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ORIGINAL ARTICLE

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Correlation between the quality of calcaneal fracture reduction and time to return to work

Correlação entre a qualidade da redução da fratura de calcâneo com o tempo de retorno ao trabalho

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ABSTRACT

Objective: The aim of this study is to test the hypothesis that patients with calcaneal fractures who are surgically treated and have Böhler and Gissane angles restored to normal have a faster return to work than patients without restoration of these angles. Calcaneal fractures represent 1-2% of all fractures, and approximately 75% of these are articular, indicating surgical treatment. Joint involvement results in functional limitation and can lead to late complications such as chronic pain, subtalar arthrosis, difficulty walking, and deformities.

Methods: Lateral radiographs of the calcaneus of 44 patients who underwent surgical treatment for calcaneal fracture during the period from 2014 to 2016 were analysed to measure the Böhler and Gissane angles and to evaluate the association of their restoration to normal with the time to return to work.

Results: Among the patients, 70.2% presented restoration of the Böhler angle and 44.7% presented restoration of the Gissane angle with surgery. The mean time away from work was 8.38 months. A total of 76.6% of patients returned to the same function. Patients who had good fracture reduction had a shorter time to return to work, but this result was not statistically significant.

Conclusion: Surgical restoration of angles can positively influence the functional outcomes of patients, but this is not the only variable and thus should not be exclusively used to analyse the functional outcome and time to return to work of patients.

Level of Evidence IV; Therapeutic Studies; Cases Series.

Keywords: Calcaneus; Bone fractures; Orthopaedic surgery; Fracture fixation.

RESUMO

Objetivo: O trabalho visa testar a hipótese de que os pacientes com fraturas de calcâneo, tratadas cirurgicamente e que tiveram a restauração dos ângulos de Böhler e Gissani na faixa da normalidade obtiveram um retorno às atividades laborais mais rápido que os que não tiveram. As fraturas de calcâneo representam 1-2% de todas as fraturas e cerca de 75% delas são articulares, o que indica um tratamento cirúrgico. O acometimento articular implica em limitação funcional ao paciente e pode levar a complicações tardias como dor crônica, artrose subtalar, dificuldade na deambulação e deformidades.

Métodos: Foram analisadas radiografias de calcâneo em perfil de 44 pacientes que realizaram tratamento cirúrgico para fratura de calcâneo no período de 2014 a 2016, para mensuração dos ângulos de Böhler e Gissani e relacionar sua restauração para a faixa de normalidade com o tempo de retorno ao trabalho.

Resultados: 70,2% dos pacientes apresentaram restauração do ângulo de Böhler com a cirurgia e 44,7% do ângulo de Gissani. O tempo médio de afastamento do trabalho foi de 8,38 meses. 76,6% retornaram à mesma função. Pacientes que tiveram boa redução da fratura obtiveram menor tempo de retorno ao trabalho, porém esse resultado não foi estatisticamente significante.

Work performed at the Hospital Universitário Cajuru, Curitiba, PR, Brazil.

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Conclusão: A restauração cirúrgica dos ângulos pode influenciar positivamente nos resultados funcionais do paciente; porém não é a única variável e não deve ser utilizada isoladamente para analisar o resultado funcional e o retorno às atividades laborais dos pacientes.
Nível de Evidência IV; Estudos Terapêuticos; Série de Casos.

Descritores: Calcâneo; Fraturas ósseas; Cirurgia ortopédica; Fixação de fratura.

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INTRODUCTION

Calcaneal fractures account for 1-2% of all fractures, and approximately 75% are articular[1-2]. These involve the subtalar joint and cause damage to the joint cartilage, which affects the return to normal activities of patients[3]. The treatment of displaced intra-articular calcaneus fractures is usually surgical. Surgical treatment has gained relevance in the last 20 years, and its aim is to anatomically reduce the joint surfaces, thus allowing the patient to return to their activities prior to trauma[1,3]. Surgical reduction of the subtalar joint allows greater correction of deformities and a shorter time to return to work[4-5].

The aim of this study is to evaluate calcaneal fractures surgically treated in the period from 2014 to 2016 and their correlation with the time away from work. It is expected that surgically treated fractures in which the angles are restored to normal result in a shorter period of time away from work, with a consequent social repercussion in the productive sector.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 83139317.8.0000.0020.

This is a cross-sectional retrospective study. Data were collected from calcaneal fracture patients who were admitted to the Orthopaedics and Traumatology Unit from 01/01/2014 to 01/01/2016 and underwent surgical treatment of the fracture, including open, minimally invasive, or percutaneous treatment.

