Evaluation of Circular Saw Injuries in a Reference Center in Microsurgery and Reimplantation*

Avaliação de lesões por serra circular em um centro de referência em microcirurgia e reimplantes

Ana Lúcia Campos Faccioni[1] Leonardo Kurebayashi[2] Kátia Campos dos Anjos[3] Marcelo Rosa de Rezende[4]

[1] Program of Professional Practice in Microsurgery, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo (IOT-HCFMUSP), São Paulo, SP, Brazil
[2] Medical Residency Programin Hand Surgery and Microsurgery, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo (IOT-HCFMUSP), São Paulo, SP, Brasil
[3] Department of Social Health, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo (IOT-HCFMUSP), São Paulo, SP, Brazil
[4] Hand Surgery and Microsurgery Group, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo (IOT-HCFMUSP),São Paulo, SP, Brazil

Rev Bras Ortop 2022;57(4):629–635.

Address for correspondence Ana Lúcia Campos Faccioni, MD, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas, Rua Dr. Ovídio Pires de Campos, 333, Cerqueira Cesar, São Paulo, SP, 05403-010, Brazil (e-mail: ana.faccioni@gmail.com).

Abstract

Objective To evaluate the epidemiologic profile, the time until care, and the type of conduct taken regarding patients who are victims of accidents with circular saws and their resulting injuries, and to make a comparison with the literature.

Methods A cross-sectional descriptive study reviewing the medical records of patients cared for from April to December 2018, analyzing age, gender, injured side, affected fingers, month and time of the accident, type of injuries, procedures performed in the emergency room, time elapsed between trauma and admission to the operating room, and reapproach during hospitalization.

Results A total of 54 male patients aged between 15 and 72 years were care for. The left side was more affected, and the most frequent type of lesion involved the thumb, which had to be amputated in many cases. In total, 23 patients underwent reimplantation, 3 of which were macroreimplantations. Regarding the time of trauma, 26 cases occurred between noon and 4 p.m., and the time elapsed between the accident and the admission to the operating room was $\geq$ 6 hours in 84% of the patients.

Keywords
- hand injuries/etiology
- hand injuries/epidemiology
- hand injuries/prevention and control
- accidents

* *Work developed by the Group of Hand Surgery and Microsurgery Instituto de Ortopedia e Traumatologia, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo (IOT-HCFMUSP), SãoPaulo, SP, Brazil.*

received
August 5, 2020
accepted
December 1, 2020
published online
August 27, 2021

DOI https://doi.org/10.1055/s-0041-1729940.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Conclusion Circular saw lesions are predominantly severe, with a potential for leaving permanent sequelae, and they affect mainly the thumb. The characterization of the type of injury and the initial care conditions obtained in the present study may contribute to the policy of prevention and care of patients who are victims of circular saw injuries. ***Level of Evidence IV; Case Series.***

Resumo

Objetivo Avaliar o perfil epidemiológico, o tempo até o atendimento, e o tipo de conduta tomada em pacientes vítimas de acidentes com serra circular e lesões decorrentes, e fazer uma comparação com a literatura.

Métodos Estudo descritivo transversal, com revisão do prontuário de pacientes atendidos de abril a dezembro de 2018, analisando idade, sexo, lado lesado, dedos acometidos, mês e horário do acidente, tipo de lesões, procedimentos realizados na urgência, tempo decorrido entre o trauma e entrada em sala cirúrgica, e reabordagem durante a internação.

Resultados Foram atendidos 54 pacientes do sexo masculino com idade entre 15 e 72 anos. O lado esquerdo foi o mais acometido, e o tipo de lesão mais frequente, a amputação, envolvendo principalmente o polegar. No total, 23 pacientes foram submetidos a reimplante, e, entre eles, 3 macrorreimplantes. Quanto ao horário do trauma, 26 ocorreram entre 12h e 16h, e o tempo decorrido entre o acidente e a entrada em sala cirúrgica foi $\geq$ 6 horas em 84% dos pacientes.

