Surgical treatment of ankle fractures and removal of plates/screws: descriptive study on health care financing in Belo Horizonte, Minas Gerais, Brazil, 2014-2019

Tratamento cirúrgico de fratura do tornozelo e retirada de placas/parafuso: estudo descritivo sobre o financiamento em Belo Horizonte, Minas Gerais, Brasil, 2014–2019

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ABSTRACT
Objective: to describe hospitalizations and hospital costs for surgical treatment of uninomalleolar ankle fractures, by surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture and by removing the plate and/or screws, in the period from 2014 to 2019, in the city of Belo Horizonte, Minas Gerais. Methods: Retrospective descriptive study carried out between 2014 and 2019 with epidemiological data obtained
in the database of the Department of Informatics of the Unified Health System, from the registration of the Hospitalization Authorization and the values, total and for hospital services, spent with the treatment. surgical fracture of the unimalleolar ankle; surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture; and the plate and/or screw removal procedure. Results: Between 2014 and 2019, 13,721 surgical procedures were recorded in the ankle region, with R$ 7,889,737.75 being spent on invasive interventions. Conclusion: from the results of this research, it is suggested the need to reinforce public policies aimed at the implementation of concrete actions to seek better efficiency in the process of selecting materials, reviewing clinical and surgical protocols.

**Keywords:** Ankle Fractures, Internal Fracture Fixation, Ankle Injuries, Health Care Financing, Orthopedics.

**RESUMO**
Objetivo: descrever as internações e os custos hospitalares por tratamento cirúrgico de fratura do tornozelo unimaleolar; por tratamento cirúrgico de fratura do tornozelo bimaleolar, trimaleolar, da fratura luxação do tornozelo; e por retirada de placa e/ou parafusos, no período de 2014 a 2019, no município de Belo Horizonte, Minas Gerais. Métodos: Estudo retrospectivo descritivo realizado entre 2014 a 2019 com dados epidemiológicos obtidos no banco de dados do Departamento de Informática do Sistema Único de Saúde, oriundos do cadastro da Autorização de Internação Hospitalar e dos valores, total e por serviços hospitalares, despendidos com o tratamento cirúrgico de fratura do tornozelo unimaleolar; o tratamento cirúrgico de fratura do tornozelo bimaleolar, trimaleolar, da fratura de luxação do tornozelo; e o procedimento de retirada de placa e/ou parafusos. Resultados: Entre 2014 a 2019 foram registrados 13.721 procedimentos cirúrgicos em região de tornozelo, sendo gastos R$ 7.889.737,75 com as intervenções invasivas. Conclusão: sugere-se a partir dos resultados desta pesquisa a necessidade de reforçar políticas públicas voltadas para a implementação de ações concretas, para a busca de melhor eficácia no processo de seleção de materiais, revisão de protocolos clínicos e cirúrgicos.

**Palavra-Chave:** Fraturas do Tornozelo, Fixação Interna de Fraturas, Traumatismos do Tornozelo, Financiamento da Assistência à Saúde, Ortopedia.

**1 INTRODUCTION**
Ankle fracture is one of the most common fractures in orthopedic traumatology, reaching an incidence of 174 fractures per 100,000 adults - year\(^1,2\). It is estimated that the number of cases will be even greater with the aging of the population, which makes the treatment of this condition very important, both from an orthopedic and an economic point of view\(^1,3,4\).

In the national scenario, we observe that automobile accidents, especially those related to motorcycles, are the ones that lead to more potential damage in the ankle region since the high energy involved in this type of trauma provides increasingly complex
fracture patterns\textsuperscript{5,6}.

When observing worldwide, trauma reaches similar incidence as a pandemic with 5.8 million deaths a year, considered one of the five most important causes of morbidity in individuals under 60 years old\textsuperscript{7} and the eighth cause according to PAHO/WHO (2018)\textsuperscript{8}.

In the United States of America, trauma has become one of the main causes of disability and death, especially in children and young adults, under the age of 45, in which trauma is responsible for 79,000 annual deaths. This total is above deaths from non-communicable diseases (49,000) and infectious diseases (15,000)\textsuperscript{9}.

Due to the greater accuracy of the imaging exams currently available, there is a higher frequency of lesions that affect tibiofibular syndesmosis\textsuperscript{10}. In this sense, the treatment of this lesion can currently be carried out by various means, such as endobuttom and graft reconstruction\textsuperscript{10,11}. However, the use of inter-tibiofibular screws is currently the most popular technique among orthopedic surgeons, whether due to the wide availability of material or the lesser technical requirement\textsuperscript{10–12}.

Although common, the use of inter-tibiofibular screws has an important drawback, which is the need for a second surgical act for its removal since the device is a rigid intra-articular fixation in the interosseous membrane, increasing the expenses with the financing of the health care in the orthopedic procedures and, therefore, the risk for the patient\textsuperscript{13}.