The following inclusion criteria were used: (1) acute calcaneal fracture - fewer than seven days between the trauma and the first evaluation at the emergency department - classified as articular by conventional radiography and computerised axial tomography; (2) skeletally mature patient; and (3) absence of previous ligamentous or degenerative injuries. The exclusion criteria were patients with (1) an open physis; (2) previous surgery; (3) previous ligament injury; (4) degenerative diseases; or (5) unsuccessful contact after three attempts over the telephone on different days.

After collecting all the data, the patients were recruited for a survey regarding their time away from work. In addition, all control radiographs that were taken in a lateral view of the calcaneus at six months after surgery were analysed. The Böhler and Gissane angle measurements were evaluated to examine the anatomy of the subtalar joint. The group of patients with a Böhler angle between 20-40º and a Gissane angle between 120-145º was considered to have good reduction quality. Angles outside this range were classified as poor reduction quality. Then, data were crossed checked, and statistical analyses were performed to test the study hypothesis, which is that fractures with better reduction quality are associated with a shorter time away from work.

The Williams G test, Mann-Whitney U test, and t-test of significance of the Pearson correlation coefficient were used to establish correlations with gender, need for time away from work, time to return to work, work function on return, and range considered normal for the studied angles. Furthermore, the main objective was to correlate the angle measurements with the time to return/time away from work. The Williams G test is an alternative to the chi-square test when the data do not meet the assumption that for samples larger than 20 elements, up to 20% of the cell data may have expected frequencies below five, and there should be no cell with an expected frequency of less than one. The test is based on the relationship between the observed and expected values. The Mann-Whitney U test was applied for independent samples to assess the heterogeneity of the samples. The t-test for significance of the Pearson correlation coefficient was used to measure the association between the variables in the presence of two or more quantitative variables.

RESULTS

A total of 97 charts from patients who met the inclusion criteria and had surgically treated calcaneal fractures

were analysed; these patients were examined during the period from 01/01/2014 to 01/01/2016. Three telephone contact attempts with the patients were made on consecutive days, with 44 patients answering the telephone call, resulting in inclusion of 47 fractures in the study sample.

The sample consisted of 41 men (87.2%) and 6 women aged between 23 and 77 years. Of these, three presented bilateral fractures. Forty-one (87.2%) took time away from work after surgery, and 36 (76.6%) returned to the same function they exercised prior to the fracture. Only one (2.1%) patient returned to work in another function that required less physical effort, and the remaining patients retired because of difficulty remaining active in the workplace.

Regarding the angles measured in the radiographs taken six months after surgery, 14 patients had a Böhler angle of less than 20°, and 26 patients had a Gissane angle of less than 110° (Table 1).

Thus, the mean age was 47 years (minimum of 23 and maximum of 77 years, with a standard deviation of 12.4); the mean time away from work was 8.38 months (minimum of zero and maximum of 36 months, with a standard deviation of 7.83); the mean Böhler angle was 22.66° (minimum of -1° and maximum of 40°, with a standard deviation of 17.01); and the mean Gissane angle was 114.6° (minimum of 90° and maximum of 140°, with a standard deviation of 12.79), as shown in table 2.

Table 1. Patient profile - qualitative variables

Variable	Overall Frequency	Frequency without missing data*
Gender		
Female	6 (12.8%)	6 (12.8%)
Male	41 (87.2%)	41 (87.2%)
Required time away from work		
No	5 (10.6%)	5 (10.9%)
Yes	41 (87.2%)	41 (89.1%)
Missing	1 (2.1%)	
Return to work		
No	6 (12.8%)	6 (14.3%)
Yes	36 (76.6%)	36 (85.7%)
Missing	5 (10.6%)	
Return to the same work function		
No	1 (2.1%)	1 (2.8%)
Yes	35 (74.5%)	34 (97.2%)
Missing	11 (23.4%)	
Böhler angle considered normal (20-40°)		
Not	14 (29.8%)	14 (29.8%)
Yes	33 (70.2%)	33 (70.2%)
Gissane angle considered normal (120-145°)		
No	26 (55.3%)	26 (55.3%)
Yes	21 (44.7%)	21 (44.7%)

* The missing data consist of cases with no response or a "not applicable" response to the categories.
Source: Prepared by the author based on the results of the research.

