

MORPHOLOGICAL EVALUATION OF ECCENTRIC SETS GUIDE-PLATES OF DCP-L 4.5 MM

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ABSTRACT

Objective: To carry out isolated and comparative evaluations of the measurements of the set eccentric guide plates used in 4.5mm surgical implants, and to determine the effect of these measurements on compression strength. **Methods:** Four eccentric guides, four large dynamic compression plates (L-DCP) from four local manufacturers, and a Vonder[®] 200 mm caliper brand were used. Five standard parameter measurements were created for the set eccentric guide-plate, which were identified as A to E. Four sets were made, using materials of the same factory, and identified as groups I to IV. The analyses were performed by measuring all the parameters from a ventral view of the plate, with the eccentric guide placed

in the plate hole. **Results:** Groups I and II showed the same values for all the parameters. All the groups showed the same measurements for E = 8.15 e B = 3.60. Group III: A = 8.10mm, C = 3.25mm, D = 1.25mm. Group IV: A = 7.00mm, C = 3.10mm, D = 0.30mm. Maximum compression force was (F Max.): Group I 80.58 N, Group. II: F Max. 81.63 N, Group. III: F Max. 36.32N, Group. IV: F Max. 37.52N **Conclusion:** The measurements evaluated show a lack of standardization in the manufacture of orthopedic instruments and its effects on the values for compression strength. *Level of Evidence: Level III, analytical study.*

Keywords: Fracture fixation, internal/methods. Bone plates. Bone screws. Biomechanics.

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INTRODUCTION

Denis, in 1949, for the AO Group, in pursuit of the appropriate treatment of fractures with surgical indication, led the presentation of the basic principles of internal fixation, then based on anatomical reduction, stable internal fixation and painless active mobilization.^{1,2} Starting from the 1990s, there was a change in these principles, in which the purely mechanical concern of the fixation was replaced by a biological fixation trend.³ In 1967, Perren et al.³ conducted the development of a self-compression plate called Dynamic Compression Plate (DCP[®]), which produced compression of the fracture focus based on eccentric screw insertion in the modified orifice of the self-compression plate, allowing the sliding of the screw head and of the bone fragment underlying the plate, leading to axial interfragmentary compression. The congruent fit between plate and screw head would occur not only in their final adjustment position, but also during the screw tightening process. The inclined slope system of the orifice makes it possible to decrease the undesirable deformations of screws upon insertion in the eccentric position, increasing the compression force.⁴ The eccentricity of the compression screw allows the plate to

slide over the fracture fragment for 1mm, causing controlled eccentric compression, preventing bone necrosis from occurring at the fracture focus.⁵

In view of these affirmations and due to the importance of compression at the fracture focus, in the absolute stability technique, there were analyses of the measurements in the eccentric guide - DCP-L sets, and of their influence on the compression force.

MATERIAL AND METHODS

DCP-L plates with their respective eccentric guides from the 4.5 mm boxes of four national manufacturers used extensively in the market were used in this study, forming Sets I, II, III and IV. (Figure 1)

Using a 200mm Vonder[®] caliper, the following standard measurements were determined in each set individually: largest distal diameter of the eccentric guide (A), guide hole diameter (B), medial distance from the hole (C), lateral distance from the hole (D), largest diameter of the plate hole (E). (Figure 2)

After determining the parameters described above, a compression test was conducted with the studied sets using polyethylene specimens with a diameter of 30 mm, to simulate bone

All the authors declare that there is no potential conflict of interest referring to this article.

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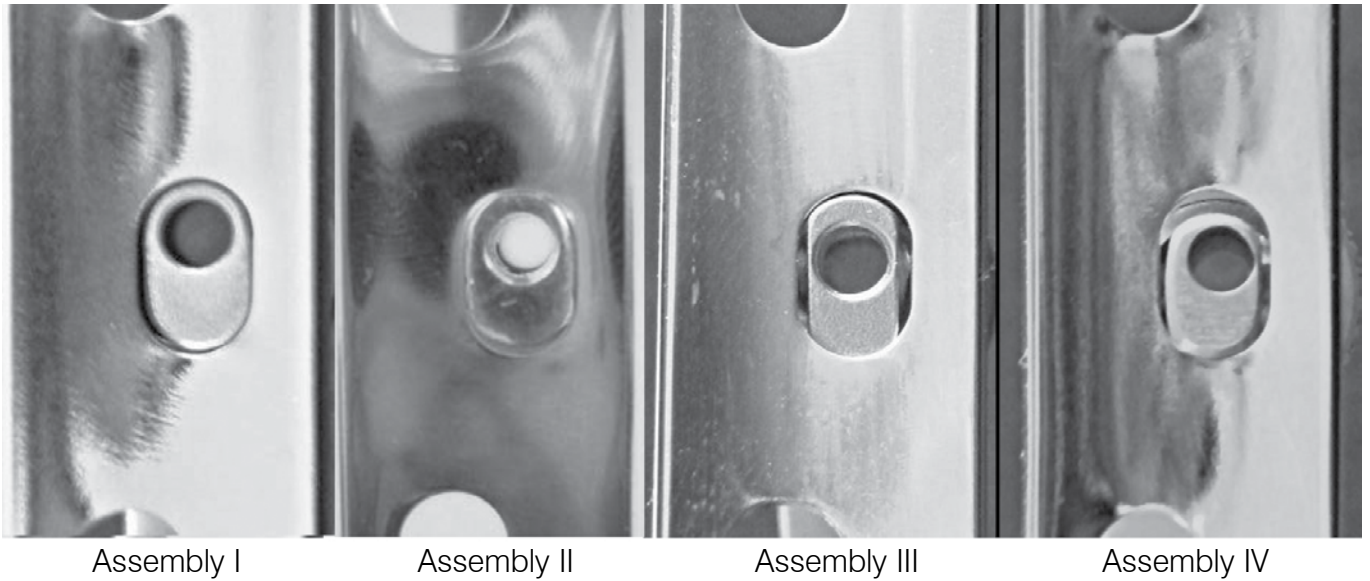