In this sense, it is important to evaluate the economic impact that the procedure of removing the inter-tibiofibular screw, so we can compare more clearly the use of this method with others that do not require a second surgery, establishing a better cost strategy for the health systems and allowing the design of other strategies that are less costly and more effective for patients, such as the use of materials that do not require their removal.

This study aims to describe hospitalizations and hospital costs for surgical treatment of unimalleolar ankle fractures, by surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture and by removing the plate and/or screws, in the period from 2014 to 2019, in the city of Belo Horizonte, Minas Gerais.

2 MATERIALS AND METHODS

This is a retrospective descriptive study carried out between 2014 to 2019 with epidemiological data obtained in the database of the Department of Informatics of the Unified Health System (DATASUS)\textsuperscript{14}, from the “Authorization for Hospitalization” (AIH) form, a document filled out by the responsible physician at the time hospitalization
and data on total values and hospital services spent on surgical treatment of unimalleolar ankle fractures (code 0408050578); surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture (code 0408050497); and the procedure for removing the plate and/or screws (code 0408060379).

We included data on patients older than 18 years old, whose primary diagnosis of hospitalization includes the mentioned codes. Population estimates were obtained from demographic censuses by the Brazilian Institute of Geography and Statistics (IBGE).

Considering that the referred study was based on a public domain database, without identification data, the study was exempted from appreciation by the Ethics and Research Committee as provided in resolution number 466 of the National Council for Ethics in Research\textsuperscript{15}.

3 RESULTS

According to data extracted from DATASUS\textsuperscript{14}, 49,262 procedures were recorded with codes 0408050578, 0408050497, 0408060379 from 2014 to 2019, with 14,657 surgical procedures for the treatment of unimalleolar ankle fractures; 17,315 surgeries to treat bimalleolar, trimalleolar ankle fractures, ankle dislocation fractures; and 17,290 for removing plate and/or screws throughout the state of Minas Gerais.

Considering only the municipality of Belo Horizonte, in the same period, the number of surgeries to treat unimalleolar ankle fractures was 4,137 procedures; considering the surgical treatment for the treatment of bimalleolar, trimalleolar ankle fractures, ankle dislocation fractures, there were 3,967 procedures; and 5,617 records were detected in DATASUS referring to the procedure for removing plaque and/or screws, making a total of 13,721 ankle-related procedures performed in hospital institutions linked to the Unified Health System (SUS). Table 1 shows the distribution per year.

<table>
<thead>
<tr>
<th>Procedure registered with the AIH</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical treatment of unimalleolar ankle fracture</td>
<td>n, %</td>
<td>n, %</td>
<td>n, %</td>
<td>n, %</td>
<td>n, %</td>
<td>n, %</td>
</tr>
<tr>
<td>677</td>
<td>33.7</td>
<td>709</td>
<td>31.9</td>
<td>703</td>
<td>28.3</td>
<td>741</td>
</tr>
</tbody>
</table>
Surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture Plate and/or screw removal procedure

<table>
<thead>
<tr>
<th>Procedure registered with the AIH</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical treatment of unimalleolar ankle fracture</td>
<td>503,550.03</td>
<td>517,769.61</td>
<td>522,949.80</td>
<td>551,967.82</td>
<td>491,621.51</td>
<td>427,987.93</td>
</tr>
<tr>
<td>Surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture, plate and/or screw removal procedure</td>
<td>474,461.68</td>
<td>455,381.23</td>
<td>561,306.01</td>
<td>535,204.04</td>
<td>593,167.96</td>
<td>574,629.91</td>
</tr>
<tr>
<td>Total</td>
<td>1,226,802.03</td>
<td>1,284,084.17</td>
<td>1,454,289.46</td>
<td>1,347,446.09</td>
<td>1,331,870.27</td>
<td>1,245,245.73</td>
</tr>
</tbody>
</table>

Source: DATASUS
We noticed that there was an expense of R$ 7,889,737.75 in the total amount spent with the procedures under study. In the amounts spent on hospital services, we noted that there is no considerable decrease, using an amount of R$ 6,015,636.58, as shown in table 3. In this sense, it is evident that the amount of R$ 1,860,852.47 was used to finance professional services.

Table 3 – Values spent on hospital services for the surgical treatment of unimalleolar ankle fractures, surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture, and with the plate and/or screw removal procedure in Belo Horizonte - MG, between 2014 and 2019.