Table 2. Patient profile - quantitative variables

Variable	Frequency	Minimum	Maximum	Mean	Standard deviation
Age	47	23	77	46.49	12.40
Required time away from work	45	0	36	8.38	7.83
Böhler angle value	47	-1	40	22.66	17.01
Gissane angle value	47	90	140	114.60	12.79

Source: Prepared by the author based on the results of the research.

Table 3. Comparison of variables between genders

Qualitative variable	Gender		p-value	Conclusion
	Female	Male		
Required time away from work				
No	2	3	0.1017[G]	No difference
Yes	4	37		
Returned to work				
No	3	3	0.0192[G]	No difference
Yes	3	33		
Returned to the same work function				
No	0	1	–	–
Yes	3	32		
Normal Böhler angle				
No	1	13	0.4298[G]	No difference
Yes	5	28		
Normal Gissane angle				
No	3	23	0.7795[G]	No difference
Yes	3	18		
Böhler angle greater than 20°				
No	2	10	0.7245[G]	No difference
Yes	4	28		
Gissane angle greater than 120°				
No	3	21	0.8102[G]	No difference
Yes	3	17		

"–" indicates that the test could not be performed due to the lack of responses in that category.
[G]: Williams G test.
Source: Prepared by the author based on the results of the research.

Analysis of the variables between genders using the Williams G test (Table 3), including the need for time away from work, return to the previous work function, and postoperative fracture reduction according to the Böhler and Gissane angles, revealed a significant difference only for the variable return to work. This finding indicates that male gender is a factor in return to previous work, since 50% of the women were not able to return to work.

Thus, requiring time away from work, the time away from work and achieving good surgical fracture reduction by obtaining angles within the normal range in the late postoperative period did not differ significantly between the genders.

The t-test of significance of the Pearson correlation coefficient between the time away from work and the angle measurements and age indicated significance only for the variable age ($p<0.05$). Thus, older patients had a longer time away from work. Patients who obtained angles within the normal range were away from work for a shorter time, but this relationship was not significant (Table 4).

No significant difference was observed for the time to return to work between the groups with angle measurements within and below the normal range (Tables 5 and 6).

Table 4. Time to return to work according to angle value and age

Quantitative variable	Correlation	p-value	Conclusion
Böhler angle	-0.201	0.186[T]	Not significant
Gissane angle	-0.030	0.985[T]	Not significant
Age	0.373	0.012[T]	Significant but weak

[T]: t-test of significance of the Pearson correlation coefficient.
Source: Prepared by the author based on the results of the research.

Table 5. Time to return according to angle values

Quantitative variable	p-value	Conclusion
Böhler angle	0.636[U]	There was no difference
Gissane angle	0.314[U]	There was no difference

[U]: Mann-Whitney U test.
Source: Prepared by the author based on the results of the research.

Table 6. Time to return to work according to angle measurement above the reference range

Quantitative variable	p-value	Conclusion
Böhler measurement greater than 20°	0,535[U]	There was no difference
Gissane measurement greater than 120°	0,512[U]	There was no difference

[U]: Mann-Whitney U test.
Source: Prepared by the author based on the results of the research.

DISCUSSION

This study analysed patients treated surgically, because the aim of this approach is the anatomical restoration of the fractured calcaneus, and the Böhler and Gissane angles were measured to determine their association with time to return to work. Patients who were offered conservative treatment with cast immobilisation were not the focus of the study, as the fracture cannot be manipulated to restore the bone anatomy. In addition, an indication for non-surgical treatment is fracture without displacement, which may influence the final results because the anatomy is preserved.

The angles did not affect the quality of life of the patients because the time away from and time to return to work were independent of the Böhler and Gissane angle values. In addition, no significant difference was found for the time away from work between patients with and without a Böhler angle greater than 20° or a Gissane angle greater than 120°. Moreover, only a weak correlation was found between the time away from work and Böhler and Gissane angle measurements.

Jiang et al.[3] found that surgical treatment was associated with better outcomes than conservative treatment due to restoration of the Böhler angle, as well as the height and width of the calcaneus. A greater rate of patients returned to their pre-injury work function, as they presented better radiographic and symptomatological results including range of motion, residual pain, and problems wearing shoes because after the fracture, there is a tendency for the calcaneus to widen and consolidate into a varus deformity if conservative treatment is performed[6].