Figure 1. Guide-plate sets of the four national manufacturers studied, seen from the ventral aspect.

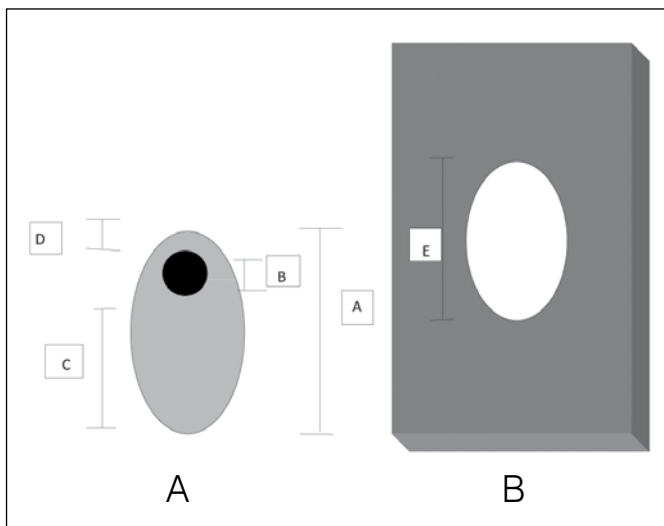


Figure 2. (A) Representation of the measurements of the distal portion of the eccentric guides. (B) Representation of the measurement of the plate hole.

diaphysis, separate from one another. The plates were fixed on each specimen with a 4.5mm cortical screw, with one side have undergone centric drilling and the other with an eccentric hole, with the compression forces on the specimens captured in tightening this screw.

The system was fixed in a BME 2000 160/ ATTN Brasvlvula[®] servo-hydraulic machine, and the test values were captured through a force transducer (F) in Newton (N), located at the top of the system. (Figure 3)

RESULTS

Sets I, II: presented the same values in their measurements: A = 8.10mm, B= 3.60mm, C= 4.00mm, D=0.50mm, E= 8.15mm. All the groups presented the same values of E= 8.15 and B = 3.60. Set III: A= 8.10mm, C=3.25mm and D= 1.25mm. Set IV: A = 7.00mm, C=3.10mm, D = 0.30mm. (Table 1).

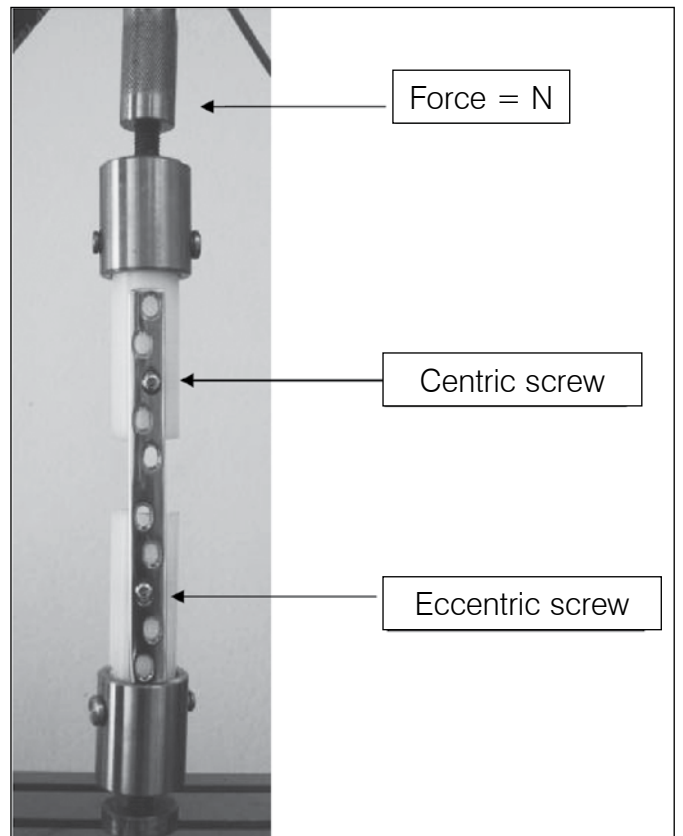


Figure 3. Complete assembly of the system in the testing machine, demonstrating: Force transducer, position of the centric and eccentric screws.

