

Mid-term follow-up after surgical treatment of fifth metatarsal base fractures in professional soccer players

Seguimento de médio prazo após tratamento cirúrgico de fraturas da base do quinto metatarso em jogadores profissionais de futebol

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ABSTRACT

Objective: Fifth metatarsal fractures occur mainly in young athletes, with an estimated incidence of 1.8 per 1,000 people a year. The objective of this study was to evaluate the functional outcome of professional soccer players subjected to surgical treatment of fifth metatarsal base fractures.

Methods: A total of 34 soccer players who underwent surgery from July 2001 to June 2016 were evaluated. All participants were evaluated by the American Orthopedic Foot and Ankle Score (AOFAS) and visual analogue scale (VAS) score before and after surgery, with a mean follow-up of 23 months. The need for grafting relative to time to surgery, time to fracture consolidation and Torg classification and graft use relative to return to sport were evaluated.

Results: There were 10 forwards, 7 offensive midfielders, 6 fullbacks, 5 center midfielders, 3 defenders, 2 goalkeepers and 1 defensive midfielder, with a mean age of 19 years. The mean pre- and postoperative AOFAS was 42 and 99 points whereas the mean VAS score was 6 and 0, respectively. The longer the time to surgery, the greater was the need for grafting ($p=0.011$). The time to return to sport was not influenced by the time to surgery, time to consolidation, Torg classification or graft use.

Conclusion: The surgical treatment of fifth metatarsal base fractures in professional soccer players showed good clinical results. The return to activities after surgery is not influenced by the time to surgery, time to consolidation, Torg classification or grafting.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Metatarsus; Athletes; Fracture fixation, internal.

RESUMO

Objetivo: As fraturas do quinto metatarso ocorrem principalmente em atletas jovens, com uma incidência estimada de 1.8 para cada 1000 pessoas ao ano. O objetivo desse trabalho é avaliar o resultado funcional de jogadores de futebol profissionais submetidos ao tratamento cirúrgico de fraturas da base do quinto metatarso.

Métodos: Foram avaliados 34 jogadores de futebol operados de julho de 2001 a junho de 2016. Todos foram avaliados pelo *American Orthopaedic Foot and Ankle Score* (AOFAS) e Escala Visual Analógica (EVA), antes e depois da cirurgia, com seguimento médio de 23 meses. Foi avaliada a necessidade de enxerto em relação ao tempo para cirurgia, consolidação da fratura, classificação de Torg e enxertia em relação ao retorno ao esporte.

Resultados: Foram 10 atacantes, 7 volantes ofensivos, 6 laterais, 5 volantes centrais, 3 zagueiros, 2 goleiros e 1 volante defensivo, com média de idade de 19 anos. O AOFAS pré e pós-operatório apresentou média de 42 e 99 pontos, respectivamente, enquanto a EVA foi 6 e 0. Quanto maior o

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tempo para operar, maior a necessidade de enxerto ($p=0,011$). O retorno às atividades não foi influenciado pelo tempo para operar, consolidação, Torg e enxertia.

Conclusão: O tratamento cirúrgico da fratura da base do 5º metatarso em jogadores profissionais de futebol apresentou bons resultados clínicos. O retorno às atividades após a cirurgia não é influenciado pelo tempo para operar, tempo de consolidação, classificação de Torg e enxerto.

Nível de Evidência IV; Estudos Terapêuticos; Série de Casos.

Descritores: Metatarso; Atletas; Fixação interna de fraturas.

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INTRODUCTION

Fifth metatarsal fractures are among the most common forefoot injuries, especially in young athletes, including elite athletes, with an estimated incidence of 1.8 for every 1,000 people per year^(1,2). Considering the general population and athletes, fractures of the proximal region correspond to 70% of fifth metatarsal fractures, especially in individuals with hindfoot varus⁽³⁾, and are fractures associated with controversy, considering the different anatomical terms and eponyms used⁽¹⁾.

The proximal fifth metatarsal has strong ligament-capsular connections with the fourth metatarsal and cuboid, which extend to its metaphyseal-diaphyseal junction⁽⁴⁾. The proximal region is therefore vulnerable to the forces acting on the most distal portion of the fifth metatarsal, which is mobile, causing the fulcrum and, consequently, the injuries to be concentrated in this transition⁽¹⁾.

Some anatomical and biomechanical features may predispose athletes to this type of injury, especially those involved in running and sudden changes in direction^(1,5), as occur with soccer players⁽⁶⁻⁸⁾.

There is still controversy regarding the type of treatment proposed for these injuries when comparing more sedentary populations to athletes. In the latter, an approach that reduces the time spent away from the sport and that allows a more predictable consolidation has been sought. Thus, based on high rates of pseudarthrosis, refractures and delayed return to activities with conservative treatment, primary surgical treatment is increasingly accepted, especially in elite athletes with fractures in Dameron zones II and III⁽¹⁾.

