In Vitro Biomechanical Study on the “Figure-of-Eight” and Kessler Sutures in Swine Flexor Tendons

Estudo biomecânico in vitro das suturas em “oito” e de Kessler de tendões flexores de porcos

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Abstract
Objective
To evaluate the biomechanical properties of the “figure-of-eight” and Kessler suture techniques for tendons.

Methods
Flexor tendons of porcine fingers were divided into two groups with triple central “figure of eight” sutures (six passages) and Kessler sutures (two passages) associated with simple and continuous peripheral sutures, and submitted to continuous longitudinal mechanical tests, to obtain the mechanical properties of maximum load and energy at maximum load.

Results
The mean maximum load and energy at maximum load in the “figure-of-8” suture were of 63.4 N and 217.3 N.mm respectively; in the Kessler suture, the values were of 34.19 N and 100.9 N.mm respectively. The statistical analysis indicated that the “figure-of-eight” suture is mechanically superior to the Kessler technique.

Conclusion
Under the conditions of this experiment and in the flexor tendon of porcine fingers, the triple “figure-of-eight” suture (six passages) is more resistant than the Kessler suture (two passages). The “figure-of-eight” suture with six passages enables active movement in the immediate rehabilitation of the flexor tendon repair of the finger, with little risk of rupture or suture spacing.

Resumo
Objetivo
Avaliar as propriedades biomecânicas dos pontos de sutura tendinosa em “oito” e de Kessler.

Métodos
Tendões flexores dos dedos de membros superiores de porcos foram divididos em dois grupos com suturas triplas centrais em “oito” (seis passagens) e de Kessler (duas passagens) associadas a suturas periféricas contínuas simples, e submetidos a ensaios mecânicos longitudinais contínuos, obtendo-se as propriedades mecânicas de carga máxima e de energia na carga máxima.

Keywords
► orthopedic procedures
► biomechanical phenomenon
► tendon injuries
► finger injuries
► suture techniques

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Introduction

The need for active postoperative movement of the flexor tendon repairs of the fingers in zones II, III, IV and V, to prevent adhesions and obtain proper range of motion, requires suture stitches with high mechanical resistance. Among the various qualifications for optimal repair, such as number of passages, thread qualities, suture volume, among others, ease of performance with minimal surgical trauma is fundamental. The six-passage “figure-of-eight” suture is easy to perform, it can be made with various types of surgical threads, has great mechanical resistance for active postoperative movement, and its efficiency has been proven in clinical and biomechanical studies. Although there are no studies on the preference of Brazilian surgeons for the suture technique used in the flexor tendons of the fingers, it is believed, by empirical observation, that the Kessler suture is one of the most widely used. The classic method to study the mechanical properties of intact or sutured tendons is to subject the specimen to strain deformation at constant speed. The experimental model to biomechanically test the immediate suture of flexor tendons using swine specimens, by mechanical test of longitudinal traction under constant traction speed, finds reference in the literature. The objective of the present study was to biomechanically evaluate, through longitudinal tensile tests at constant speed, the deformation by tension of the “figure-of-eight” and Kessler sutures in swine flexor tendons.

Materials and Methods

The upper limbs of 18 pigs were disarticulated at the elbow, packed in plastic bags and kept in a freezer at -20 degrees Celsius. On the day of the experiments, the anatomical parts were thawed at room temperature, and the deep flexor tendons of the fingers were dissected and isolated. The tendons of the right upper limbs were divided into two groups: group F8 (3 “figure-of-8” stitches) and group K (Kessler suture). The tendons of both groups were sectioned in the central region with a scalpel blade number 15 and submitted to sutures: the F8 group with 3 “figure-of-8” stitches with polypropylene monofilament yarn 3–0 (Prolene, Ethicon, São José dos Campos, SP, Brazil), and, in group K, Kessler suture with the same surgical thread; in both groups there were continuous peripheral sutures with polypropylene monofilament thread 4–0 (Prolene) (►Figure 1). After suturing, the tendons were fixed in aluminum sinusoidal metal claws, compressed by screws with a distance of 20 mm from the suture region in the central part. The claws were mounted axially in a universal mechanical testing machine with a 1,000-N load cell and application...
speed of 30 mm/min (EMIC DL 10000, Instron, São José dos Pinhais, PR, Brasil). After the test, the computer coupled to the equipment provided the mechanical properties of maximum load (N) and energy at maximum load (N.mm).

The present study has methodological limitations: no measurement of the necessary load to produce suture spacing that can, theoretically, impair healing; the use of continuous and longitudinal mechanical testing instead of cyclic and curvilinear tests; and, finally, the use of isolated swine tendons instead of human hand or finger tendons. However, within these limitations inherent to the methods used, one should keep in mind that the central basis of the present study was the comparison of the immediate mechanical properties of the “figure-of-eight” and Kessler sutures, both performed and tested under the same experimental conditions and, therefore, the results obtained have scientific validity.

## Conclusions

Under the conditions of this experiment and considering the use of flexor tendons of porcine fingers, the Al-Qattan and Al-Turaikí triple “figure-of-eight” suture (six passages) is more resistant than the Kessler suture (two passages). The “figure-of-eight” suture with six passages enables active movement in the immediate rehabilitation of flexor tendon repair in fingers, with little risk of rupture or spacing of the suture.

## Conflict of Interests

The authors have none to declare.

## References


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### Table 1

Means, standard deviations, maximum and minimum values and statistical analyses of the mechanical properties of maximum load (N) and energy at maximum load (N.mm) in the experimental groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Maximum load</th>
<th>Energy at maximum load</th>
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<tbody>
<tr>
<td>K (n = 8)</td>
<td>34.19 ± 11.4; maximum: 58.55; minimum: 18.29</td>
<td>100.9 ± 52.48; maximum: 206.5; minimum: 34.61</td>
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<tr>
<td>F8 (n = 10)</td>
<td>63.40 ± 20.40; maximum: 86.04; minimum: 23.17</td>
<td>217.3 ± 93.67; maximum: 365.7; minimum: 33.39</td>
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*p-value: 0.0024*, 0.0064*

Note: *p < 0.5.*