<table>
<thead>
<tr>
<th>Procedure registered with the AIH</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical treatment of unimalleolar ankle fracture</td>
<td>R$ 400,112.65</td>
<td>R$ 412,454.58</td>
<td>R$ 416,642.63</td>
<td>R$ 439,937.68</td>
<td>R$ 391,452.71</td>
<td>R$ 340,453.61</td>
</tr>
<tr>
<td>Surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture</td>
<td>R$ 343,867.02</td>
<td>R$ 332,927.77</td>
<td>R$ 415,137.06</td>
<td>R$ 398,170.62</td>
<td>R$ 444,336.87</td>
<td>R$ 432,300.71</td>
</tr>
<tr>
<td>Plate and/or screw removal procedure</td>
<td>R$ 190,648.60</td>
<td>R$ 226,620.10</td>
<td>R$ 271,594.73</td>
<td>R$ 192,603.29</td>
<td>R$ 185,376.87</td>
<td>R$ 180,999.08</td>
</tr>
<tr>
<td>Total</td>
<td>R$ 934,628.27</td>
<td>R$ 972,002.45</td>
<td>R$ 1,103,374.42</td>
<td>R$ 1,030,711.59</td>
<td>R$ 1,021,166.45</td>
<td>R$ 953,753.40</td>
</tr>
</tbody>
</table>

Source: DATASUS

The average amount per AIH and hospitalization from 2014 to 2019 was the equivalent of R$ 619.90 as shown in graph 1.
Graph 1 - Distribution of the average amount (R$, Reais Brazilian currency) spent on hospitalization according to AIH emission for the surgical treatment of unimalleolar ankle fractures, surgical treatment of bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture, and with the plate and/or screw removal procedure in Belo Horizonte - MG, between 2014 and 2019.

Source: DATASUS

3 DISCUSSION

Considering the data from DATASUS, only in 2019, 47,498 surgeries were performed in the country for surgical treatment of ankle fractures in the Unified Health System (SUS), totaling an expense of over 36 million Reais.

In Brazil, two factors favor the increase in the number of patients undergoing surgical treatment of fractures or fractures-dislocations of the ankle, the increase in the number of high-energy car accidents, and the aging of the population. In this context, evaluating strategies to correct ankle injuries that favor quality of life in the post-surgical period, and the use of measures that try to combat the process of decreasing bone mineral density are necessary.

The analysis of strategies with a better relationship between cost and effectiveness in the treatment of ankle injuries is fundamental not only for a better recovery of patients but also for the financial viability of health systems.

Studies show that the costs related to different methods of treating ankle injuries are very divergent, with national studies still scarce. Ankle fractures demand a large expenditure of public resources for their treatment due to their high prevalence and frequent need for surgical interventions. A study carried out in Finland showed that the...
use of specific surgical materials for the treatment of ankle fractures substantially reduced the hospital costs of extra removals, with a particular reduction in plaque removal surgeries\textsuperscript{20}.

We observed that most of the total expenses presented are due to the costs of hospitalization, a counterpoint with a lower amount spent on paying professionals. In the same way, there is a lack of studies that show a correlation between variables concerning surgical treatment of ankle fractures. Research that analyzed the temporal trend of surgical admissions by the Unified Health System (SUS), exposes that, for musculoskeletal surgeries, there was a constant trend between surgical admissions and the subgroup of procedures\textsuperscript{21}. The time trend of the average hospital stay according to the subgroup of surgical procedures increased from 2008 to 2016\textsuperscript{21}.

Considering a study carried out in the city of Uberlândia, Minas Gerais, MG, Brazil, the total expenses spent on surgeries performed at a federal university hospital, is directly related to the number of procedures and their complexity such as the general surgery specialties, orthopedics, and traumatology\textsuperscript{22}.

We highlight the questioning that despite the screws generally used in syndesmosis lesions being the material with the greatest availability and the lowest cost, hospitalization associated with the new surgical procedure for the removal of this material burdens the public financing systems health and exposes the patient to risks inherent to the procedure.

The evaluation of new strategies such as the use of suture buttons for the treatment of syndesmosis lesions, although more expensive at first, should be better studied and evaluated both for the best clinical and financial results\textsuperscript{23,24}. The suture end button offers potential advantages, including more anatomical mobility of the joint, faster return to weight support, and without the need to remove the implant\textsuperscript{24}.

The use of devices such as suture buttons still not very popular due to the high cost and lack of familiarity of surgeons is a relevant option in the current scenario since recent studies show satisfactory clinical results and without the need for its removal in a second moment\textsuperscript{24–26}.

\section*{4 CONCLUSION}

This study revealed that, according to the TABNET/DATASUS data, Belo Horizonte corresponds to the highest proportion of procedures performed in the surgical treatment of unimalleolar ankle fractures (code 0408050578); surgical treatment of
bimalleolar, trimalleolar ankle fracture, ankle dislocation fracture (code 0408050497); and the plate and/or screw removal procedure (code 0408060379), from 2014 to 2019.

We can reflect that the expenses related to the procedures can be minimized, according to national and international literature, with the possibility of replacing orthopedic surgical material.

There is an urgent need for new public policies to consider implementing concrete actions, aimed at seeking maximum effectiveness in the process of selecting materials and reviewing clinical and surgical protocols, reflecting on the quality of life for the patient and optimization of funding. Another essential way forward is the development of new works, research, and extensions, with the aforementioned theme.
REFERENCES