In a sample of 94 patients with surgically treated calcaneal fractures, Backes et al.[7] found that an average of 4 months was required until return to work - 6.5 months for patients who performed heavy physical work and 3.5 months for mild activities; 17% of patients were not able to return to their previous work activities; and 31% needed adaptations to their work function. The relationship with restoration of angles was not analysed. Similar results were obtained in the present study, in which 23.4% of the patients did not return to work, despite the smaller sample size. Surgical treatment has the disadvantage of postoperative complications, such as infection, suture dehiscence, skin necrosis, and thromboembolic phenomena, which have the potential to require new surgical interventions, prolonging hospitalisation and increasing treatment cost[4].

Regarding the Böhler angle, Paula et al.[8] conducted a study in the same hospital with 71 patients treated between 2000 and 2003 and found that the mean Böhler angle of

the patients was 22.08°. Patients with Böhler angle less than 20° had worse outcomes, and 20% did not return to work, which was associated with late complications such as chronic osteomyelitis, subtalar arthrosis, oedema, chronic pain, changes in gait, non-alignment of the foot, and restricted range of motion. In the present study, performed more than 10 years later, the results were similar, with a mean Böhler angle of 22.66°, and 23.4% of patients did not return to their previous activities. In contrast, Biz et al.[2] compared the functional outcomes of patients, including return to work, ability to walk, joint stiffness, shoe use, and they did not find a significant difference between those with and without restoration of the Böhler angle.

Bruce et al.,[9] Brauer et al.[10], and Murachovsky et al.[11] found associations between surgical treatment and a lower rate of progression to subtalar arthrosis and a shorter time to return to activities at 15-27 weeks, 7.5 months, and 7.9 months, respectively. The latter study also analysed the angle measurements and found a mean Böhler angle of 22.8° (-10° to 42°) and mean Gissane angle of 106.4° (80° to 130°), but no significant difference was observed in the functional outcomes of patients with and without angles restored to values considered normal[11]. Our study found a mean of 22.6° (-1° to 40°) for the Böhler angle and 114.6° (90° to 140°) for the Gissane angle, and a weak and non-significant correlation was found between angles in the normal range and a shorter time to return to work.

Sanders et al.[12] followed a group of patients for 10 to 20 years and found that most returned to their previous work with minimal changes, but all had a limited range of motion in the subtalar joint, and approximately 50% of those who needed changes in the work environment developed subtalar arthrodesis. Because our study did not have a similar follow-up time, we could not assess the development of a new condition such as arthrosis and how it affected patients at work.

Regardless of the time at which the studies were conducted, which ranged from 1996 to 2018, concerns regarding calcaneal fractures treated surgically remain. These studies show that displaced calcaneal fractures are treated surgically, despite the possibility of increased complications compared to conservative treatment. However, the functional outcomes of both treatments are considered similar, or surgical treatment is considered slightly better[3-5,9].

When studies conducted more than 20 years apart are compared, the results are similar[2,13]. Calcaneal fractures are still difficult to manage, and little progress has occurred in this sense despite new surgical approaches, such as minimally invasive surgery. Even with functional outcomes considered to be good, patients still present chronic pain or restriction in the range of motion, in addition to enlargement and varus of the calcaneus after fracture consolidation. Wu et al.[14] developed a new minimally invasive surgical technique featuring an anatomical plate, but their functional outcomes were also not statistically significant.

Leite et al.[15], in a retrospective study of 52 patients with calcaneal fractures, found that the majority (84.6%) of patients were young men, and approximately one year was required for full functional recovery. A similar percentage was observed in the present study, in which 87.2% of the patients were men, and the recovery time until return to work was 8.38 months. It is important to note that the affected population is economically active, and this implies the need for correct treatment to avoid complications that lead to debilitating sequelae.

The present study has limitations including a small sample size and a small number of female patients in the group, and this low representation may have masked the actual results. Moreover, functional variables aside from the time to return to work and the value of the reference angles on the radiographs after 6 months of follow-up were not evaluated, including the surgical technique used, functional scores, and postoperative complications. However, the results obtained were similar to those of previous studies.

CONCLUSION

Calcaneus fractures treated surgically and in which the Böhler and Gissane angles were restored to the normal range presented a slightly shorter time to return to work than those in patients who did not obtain the desired reduction, but this difference was not statistically significant. These results corroborate those of similar studies.

Additional studies are needed to determine the role of the surgical technique used to achieve optimal angle restoration and the quality of the postoperative period with regard to patient compliance with medical guidelines. Functional scores, complications, the need for new procedures due to skin infection/necrosis or ankle arthrodesis, and patient satisfaction should also be evaluated; angle restoration is not the only variable that affects return to work.

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