Among the possible types of surgical treatment, intramedullary screw fixation is the most accepted option currently for zone II and III fractures in athletes^(9,10), a procedure that may or may not be associated with the use of autologous bone grafts, considering the more fragile vascularization of

these fractures and the time elapsed from injury to treatment. The use of plantar plating for the treatment of these injuries has been recently investigated^(11,12).

The objective of this study is to evaluate the functional outcome of professional soccer players subjected to surgical treatment of fifth metatarsal base fractures in Dameron zones II and III with intramedullary screw fixation, with or without a bone graft.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 01996818.6.0000.5125.

This is a retrospective study that included 34 male professional soccer players who underwent fixation of fifth metatarsal base fractures at Dameron zones II and III. The mean age was 19 years (ranging between 14 and 31 years), and the surgeries were performed between July 9, 2001, and June 2, 2016, with a mean follow-up of 23 months.

All patients underwent fracture fixation with 4.5-mm cannulated screws by the same surgeon. Spongy autologous bone grafts were used for fractures classified as Torg III, and the grafts were removed from the proximal region of the ipsilateral tibia. The graft was positioned via a 1-cm incision over the fracture focus after perforation of the canal and before insertion of the screw. Only one fracture classified as Torg II was subjected to graft placement after an intraoperative decision by the surgeon.

The postoperative protocol consisted of the use of a plaster splint for two weeks without weight-bearing, after which the stitches and splint were removed and replaced with a long immobilizer boot. Partial weight-bearing was allowed with the aid of crutches, followed by full weight-bearing at four weeks. When the patient had little or no sensitivity to palpation of the fracture site and presented

signs of consolidation on radiographs, full weight-bearing was allowed for the purpose of walking and, gradually, running rehabilitation, usually starting at the sixth week after surgery. Return to sport occurred on average 10 weeks after surgery.

All patients underwent functional assessment by the American Orthopedic Foot and Ankle Score (AOFAS) and pain assessment with a visual analog scale (VAS). Demographic data were collected, and the need for grafting was evaluated relative to time to surgery, time to fracture consolidation, and Torg classification and graft use relative to return to sport.

Statistical analysis was performed with GRETL software (2018c). Student's t-test was used to compare preoperative and postoperative data. We adopted an alpha error value of 0.05 and consequent rejection of the null hypothesis.

RESULTS

The 34 subjects evaluated included 10 forwards, 7 offensive midfielders, 6 fullbacks, 5 center midfielders, 3 defenders, 2 goalkeepers and 1 defensive midfielder, and the left side was the most affected (56% of cases). Surgeries were performed on average 34 days after fracture, ranging from 4 to 400 days. Consolidation was evidenced on average 97 days after surgery, with a minimum of 80 and a maximum of 130 days, whereas the return to the sport occurred on average 73 days after surgery. Most fractures were classified as Torg II (59%), followed by Torg III (23%) and Torg I (18%). Surgical treatment was performed with screw fixation only in 74% of the cases and with screw fixation combined with bone grafting in 26% of cases.

Table I shows the comparative analysis of functional outcomes. The mean AOFAS score was 42 points before surgery and 99 points at the last follow-up ($p < 0.001$). The mean VAS score was 6 in the preoperative period and 0 in the postoperative period ($p < 0.001$).

Three of the 34 players had complications: granuloma in the sixth postoperative month, a refracture that consolidated after 45 days of rest, and a break in the guidewire during the procedure. Consolidation occurred in all cases.

A direct relationship ($p = 0.011$) was found between the time to surgery and the need for grafting (Figure 1). Furthermore, each day waiting for surgery increased the chance of graft use by 1.015 times.

The time to return to sport was not influenced by the time to surgery ($p = 0.172$), time to fracture consolidation

($p = 0.734$), Torg classification ($p = 0.683$), graft use ($p = 0.979$) or player position ($p = 0.614$).

DISCUSSION

According to Bishop et al.⁽¹³⁾, surgical treatment of fifth metatarsal base fractures is preferable when faster rehabilitation and more reliable fracture consolidation are desired. This result was confirmed by Mologne et al.⁽¹⁴⁾ in a randomized clinical trial that compared patients with acute zone II and III fractures treated with immobilization versus intramedullary screw fixation. They found a failure rate of 44% with conservative treatment and 5.2% with surgical treatment. Moreover, the mean time to consolidation and return to sports for the surgical group was significantly ($p < 0.01$) shorter (7.5 and 8 weeks, respectively) than those for the conservative treatment group (14.5 and 15 weeks, respectively). According to a systematic review of

Table 1. Results of the functional assessment according to the AOFAS and VAS score

	AOFAS	VAS
Presurgery	42	6
Postsurgery	99	0
p-value	$p < 0.0001$	$p < 0.0001$

AOFAS: American Orthopedic Foot and Ankle Score; VAS: visual analogue scale.
 Source: Prepared by the author based on the results of the research.

