategy is being applied typically in fractures such as shaft of humerus, proximal and distal femur, proximal and distal tibia and fracture ribs, with a number of advantages over its standard counterparts.**

Keywords: **Minimally Invasive Plate Osteosynthesis (MIPO), Proximal and Distal Femur, Proximal and Distal Tibia.**

1. INTRODUCTION

Due to an increasing demand for minimally intrusive treatments, less invasive stabilisation systems became available in the late 1980s. These systems were created to be inserted though small, tactically placed cuts. Following this development, minimally invasive plate osteosynthesis (MIPO) was introduced for fracture fixation [1,2] With the MIPO method, treatments could be carried out with smaller sized cuts and hence with less soft tissue damage and a better protected blood supply. MIPO has up until now only been explained in diaphyseal and metaphyseal fractures of the femur, tibia, and the humerus [3,4]. The price was the risk of bone or soft tissue necrosis and postponed healing as there was widespread soft tissue dissection and interruption of periosteal blood flow [3] This resulted in advent to more biology friendly techniques. These biological strategies lay tension upon maximal preservation of blood supply around the fractured bone by very little direct handling of the fracture environment [4-5] They provide advantages which include conservation of the fracture hematoma, less surgical trauma to the surrounding soft tissues [6], lowered personnel time therefore decreased risk of infection and ultimately causing indirect bone recovery with abundant callus. Minimally intrusive plate osteosynthesis (MIPO) is a novel method for application of principles of biological fracture recovery with an approach of handling soft tissues with utmost regard. Brunner and Weber are credited for promoting this method in the early eighties. [7] Further later on, following developments in implant technology and advancement of methods of indirect fracture reduction this method got more appeal. The development of MIPO began with making use of bridge plating [8] In initial days a conventional plate was requested comminuted femoral fractures utilizing long incisions but with conservation of the vastus lateralis muscle leading to healing with plentiful callus [9] Subsequently, the size of incisions got decreased, rather 2 small incisions were provided at proximal and distal plates and ends were bridged sub muscularly over the fracture pieces [10-12] This strategy triggers minimal distress to soft tissues and bone, provides

access to the bone through soft tissue windows, with minimal or no contact with the fracture by indirect decrease tools and leaving behind very little foot prints.

This review focuses in reviewing the evidence based on various aspects of application of minimally invasive plate osteosynthesis (MIPO) technique used in commonly indicated fractures, along with factors influencing its mechanical stability. we intended to overview also the consideration for these procedures:

2. METHODOLOGY

Comprehensive search was conducted through; PubMed/Medline, and Embase databases, searching literature concerning minimally invasive plate osteosynthesis (MIPO), We searched studies published until end of 2016, Restricted our search to English language articles.

- **Regional Considerations of MIPO:**

Shaft Humerus:

A wide variety of treatment methods are readily available for treatment of shaft humerus: functional cast bracing [14], open compression plating [15], intra-medullary nailing. [16] All these approaches have actually revealed excellent outcomes when used carefully with their respective indicators. Non operative treatment is economical and technically less demanding. However it causes extended immobilisation and increased malunion rates. Open compression plating guarantees better reduction of fracture fragments [17] Causes extensive soft-tissue handling, loss of fracture hematoma and therefore loss of biological environment for fracture to recover [18] It is likewise connected with problems such as sepsis, iatrogenic radial nerve injury [19] and nonunion. It is likewise a technically requiring procedure needing long discovering curve [20] Use of MIPO by the ways of anterior bridge plating assists in conservation of biological environment and thus promotes sufficient healing at the fracture site. Surgical treatment is minimally intrusive so there is less blood loss, neurovascular problems, post-operative pain, opportunities of sepsis and lower health center stay. In the middle 3rd fractures, MIPO is much safer from the dangers of iatrogenic radial nerve injuries. It is not the case with distal 3rd fractures as there is risk of radial nerve entrapment under the plate [21]

Proximal & distal Femur:

