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Original Article

Analysis on the mechanical resistance of fixation of femoral neck fractures in synthetic bone, using the dynamic hip system and an anti-rotation screw☆,☆☆

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ABSTRACT

Objective: To statistically analyze the results obtained from biomechanical tests on fixation of femoral neck fractures of Pauwels III type, in synthetic bone, using the dynamic hip system with an anti-rotation screw, versus a control group.

Methods: Ten synthetic bones from a Brazilian manufacturer (model C1010) were used and divided into two groups: test and control. In the test group, fixation of an osteotomy was performed with 70° of inclination at the level of the femoral neck, using DHS with an anti-rotation screw. The resistance of this fixation was evaluated, along with its rotational deviation at 5 mm of displacement (phase 1) and at 10 mm of displacement (phase 2), which was considered to be failure of synthesis. In the control group, the models were tested in their entirety until femoral neck fracturing occurred.

Results: The test values in the test group (samples 1–5) in phase 1 were: 1512 N, 1439 N, 1205 N, 1251 N and 1273 N, respectively (mean = 1336 N; standard deviation [SD] = 132 N). The rotational deviations were: 4.90°, 3.27°, 2.62°, 0.66° and 0.66°, respectively (mean = 2.42°; SD = 1.81°). In phase 2, we obtained: 2064 N, 1895 N, 1682 N, 1713 N and 1354 N, respectively (mean = 1742 N; SD = 265 N). The failure loading values in the control group were: 1544 N, 1110 N, 1359 N, 1194 N and 1437 N, respectively (mean = 1329 N; SD = 177 N). The statistical analysis using the Mann–Whitney test showed that the test group presented maximum loading at a displacement of 10 mm, i.e. significantly greater than the failure loading of the control group ($p = 0.047$).

Conclusion: The mechanical resistance of the test group was significantly greater than that of the control group.

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Análise da resistência mecânica de fixação de fratura do colo femoral em osso sintético com DHS e parafuso antirrotatório

Palavras-chave:
Fraturas do colo femoral
Fixadores internos
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RESUMO

Objetivo: Analisar estatisticamente resultados obtidos em ensaios biomecânicos de fixação de fratura do colo femoral tipo Pauwels III, em osso sintético, com o uso do sistema dinâmico do quadril (DHS) com parafuso antirrotatório *vs* um grupo controle.

Métodos: Foram usados dez ossos sintéticos, de um fabricante nacional, do modelo C1010, divididos em dois grupos: teste e controle. No grupo teste foi feita fixação de osteotomia, com 70° de inclinação em nível de colo femoral, com o uso de DHS com parafuso antirrotatório. Avaliou-se a resistência dessa fixação e seu desvio rotacional em 5 mm de deslocamento (fase 1) e em 10 mm de deslocamento, considerado como falência da síntese (fase 2). No grupo controle, os modelos foram ensaiados em sua integridade até que ocorresse a fraturado colo femoral.

Resultados: Os valores do ensaio no grupo teste na fase 1, nas amostras de 1 a 5, foram:1.512 N, 1.439 N, 1.205 N, 1.251 N e 1.273 N, respectivamente (média = 1.336 N; desvio padrão [DP] = 132 N). Os desvios rotacionais foram: 4,90°; 3,27°; 2,62°; 0,66° e 0,66°, respectivamente (média = 2,42°; DP = 1,81°). Na fase 2, obtivemos: 2.064 N, 1.895 N, 1.682 N, 1.713 N e 1.354 N,respectivamente (média = 1.742 N; DP = 265 N). Os valores da carga de falência no grupo con-trole foram: 1.544 N, 1.110 N, 1.359 N, 1.194 N e 1.437 N, respectivamente (média = 1.329 N; DP = 177 N). A análise estatística pelo teste de Mann-Whitney demonstrou que o grupo testeapresentou carga máxima, em 10 mm de deslocamento, significativamente maior do que acarga de falência do grupo controle (p = 0,047).

Conclusão: A resistência mecânica do grupo teste foi significativamente superior à do grupo controle.

Introduction

Hip fractures account for around 20% of the surgical fractures seen at orthopedic trauma units and generate significant annual cost in any healthcare system. Femoral neck fractures account for approximately 50% of all fractures of the hip region. They mainly affect elderly people and are uncommon among individuals under the age of 60 years.[1]

The World Health Organization has predicted that the incidence of osteoporotic fractures of the proximal femur will triple by 2050.[2] In the population under the age of 65 years, the incidence of femoral neck fractures is 2–4 cases per 10,000 inhabitants. However, the incidence is much higher in the population over the age of 70 years: 28/10,000 among men and 64/10,000 among women.[3,4]

Among young adults, fractures in the hip region are generally uncommon. However, because of high-energy accidents involving sports practices and traffic accidents, this incidence has been increasing. The pattern of this type of fracture frequently has a vertical line with unstable characteristics, classified as Pauwels III. This classification correlates the prognosis with the angle of the fracture plane: as the angle increases, the instability of the fracture also increases and the complications relating to its fixation and consolidation worsen.[1]

The treatment for femoral neck fractures varies according to the patient's age and the fracture pattern.[5] In young patients, osteosynthesis should always be prioritized, while in older patients, arthroplasty should be cogitated. For middle-aged patients (40–65 years), the indication should be defined individually.[6]

For femoral neck fractures without displacement, rigid fixation with early mobility for the patients is the standard treatment. Multiple cannulated screws (MCS) or the Dynamic Hip System (DHS) is commonly used in the treatment.[5]

Failure of fixation and pseudarthrosis are the main forms of complication following fixation of femoral neck fractures, with or without displacement. Pseudarthrosis occurs more commonly and affects between 3.1% and 8.8% of the cases, with a mean of around 6%.[1]

In the light of the situation described above, we proposed to conduct a statistical analysis in order to evaluate the mechanical resistance of the fixation of femoral neck fractures classified as Pauwels III, in which the DHS and antirotational screws were used in synthetic bones, in comparison with a control group.

Material and methods

Ten synthetic bones for the proximal third of the femur were used. These were from a Brazilian manufacturer (model C1010) and were made of rigid polyurethane for the cortical layer and trabeculated material for the spongy layer. The samples were divided into two groups: control and test.