Conclusão As lesões por serra circular são predominantemente graves, com potencial de deixar sequelas permanentes, e acometem principalmente o polegar. A caracterização do tipo de lesão e as condições de atendimento inicial obtidas neste trabalho poderão ajudar na política de prevenção e atendimento a pacientes vítimas de ferimentos por serra circular. ***Nível de Evidência IV; Série de Casos.***

Palavras-chave
- traumatismos da mão/etiologia
- traumatismos da mão/epidemiologia
- traumatismos da mão/prevenção e controle
- acidentes

Introduction

According to Fikry et al.,[1] circular saw accidents are the classic pattern of hand-related trauma in developing countries, being recognized as a socioeconomic scourge. These are serious lesions that are relatively frequent, and have the potential of leaving permanent sequelae.[1]

In 2001 in the United States, the US Consumer Product Safety Commission identified more than 42,000 injuries from circular saws (table or bench).[2] Annually, more than 31,000 non-work-related circular saw injuries are estimated in the United States.[3] Other regional studies on specific populations, such as those by Hassine et al.,[4] in Tunisia, and Fikry et al.,[1] in Morocco, demonstrate a high frequency of these accidents and a high severity of the injuries, often leading to amputations.

Nevertheless, there is little information in the literature, especially in Brazil, about its particularities and social impact. It is of great importance to obtain national epidemiological data on the type of injury and factors related to this type of trauma

Therefore, the present study aims to identify the main characteristics of these lesions, outlining the epidemiological profile and conduct in the care provided to these patients.

Materials and Methods

A descriptive cross-sectional study was conducted, with retrospective data collection from the medical records of patients treated at a quaternary hospital, a reference center for the care of complex traumas of the upper limb.

We included 54 patients treated from April to December 2018 with injuries resulting from circular saw accidents. The research was carried out in the MV Electronic Medical Records (MV Informática Nordeste Ltda., Recife, PE, Brazil) by a single researcher, after evaluation and authorization by the Hospital Ethics Committee (CAAE 96464418.5.0000.0068).

The variables analyzed were age, gender, education, occupation, occupational status, injured side, affected fingers, month and time of the accident, types of injuries, procedures performed in the emergency room, time elapsed between trauma and admission to the operating room, and need for reapproach during hospitalization.

The data obtained were analyzed with the Statistical Package for the Social Sciences (SPSS, IBM Corp. Armonk, NY, US) software, through which the frequency was obtained.

Results

In the 9 months included in the study, 54 patients were treated, all male, aged between 15 and 72 years (mean: 46.24 years; standard deviation: 13.19 years). The most affected age groups were between 45 and 54 years (19 patients; 35.2%), 35 to 44 years (11 patients; 20.4%) and 55 to 64 years (9 patients; 16.7%) (►**Figure 1**).

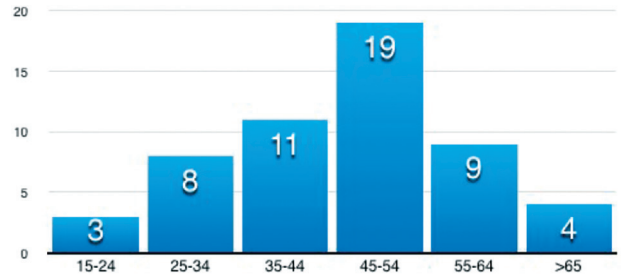

Fig. 1 Number of patients by age group.

Table 1 Occupations most involved in accidents

Profession	N	Percentage
Mason	16	29.6%
Woodworker	9	26.7%
General assistant	4	7.4%
Retired	3	5.6%
Other	22	30.7%
Total	54	100%

Table 2 Type of accident

Type of accident	N	Percentage
Formal work accident	16	29.6%
Informal work accident	21	38.9%
Domestic accident	17	31.5%
Total	54	100%

Table 3 Schooling

Schooling	N	Percentage
Complete or incomplete Elementary School	15	27.8%
Complete or incomplete High School	20	37%
Vocational school	1	1.9%
Not informed	16	29.6%
Higher Education	2	3.7%
Total	54	100%

The occupation most involved was that of mason, corresponding to 16 cases (29.6%), followed by woodworker, in 9 cases (►**Table 1**), and 36 of the patients (66.7%) had a social security relationship in employment, which guaranteed access to social security benefits during the leave period, with 21 cases (38.9%) characterizing formal work accidents (►**Table 2**). Regarding schooling, 15 patients (27.8%) had complete or incomplete Elementary School, and only 2 patients (3.7%) had completed Higher Education (►**Table 3**).