The practical results following plating of subtrochanteric fractures are far more inferior to those following the intramedullary devices [22-23] But nailing in certain complex fracture can be technically requiring. In such situations plating can be useful. In addition plates are less expansive as compared to nails. Other relative indicators are cases with little medullary canals or cases of poly trauma involving the lung system where reaming can be destructive [24] In such situations plating can be done with minimal access to have the biological advantages. Implants such as DCS, Condylar buttress plate can be used with satisfying result with MIPO strategy [25]: The standard lateral technique to distal thigh offers the window for exceptional visualization and direct decrease of the fracture. However this comes at a cost of massive soft tissue direct exposure, loss of blood, devitalisation of fracture fragments and require for bone grafting in specific scenarios ultimately causing infections, non-unions [26] But with the development of various minimally invasive procedures in different forms has caused decreased incidence of such problems. Numerous strategies have actually been gadgets such as MIPO, MIPPO, TARPO, LISS using very little of complications. MIPO is convenient for cases with additional articular involvement with complicated Meta/diaphyseal fragments. MIPPO (minimally intrusive percutaneous plate osteosynthesis) strategy encompasses use of specialized instruments for application of implants such as DCS. Hence, using advantage of DCS with minimal soft tissue handling [10] TARPO (Transarticular Approach and Retrograde Plate Osteosynthesis) uses direct visualization of articular surface area with very little access to the metaphyseal region. Thus, its benefit depends on osteosynthesis of articular fractures. It utilizes making use of a cut given for lateral parapatellar arthrotomy for direct visualization for repair of the articular congruity and an indirect fixation of the diaphyseal component [27] Although these strategies are beneficial, but they are technically more requiring. LISS for distal femur (Less invasive stabilization system) consists of the use of an anatomically contoured plate which is inserted by means of minimal access into the sub-muscular aircraft through an intending device after indirectréduction of the fracture [28] Screws are inserted using the aiming device with very little incisions. Therefore the advantages of minimal tissue handling are offered, however the technique is expensive and needs availability of high profile instrumentation.

Proximal Tibia: High velocity tibial plateau fractures frequently include a mix of complicated articular participation with significant communition and associated serious soft tissue injuries. Running upon such injuries with conventional

methods in existence of the damaged soft tissues leads to occurrence of high quantity complications such as infections [29], wound dehiscence, hardware prominence. To prevent such scenarios a 2 staged approach, use of dual incisions or conclusive external fixation is preferred. These methods can increase morbidity and are not cost effective as multiple surgical treatments are needed and increased hospital stay is needed. The usefulness of minimally invasive techniques pertains to advantage in such scenarios. Here, MIPO has actually shown lower occurrence of soft-tissue issues and yields in much better end-results than ORIF [30-31]

Distal Tibia: Plating is gold standard in personnel treatment of distal tibial fractures. Intramedullary nailing is not chosen treatment for distal tibial fractures as these fractures commonly encompass the tibial pilon [32] Application of external fixators in distal tibial fractures is commonly associated with a high complication rate. Issues such as pin system infection pin loosening and high rate of malunion are common [33] Optimum treatment of distal tibial fractures is challenging owing to its fragile soft tissue cover and tenuous blood supply. Cadaveric studies have shown that its vascularity is stemmed from extra osseous anastomosis of branches of anterior and posterior tibial arteries. These arteries get here into distal tibia from the median side. Open plating can hence result in interruption of this blood supply and obstruct the vascularity [34] MIPO has actually revealed to have higher of union rates and lower issue rates as compared to the standard open technique [35-36] Factors Influencing Stability of Construct [37] In order to accomplish a stable construct the following standards are advised:

Plate Length: Plate length should be two to three times larger than length of the fracture in comminuted fractures and eight to 10 times higher in easy fractures. Use of such longer constructs is requirements for a preferably steady construct. The length increases the pullout force acting upon the screw because of long lever arm for each screw. MIPO with its intrinsic ability of plate insertion with minimal cuts offers such benefit of placement of bigger plates without comprehensive exposure.

Number of screws: Two screws on each side of the fractures are prerequisite for a steady construct. But, being on the more secure side it is recommend to use 3 screws on either side so regarding take care of opportunities of failure due to screw breakage. A plate screw density below 0.4 to 0.5 is advised, this implies that less than half of the plate holes are inhabited by screws.