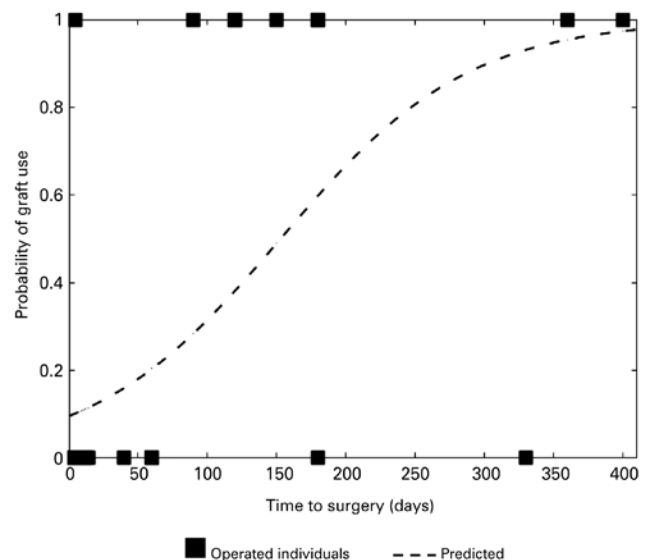


Figure 1. Probability of graft use relative to time to surgery.
Legend: Graph showing a greater probability of graft use with delayed surgery.
Source: Prepared by the author based on the results of the research.

outcomes of surgical treatment of zone II and III fractures with intramedullary screw fixation⁽⁹⁾, clinical consolidation time ranged from 3-11 weeks, radiographic consolidation time ranged from 4-24 weeks, and time to return to sport ranged from 4-18 weeks. In our study, we observed a mean radiographic consolidation time of 13.8 weeks and a mean time to return to sport of 10.4 weeks, results that are within the standard times observed in the literature, with consolidation occurring in all cases. Considering the high demand for a quicker return to sport, athletes, especially elite athletes, would benefit most from surgical treatment of these fractures.

Soccer players constitute a more specific risk group for these injuries due to some peculiarities. In a study by Ekstrand et al.⁽¹⁵⁾, 15 elite European soccer teams were monitored from 2001 to 2012, and fifth metatarsal base fracture was present in 0.5% of the injuries observed. Although rare, these injuries can be severe and develop complications that compromise athlete performance. Each team presented a risk of one fifth metatarsal base fracture every five seasons. The nondominant side was the most affected, and there was a higher risk of injury in the first 3 months of training; 76% of the cases were treated surgically; 25% of the patients experienced refractures. Of the 24% of patients treated conservatively, only 33% presented consolidation, and 55.5% experienced refractures. In our study, we found a considerably lower refracture rate (2.9%).

According to the Torg classification⁽¹⁶⁾, the chronicity of fractures can be defined based on radiological findings. In a study by Ekstrand et al.⁽¹⁵⁾, 46% of cases were classified as Torg I and 54% as Torg II, and no Torg III fracture was identified. In our study, most fractures were classified as Torg II (59%), followed by Torg III (23%) and Torg I (18%). Furthermore, as evidenced in our study, the Torg classification did not influence the time to return to sport.

Regarding the type of implant, intramedullary screws are undoubtedly the most accepted. DeLee et al.⁽¹⁷⁾ (1983) were the first to describe the use of intramedullary screws for the treatment of fifth metatarsal fractures. There is debate regarding the ideal screw for fixation. Solid screws are considered to be more resistant to breakage. Regarding diameter, it is argued that larger diameter screws can better fill the channel and therefore offer greater stability to the system, with better functional results. However, according to a study by Porter et al.⁽¹⁸⁾, which compared the results of patients treated with 4.5-mm and 5.5-mm cannulated screws, there was no significant functional or radiographic difference regarding the two types of implants. In our study, all cases were treated using 4.5-mm partially

threaded cannulated screws. Although these devices are the most commonly used and present results superior to conservative treatment, fixation with intramedullary screws is associated with complications such as pseudarthrosis and refractures in 4 to 30% of cases⁽¹⁹⁻²²⁾, which was not observed in our study; in our study, all of the fractures were consolidated, and there was only one case of refracture and no cases of pseudarthrosis.