In the compression test, set I presented Maximum force (F max) 80.58 N, set II: F max 81.63 N, set III: F max 36.32N, set IV: F max 37.52N.(Table 2).

Measurement D was determined with the most important standard for greater eccentricity of the hole, with an inversely proportional ratio. The smaller the measurement D, the greater the

Table 1. Values of the measurements of the sets studied.

Measurements	Set I	Set II	Set III	Set IV
A	8.10	8.10	8.10	7.00
B	3.60	3.60	3.60	3.60
C	4.00	4.00	3.25	3.10
D	0.50	0.50	1.25	0.30
E	8.15	8.15	8.15	8.15

Table 2. Analysis of Maximum Force (F Max) in Newton, according to the Sets.

Assembly	FMax
I	80.6
II	81.6
III	36.3
IV	37.5

eccentricity of the hole and thus the greater the compression force. This measurement ranged from 0.3mm to 1.25mm, information that was determined with the analyses of sets II and III, as there was a perfect fit between guide and plate.

Macroscopically, it was observed that set IV presented the smallest measurement D, which should produce greater eccentricity of the hole, and therefore greater compression force. However, this was not observed, as there is a space between the plate and the guide, as observed in Figure 1. Thus even with the correct positioning of the guide in the plate, the eccentric hole was made at a distance of 1.15mm from the highest side of the slope, in the plate hole. The compression study for this set was carried out as described above, thus reproducing the worst form of its use, reducing its sliding power and consequently reducing compression through this hole. Accordingly, note that the correlation of measurement D with the compression force of the eccentric hole should only be considered if there is a perfect fit between guide and plate. If there is not, there will be no optimization parameter of the eccentric hole for the guide used.

There were no differences among the plates, i.e., they all presented the same measurement E, and the same inclination for the slope.

DISCUSSION

In the description of the technique for use of the DCP plate, the AO group determined the angulation limits at 25 degrees in the longitudinal plane and 7 degrees in the axial plane, for obtainment of greater interfracture compression force.⁶ This declaration may be compromised by the results obtained in this study, since there is no standardization in the production of the eccentric guides, different compression values will be obtained even if we respect such angulations.

In the treatment of fractures professionals aim to reduce mobility at the fracture focus, which may be compromised under functional load, and the only technique that will effectively abolish movement at the fracture focus is interfracture compression, which favors absolute stability and can be obtained through the

use of DCP plates.⁶ This absolute stability can be hampered by changes in the engineering of materials, as set forth in this study. Under the principles of fracture fixation with absolute stability, conceived by the AO foundation, with the use of DCP plates, each eccentric screw causes displacement of 1mm in the fragment fixed to it, thus determining a compression value.⁶ These compression levels obtained in the intra-operative stage decrease over five to nine weeks,⁵⁻¹² not due to necrosis or bone reabsorption, but rather due to viscoelastic alteration of the actual bone material and to gradual remodeling. The absolute stability technique compromises bone vascularization more than other fixation methods. Therefore, the surgeon's expertise in executing the technique may be crucially important in the good treatment evolution.^{6,13} It can be seen from the description that displacement in the fragment, due to lack of standardization of guide production, may be variable, and can thus compromise stability in shorter periods of time than those already described, also compromising consolidation.

Through scientific studies it was verified that compression at the fracture focus determines bone necrosis, yet there is no specification of absolute values of how much this compression can compromise the treatment.⁸ The lack of clinical studies determining the optimal compression value for the treatment of fractures with absolute stability does not allow us to affirm whether the non-standardization of the synthesis materials studied here can compromise the evolution of fracture treatment due to excessive compression or lack of compression.

The good technique of the surgeon, aiming at causing less aggression to the tissues adjacent to the bone, and especially the quality of the reduction in absolute stability technique, is directly related to good evolution in the treatment of fractures. The results obtained in this study motivated the performance of mechanical compression trials, with a numerically significant sample for determination of a statistical value of such results. Such work is currently under execution in our department.

During macroscopic analysis of the implants and instruments used in this study, we did not observe significant alterations in the morphology (size, thickness, diameter of the orifice and slope inclination) of the plates. However, the eccentric guides appeared morphologically different, allowing the drilling of holes with a greater or lesser degree of eccentricity, depending on the manufacturer. Such fact is directly related to the compression force levels. The values reproduced in this study allow us to infer that the non-standardization in the production of national orthopedic instruments entails different values of compression at the fracture focus. Such differences may compromise good treatment evolution.^{14,15}

CONCLUSION

The variation of one of the characteristics of the orthopedic synthesis material may entail a difference in the desired end result. There is a clear difference among the materials used on a day-to-day basis by orthopedists in our field, probably due to the lack of standardization and of laws that regulate the production of these materials. The lack of knowledge of the fact that engineering alterations can completely alter the compression levels offered by compression plates can lead the professional to carry out surgical procedures without precision, even though the technique is correct, and to achieve results that fall short of requirements or even provoke failure in the treatment.

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