Locking versus non locking screws: Use of locking screws is advised specifically in bones with poor quality as locking heads supply strength against not only pullout however likewise bending.

Bicortical versus unicortical screws: A purchase of certain quantities of threads in the engaging cortex is essential for company anchorage of plate to the bone surface. Healthy cortices are thick enough for an excellent purchase. In such bones even a monocortical screw can withstand the torsional forces acting over the fracture site. Whereas, in case of permeable bones the cortex is thin. Here, even minimal torsional forces can lead to instability as the screw pullout strength becomes lower due to reduced working length of the screw. For that reason, in such cases use of bicortical screw is suggested. Self-drilling versus non self-drilling screws: Use of self-drilling screws is recommended just for unicortical screws as they can trigger soft concern damage while drilling far cortex for bicortical applications.

Screw direction: Parallel insertion has lower strength against pull-out, as a pull-out force is applied, whole screws and plate interface pulls out as a whole. The pull-out strength can be increased using of screw in diverging directions [37]

Minimally invasive plate osteosynthesis tools for rib fracture fixation:

When initiating the operation, additional tools and strategies assist in the application of the MIPO principles [38] The Alexis wound retractor is a regularly used instrument in thoracoscopic- and laparoscopic-assisted procedures. No scientific reports have actually yet explained the use of the Alexis injury retractor in approaches to the chest wall and surgical rib fixation. When beginning the MIPO treatment, the skin is incised at the predetermined location, followed by department of the subcutaneous tissue. Depending on the location of the fractures, muscle fibres are divided in a muscle-sparing manner until the chest wall is reached. Subsequently, a cavity is created between the chest wall and the overlying soft tissue, allowing the placement of the Alexis wound retractor. This retractor is readily available in a number of sizes, but we generally utilize the retractor with a size of 4 cm. After placement of the inner ring between the chest wall and the soft tissue, the retractor is tensioned by rolling itself on the outer ring, producing an outward withdrawing force and forming a window through which the procedure can be carried out. Another benefit of the Alexis injury retractor is that the rubber seal in between the inner and external ring has a haemostatic function, developing a dry operating window. Analogously to the MIPO technique used in long bone fractures, additional tools are had to facilitate surgery. These extra

tools are available in a separate MIPO matrix set (Depuy-Synthes, West Chester, PA, USA) (**Figure 1**) [38,39] This package, together with the 90-degree drill and screwdriver, allows the cosmetic surgeon to stabilize almost every fracture type. In the next paragraphs, we explain the MIPO strategy with illustrative examples of its application in patients.

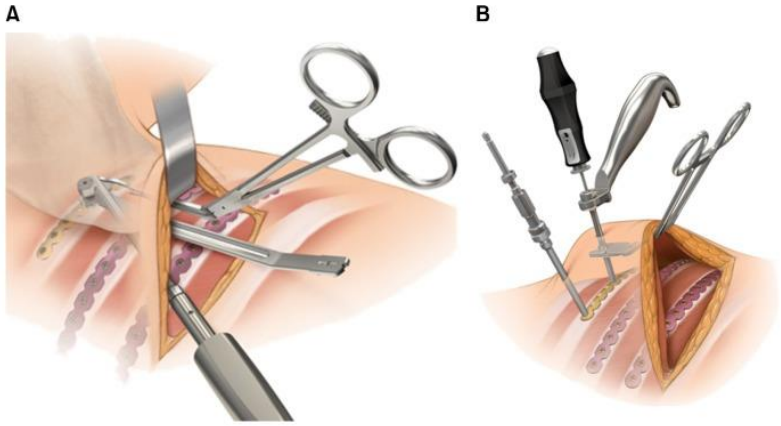

Figure 1: MIPO instruments. (A) The 90-degree angle drill. (B) Trocar in the plate

The 90-degree drill and screwdriver make it possible for the cosmetic surgeon to drill through a little incision in a perpendicular fashion to the plate and rib, guaranteeing the right positioning of the locking screws. The drill has a knob at the end, making it possible to manually drill a hole. Because ribs have a fairly thin cortex, manual drilling is reasonably effortless. If power drilling is preferred, the rear knob can be substituted with a maxilla facial power drill or the Pendrive (Depuy-Synthes). The 90-degree drill device likewise operates as a 90-degree screwdriver if the drill bit is substituted with a screwdriver bit. The difficulty with using the 90-degree drill gadget is to drill a hole perpendicular to the rib exactly in the middle of a well-positioned plate. It is necessary to realize that an off-angle positioning with a maximum of just five degrees will be tolerated by the plate and screw [40].