Table 4 Number of injured fingers

Number of injured fingers	N
1 finger	26
2 fingers	9
3 fingers	11
4 fingers	1
5 fingers	1
Proximal	6
Total	54

The left side was affected in 83.3% (45 cases). Considering all types of injury, 26 patients (48.1%) had an injury in only one of the fingers, while 6 patients (11.1%) had proximal lesions (►**Table 4**).

Considering the total number of lesions, the thumb was more involved, corresponding to 30 cases (55.6%), followed by the second finger in 19 cases (35.2%); thumb involvement was also predominant in lesions affecting a single finger, with 18 cases (69.2%), followed by the second finger in 5 cases (19.2%). In lesions involving 2 fingers, the combination with the highest occurrence was thumb and second finger in 3 cases (33.3%), followed by the third and fourth fingers in 2 cases (22.2%). In lesions involving three fingers, the involvement of thumb, second and third fingers was observed in 4 cases (36.4%), as well as the second, third, and fourth fingers (►**Figure 2**).

Amputations were identified in 35 patients (64.8%), 21 of whom (60%) involving the thumb, and 13 (37.1%) without involvement of other fingers. A total of 8 patients (22.9%) had amputations of the second finger, but only in 2 (5,73%) of them the lesion affected this finger alone. All patients with amputations in the third, fourth, and fifth fingers had lesions on other fingers.

In total, 23 (65.7%) patients underwent reimplantation, with 3 cases of macroreimplants (13.7%), 1 transmetacarpal and 2 at the level of the wrist. Two other patients underwent reimplantation attempts, but without success. A total of 8 (30.4%) of these patients required subsequent regularization during hospitalization.

Regarding the 25 patients submitted to reimplantation or an attempt thereof, the time elapsed between the lesion and admission to the operating room ranged from 4 hours and 40 minutes to 15 hours and 15 minutes (average: 8 hours and 7 minutes; standard deviation: 2 houras and 31 minutes), and it was $\geq$ 6 hours for 21 patients (84%) (►**Figure 3**).

In addition to the 35 amputations described, 3 patients (5.5%) presented vascular lesions, 2 of which underwent revascularization of fingers, 1 with irreparable arteries, 10 (18.5%) presented complex lesions with bone and soft-tissue involvement (open fractures), and 6 (11.1%) had blunt cut injuries affecting only soft tissues (skin, tendons or nerves).

Regarding the time of the trauma, 14 injuries (25.9%) occurred between 2 p.m. and 4 p.m., 12 injuries (22.2%), between noon and 2 p.m., and 10 cases (18.5%), between 10 a.m. and noon, totaling 36 cases (66.7%) between 10 a.m. and 4