In addition to screw fixation, these fractures can be treated in other ways. The more recent development of lateral plantar plating has gained prominence. According to a cadaveric study by Duplantier et al.⁽¹²⁾, this fixation method, compared to intramedullary screw fixation, showed a higher number of cycles before failure, higher peak loads before failure and less fracture gapping immediately before implant failure. Bernstein et al.⁽¹¹⁾ also showed promising results in the treatment of 8 elite athletes with primary fractures or refractures at the fifth metatarsal base. There were no cases of wound complications, delayed consolidation, pseudarthrosis, refracture, implant failure or complaints of hardware prominence, with clinical consolidation occurring on average 6.5 weeks after surgery and with a return to sport at the same performance level as before the injury.

The use of a graft in the osteosynthesis of zone II and III fractures of the fifth metatarsal remains controversial. Since the study by Dameron et al.⁽²³⁾, grafting has become more popular, especially for subacute or chronic fractures. In our study, surgical treatment was performed with screw fixation in 74% of the cases and with screw fixation combined with bone grafting in 26% of cases. Grafting was used for all of the Torg III fractures and for only one Torg II fracture. In the latter case, the decision was based on maintaining a gap greater than 2mm in the fracture focus associated with major sclerosis, which motivated the use of the bone graft. This case was kept in the sample so that there was no patient selection bias and so that all patients operated on during the period were included. In addition to the use of grafts from the proximal region of the tibia or iliac crest, the use of bone marrow aspirate has become more frequent, as demonstrated in some studies^(24,25), combined or not with demineralized bone matrix. In a study by Hunt and Anderson⁽²⁰⁾, 21 elite athletes with pseudarthrosis or refractures were treated with revision of the surgical procedure using larger diameter screws combined with spongy bone graft or bone marrow aspirate plus demineralized bone matrix. All athletes returned to their preinjury competition level, on average 12.3 weeks after surgery, and there was no significant difference between the graft types used with regard to radiographic consolidation or return to sport.

Our study showed a direct relationship ($p=0.011$) between the time to surgery and the need for graft use, as shown in Figure 1, which corroborates the main recommendations for the use of grafts in cases of chronic fracture. Furthermore, each day waiting for surgery increases the chance of graft use 1.015-fold.

Regarding the rehabilitation protocol, an efficient approach for athletes should be employed but without jeopardizing the ongoing fracture consolidation process. An aggressive protocol that can increase the chances of fixation failure is observed in some rehabilitation centers. A clear illustration of this scenario is provided by Larson et al.⁽²⁶⁾. Of the 15 patients treated surgically, six experienced treatment failure, with four refractures and two symptomatic pseudarthrosis. The mean time to return to activities was 6.8 weeks in the group with failure and 9 weeks in those without complications. In addition, 83% of the patients in the group with failures were elite athletes, compared to only 11% in the group without failures. This confirms the high risk of an early return to activity, as occurs in high-performance athletes. In our study, we considered a gradual return to activities when the patient was asymptomatic and showed signs of clinical and radiographic consolidation. Patients were allowed to return to sport on average 10 weeks after surgery, a time considered safe and with a lower risk of failure.

It is important to note that some patients underwent functional assessment using the AOFAS before its valida-

tion in Portuguese in 2008⁽²⁷⁾; however, this factor does not compromise the interpretation of the presented results.

Numerous complications may be present in the surgical treatment of fifth metatarsal base fractures. According to a literature review by Roche and Calder⁽⁹⁾, a superficial wound infection rate of 1.7%, sural nerve injury of 0.8% and intraoperative fractures of 1.4% were observed. None of the cases of infection caused considerable problems for the patients. One of the cases of sural nerve injury progressed to a painful neuroma, which forced the athlete to retire. In some cases, the screws became prominent and were subsequently removed. In our study, granuloma formation occurred in the sixth month, without significant consequences for the patient. One of the cases showed refracture, which consolidated after 45 days of rest, and during one procedure, the guidewire broke, which did not compromise the performance of the surgical procedure.

CONCLUSION

The surgical treatment of fifth metatarsal base fractures in professional soccer players has good clinical results. Care should be taken to perform efficient rehabilitation without putting fracture consolidation and patient recovery at risk, thus preventing failures such as refractures and pseudarthrosis. The time to return to sport after surgery was not influenced by the time to surgery, time to consolidation, Torg classification or graft use.

Authors' contributions: Each author contributed individually and significantly to the development of this article: LPVL *(<https://orcid.org/0000-0002-0315-6938>) interpreted the results of the study, wrote the article, participated in the review process; TSB *(<https://orcid.org/0000-0001-9244-5194>) interpreted the results of the study, participated in the review process, approved the final version; BDM *(<https://orcid.org/0000-0003-2178-5671>) participated in the review process, approved the final version; CASN *(<https://orcid.org/0000-0002-9286-1750>) participated in the review process, approved the final version; JPB *(<https://orcid.org/0000-0003-1172-8630>) conceived and planned the activities that led to the study, approved the final version; DSB *(<https://orcid.org/0000-0001-5404-2132>) conceived and planned the activities that led to the study, participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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