The MIPO matrix package consists of a number of tools. Among these tools is a trocar set with a soft tissue clamp (**Figure 2**) [5,41] This trocar set assists in fixing fractured ribs at some distance from the incision. The designated rib fracture is exposed underneath the soft tissue and lowered. An appropriate plate is pre-bent by the cosmetic surgeon and positioned on the rib. Particular clamps can hold the plate in the proper location. Through a stab incision, a trocar is put in a tactical manner making it possible for the placement of multiple screws. Next, through the trocar, a drill guide is put in the designated hole and screwed in the thread of the plate. Additionally, a soft-tissue clamp is placed underneath the tissue envelope on the exact same trocar. When raised and closed, the clamp will tension the soft tissue, producing a window through which the plate can be imagined and approached. Subsequently, the rib is drilled with the appropriate drill length, the drill guide is eliminated, and an appropriate-length screw is placed. This sequence is duplicated until all screws are placed [42]

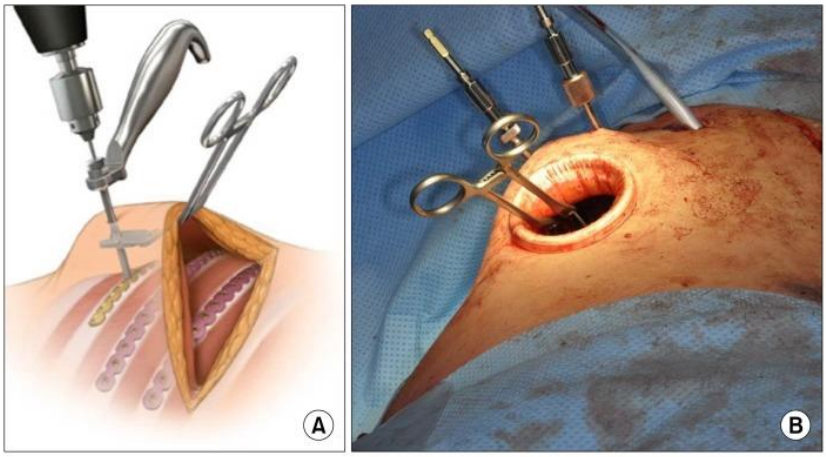

Figure 2: (A, B) The position of the trocar in the plate and with the clamp around the trocar lifting up the soft tissue.

The MIPO kit likewise provides a threaded reduction tool (TRT), which is extrapolated from the less invasive stabilisation system utilized for long bone fractures. This TRT consists of a threaded drill with a nut at the end. With this tool, it is possible to temporarily fix the plate to a rib. The TRT needs to be placed through the trocar and drilled into the designated rib. After drilling, the nut at the end of the TRT should be declined, pressing the trocar with the plate onto the rib (**Figure 2**) [42] This results in a momentarily repaired plate, making it possible for the surgeon to drill and position all other screws into the plate. Lastly, the TRT is eliminated and a screw can be put, utilizing the hole that was pre-drilled [43,44]

3. CONCLUSION

This has led to development of minimally intrusive plate osteosynthesis. This strategy if used when suggested leads to many advantages such as greater rates of union with decreased surgical time, blood loss, post-operative pain, infection rates and specific other postoperative issues. This strategy is being applied typically in fractures such as shaft of humerus, proximal and distal femur, proximal and distal tibia and fracture ribs, with a number of advantages over its standard counterparts. MIPO is simple, safe and efficient approach of treatment for diaphyseal & metaphyseal fractures. It does not require direct visualization of the fracture at the cost of comprehensive soft tissue dissection. We are positive in suggesting this alternative technique of plating.

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