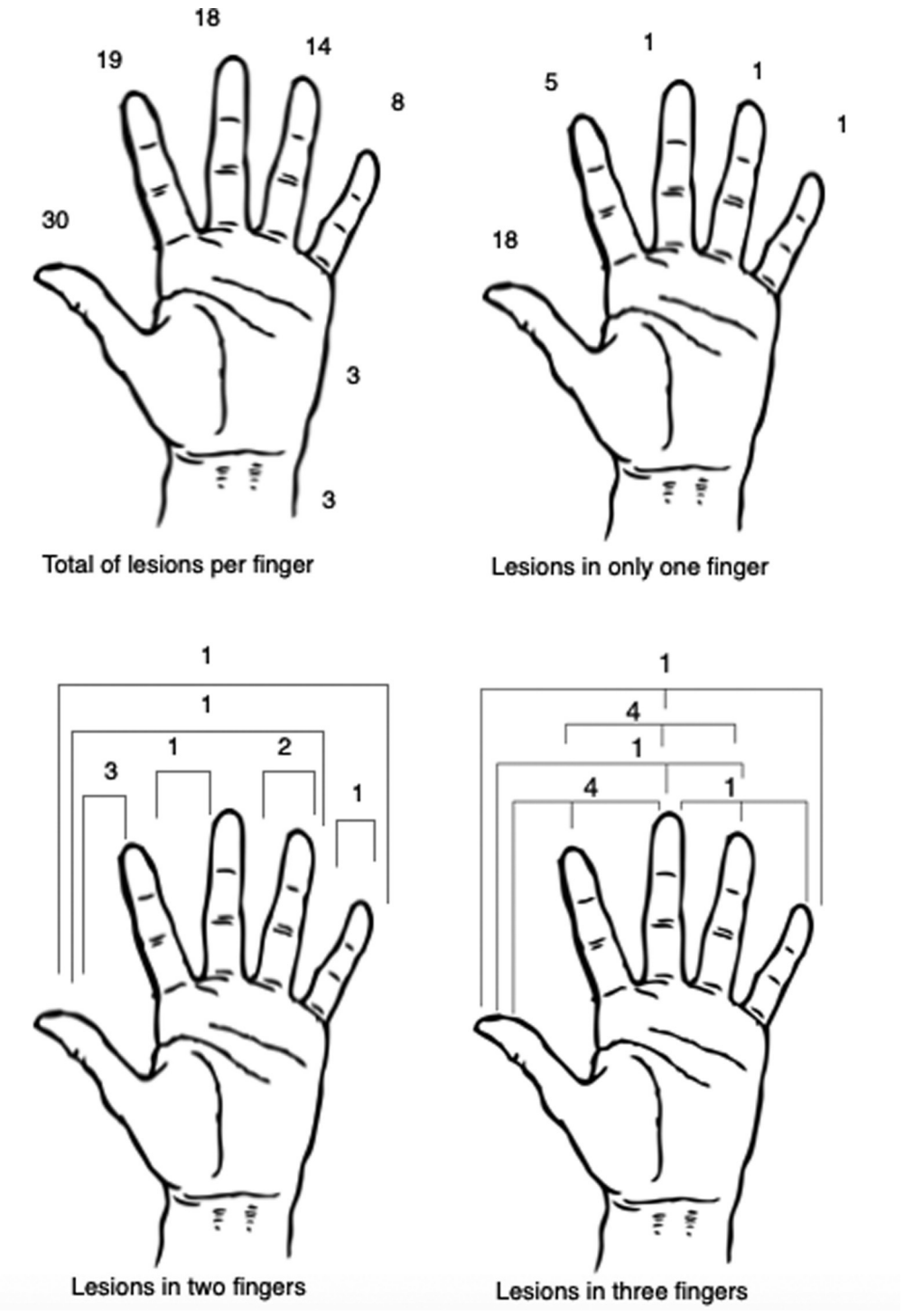

Fig. 2 Number of injuries affecting single finger, two or three fingers.

p.m. (►**Figure 4**). The highest number of occurrences was in the month of June, with 13 cases (24.1%) (►**Figure 5**).

Discussion

Circular saw injuries occur predominantly in males, possibly due to the association with woodwork activities, which are typically performed by men. Frank et al.[2,3] described a sample of 114 patients, with only 8 females, while Selig et al.[5] reported a male predominance with a ratio of 7:1, and Sabongi et al.[6] reported a sample composed of 98.1% of male patients. Fikry et al.[1] and Hassine et al.[4] reported an exclusively male sample, similar to that observed in the present study.

Frank et al.[2] reported ages between 15 and 81 years, with a mean of 49 years, similar to the age range found by Hassine et al.[4], which described ages between 16 and 67 years, with an average of 31.24 years. The authors, however, decribe a majority of lesions in patients under 30 years of age. Selig et al.[5] described a higher incidence in patients aged between

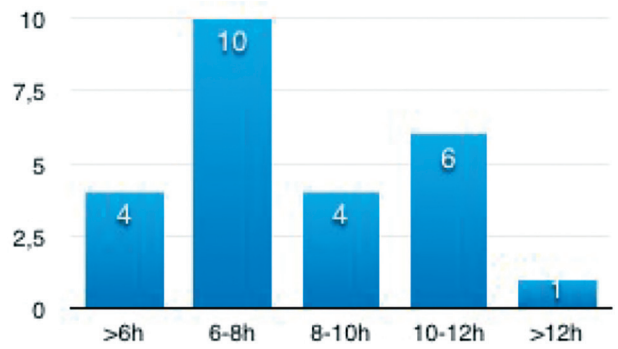

Fig. 3 Time elapsed between trauma and admission to the operating room.

