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Bone Reduction Clamp and Internal Fixation for Plate Insertion

Ali Tabrizi [1,*], Mohammad Javad Shariyate [2] and Sajjad Zakeralhoseini [3]

[1]Department of Orthopedics, Clinical Research Development Unit, Imam Khomeini Hospital, Urmia University of Medical Sciences, Urmia, Iran
[2]Department of Orthopedics, Emam Khomeini Hospital, Urmia University of Medical Sciences, Urmia, Iran
[3]Mechanical Engineer, Bern, Switzerland

[*]*Corresponding author*: Department of Orthopedics, Clinical Research Development Unit, Imam Khomeini Hospital, Urmia University of Medical Sciences, Urmia, Iran. Email: ali.tab.ms@gmail.com

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1. Introduction

Internal fixation of bone fracture is a common method in the surgical treatment of fracture in long bones (1). Bridging the broken bone as well as obtaining a rigid fixation plays an essential role in proper healing (1). Several instruments can help orthopedic surgeons to preserve the alignment in an anatomical condition. Once the reduction is done, it can be maintained by internal fixation through the application of plate, screw, or other implants to recreate the normal anatomy of the fractured bone (1, 2). This study presents a new bone reduction clamp for easy insertion of the plate during internal fixation.

2. Designed Clamp

The clamp is a scissor-like compressing reduction device usually used in orthopedic surgeries for internal fixation. This device comprises a first clamp member and second clamp member including upper, middle, and lower sections giving rise to a scissor-like structure; in which the first and second clamp members are hinged to each other at a pivotal point using a screw in the middle section. The upper sections of the first and second members are configured to have a pair of arcuate members to define a first opening to receive and hold a fractured bone for reduction and second opening in U-shaped profile to define a substantially wide area for slidably receiving of a plate during internal fixation. The lower section is a handle configured to have a pin member and fixation screw to adjust the amount of opening of members. This device assists in aligning the fractured bone in a stable position and simultaneously performing the reduction and internal fixation of the plate without removing the device during surgery (Figures 1 and 2). Due to the wide variety in bone diameters or plate thickness, these clamps are designed and built in three sizes. This device is registered in the United States patent and trademarks office with the publication number of US-2018-0168707-A1 (https://patents.google.com/patent/US20180168707A1/en).

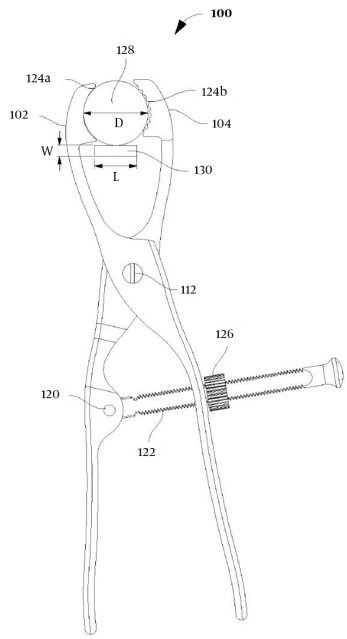

Figure 1. A front view of a bone reduction and internal fixation device to receive a 4.5-inch heavy plate

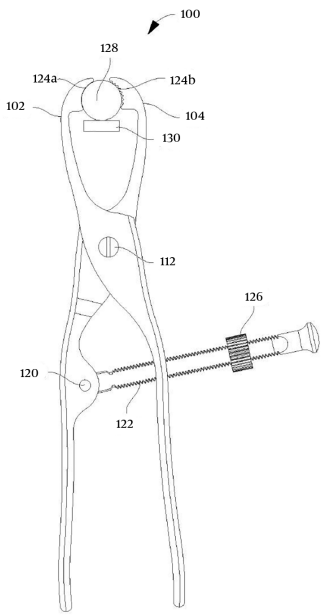

Figure 2. A front view of a bone reduction and internal fixation device to receive a 3.5-inch thin plate

Figure 3. Experimental assessment of plate insertion by the new designed device

Figure 4. Comparison of new clamp reduction device with a conventional clamp

3. Assessment of Clamp

The new clamp was used practically in the operation of real trauma circumstances in the Trauma Center of Urmia University of Medical Sciences and Isfahan University of Medical Sciences. It was also examined in moulage for the first time to assess and compare the applicability for insertion of standard plates (3.5 and 4.5). The easy insertion of the plate was proved in comparison with conventional common devices (Figures 3 and 4). Evaluation of the clamp resistance by tension machine in biomechanics engineering school showed that its resistance power against deforming forces in long bones fractures was 720 $\pm$ 11.8 N more than conventional clamps. Under clinical condition, was applied in 30 long bone fractures operation. The duration of surgery time in long bones fractures was significantly different from conventional clamps (time of plate insertion and fixation in new clamp was 32.4 $\pm$ 10.7 min versus 48.9 $\pm$ 11.3 min for conventional ones; P = 0.01) (by Medcalc softer).

4. Discussion

Using this method, the surgeon could easily insert the plate without any need to remove the clamp. The reduction can be maintained by using this clamp while the plate and screws are introduced. Several experimental and clinical experiences have confirmed the practical advantages of this device of this method. Several implements have been designed to help orthopedic surgeons during internal fixation (1, 2). Dynamic compression bone clamp for transverse fracture was first described by Lalonde in 2008. It is a suitable instrument to reduce transverse fractures during internal fixation (2). In addition, in an old report in 1984 by Mennen, the para skeletal clamp plate was used to maintain the reduced position of the fractured long bone during the healing phase (3). According to this report, it was a simple and effective method for treatment of long bones (3). The present device can be used as bone reduction and internal fixation apparatus during orthopedic surgeries. Utilizing this clamp brings about the advantage that bone

reduction and internal fixation procedures can be simultaneously carried out without removing the device from the fracture site.

Currently, numerous devices and methods are employed to treat the fractured bones. However, there is a need for advanced devices that help surgeons carry out both reduction and internal fixation of long bones like leg, forearm and femoral bones as well as external fixation of articular fractures. Most of the conventional devices do not allow the surgeons to simultaneously place the plates and pursue the reduction process. Using conventional bone clamps such as provisional fixation techniques, surgeons must make a temporary fixation by passing pins or screws, which are so narrow and weak through the fracture site by drilling followed by opening the bone clamp to apply the plate. However, this method suffers from several limitations such as failure of reduced position midway due to inherent weakness. This method may also cause an additional fracture in the bone as the result of shearing fracture on the pathway of pins or screw. To set the plate after provisional fixation sometimes the pins or screws should be removed because they do not let the surgeons place the plate in anatomic position. Longer operation time and secondary complications such as infection, blood loss and failure of anesthesia, can also be mentioned.

The drawback with the conventional bone clamps is that when they hold the bone in the fracture site, there won't be any ample space available to pass the plate for intended bone. This defect is a common problem in all types of conventional bone clamps.

5. Conclusions

The invented explained reduction clamp fulfills the need for a clamping device for simultaneous reduction and internal fixation without removing the device from the fracture site.

Footnotes

Conflict of Interests: There is no conflict of interest to be reported.

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