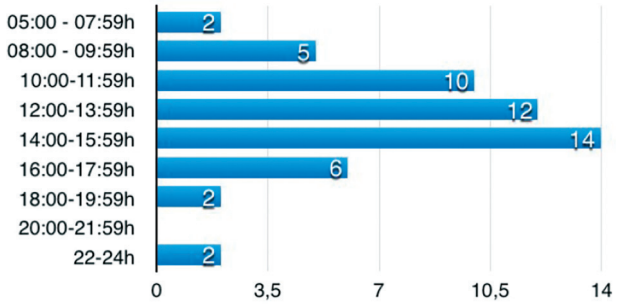

Fig. 4 Time of injury.

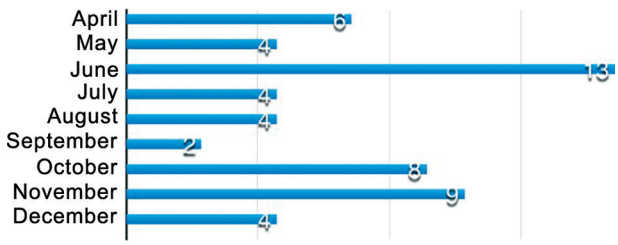

Fig. 5 Months in which the lesions occurred.

45 and 64 years and in those older than 65 years, but they group amputations by various mechanisms, although most of the lesions occurred by circular saw. In the work by Fikry et al.,[1] the average age of the patients was 25 years (range: 12 to 60 years). This variation may be due to the socioeconomic profile of circular saw users in different countries. In the present study, most lesions (47 cases; 87%) occurred in individuals aged between 25 and 64 years, and they were mainly concentrated among those aged between 45 and 54 years (19 patients; 35.2%), which is similar to the findings by Frank et al.[1] It is assumed that this peak at older ages may occur due to negligence in using protective equipment and a feeling of confidence when handling the object; more experienced patients reported skipping safety steps due to excessive confidence. As for younger people, lack of experience can play an important role in accidents.

Due to the low level of schooling of most of these patients, many end up taking informal jobs, as evidenced in the 38.9% of accidents at informal jobs in the present study. Among the activities performed, construction workers are more affected, indicating that the risks of occupational accidents in these sectors are considerably high in relation to those of other occupations because they require physical effort and skill, exposing workers to various risks.

Fikry et al.[1] reported 88% of lesions affecting the left side, and Hassine et al.,[4] 64.61%. Frank et al.[2] found 54 non-dominant left-hand injuries, and 49 in the dominant right hand. Similarly, in the present study we observed 83.3% of lesions (45 cases) affecting the left side. The predilection of this lesion for the left hand is justified by the fact that it is the hand closest to the saw blade, which holds the object to be cut; therefore, it is more susceptible to injuries. This data deserves attention regarding the planning of safety standards.

Hassine et al.[4] identified amputations as the most common lesions, occurring in 85% of the cases, but only 5% involving the thumb. In the present study, however, amputations were less frequent (64.8% or 35 patients), but the thumb was the most affected finger (60% or 21 cases). The higher incidence of injury to this digit may be due to the pinch position when holding the object to be cut.

Frank et al.[3] described amputations in 1 finger in 16 cases, comparable to the 13 cases of thumb amputation without involvement of the other fingers found in the present series. Selig et al.[5] described reimplantation in 28% of amputation cases, a value well below the 65.7% found in the cases in the present study corresponding to 23 patients. The only mention of macroreimplants is made by Frank et al.,[2] who described one case at the level of the hand, similar to our findings (one hand macroreimplant and two at the level of the wrist).

Lesions affecting a single finger were observed in 48.1% of the cases in the present study (26 patients). The numbers are in line with those of the work by Sabongi et al[6], who reported a majority of single finger injuries (50 cases), as well as Frank et al[2], who describes, in this same study, in single-finger lesions, 24 lesions to the thumb and 14 to the second finger, matching our finding of predominance on the radial side, as well as the combination of thumb and second finger as the most prevalent in lesions affecting two fingers. Besides being the most amputated, the thumb is also the most affected finger in isolated lesions.

In two-finger injuries, the combination most found by Frank et al.[2] was thumb and second finger, which is similar to the findings of the present study, and in lesions involving three fingers, the combination of the second, third and fifth fingers. Another combination of 3 fingers frequently reported was third, fourth and fifth fingers, which we only identified in one case; however, we identified the same incidence of lesions in the thumb, second and third fingers, and in the third, fourth and fifth fingers. Hassine et al.[4] described lesions in multiple fingers in 77% of the cases, with a predominance of lesions in the second and third fingers.

Frank et al.[3] described a higher incidence of lesions in the radial fingers (thumb, second or third fingers), with one of them involved in 88% of the single-finger lesions, and in 88% of lesions involving 2 fingers. The finding is in line with the

present study, in which we identified a total of 30 lesions (55,6%) involving the thimb, 19 lesions (35,2%) in the second finger and 18 (20,22%) in the third finger. Because radial fingers are responsible for pinching and grip in oponence, sequelae affecting them can lead to great functional impairment.

Regarding the time of trauma, the literature describes a bimodal distribution, with two peaks of incidence. Hassine et al.[4] reported incidence peaks from noon to 2 p.m. (27 cases) and 27 cases between 4 p.m. and 6 p.m. Fikry et al.[1] described incidence peaks from 9 a.m. to noon and from 1 p.m. to 4 p.m., and Selig et al.,[5] between 10 a.m. and noon, and between 2 p.m. and 4 p.m. In the present series, 26 lesions (48.1%) occurred between noon and 4 p.m., which may be related to postprandial sleepiness. Another 10 cases (18.5%) occurred between 10 a.m. and noon, and may be correlated with tiredness at the end of a long period of work.

Regarding the time elapsed until admission to the operating room, the average of 8 hours and 7 minutes may compromise the outcome of the treatment, since they are mostly ischemic lesions that require vascular procedures, which ideally require prompt revascularization. This data evidences a deficiency in public care, and it is important for awareness about the need to create specialized centers to care for these lesions, especially considering that most of these cases require revascularization, whose success depends fundamentally on the reduction of the time of ischemia of the amputated segment.

Selig et al.[5] described a peak in prevalence in May, and an increase in frequency between August and November. We identified a peak prevalence in June; however, the present study comprised only nine months. We did not observe factors that could justify this data.

Based on the description of the population most affected by these lesions, one can begin to think about defining public prevention policies in an attempt to reduce their number. These policies can only be created by understanding the most frequent types of injuries, their characteristics, and the factors that lead to their occurrence. Fikry et al.[1] divide the risk factors for saw injuries among those connected to the saw (failure of the safety system, most commonly removed by the user, or defects in maintenance, especially the lack of a wire in the blade), wood-related factors (fiber orientation and presence of nodes), and human-related factors (young age, lack of qualification, and lack of attention). In the present study, it was not possible to identify the mechanism that led to the injury, but the mechanism of kickback was identified in the literature[2,6] as the main cause, which is in line with the informal reports of patients, who refer to a kickback mainly when cutting through wood nodes. The hypothesis of incorrect use of the saw should also be considered, because the use of blades inadequate to the rotation of certain machines and the removal of mechanisms to protect it and lack of use of personal protective equipment (PPE) are common, and have also been reported by Sabongi et al.[6]

In the work by Hassine et al.,[4] 170 patients were described in 8 years (only 130 were included in the study) in a single service. Frank et al.[2,3] identified 179 patients in a similar period (114 were patients included in the study). We obtained a small number compared to these studies, but when taking into account the short period of time, we observed a frequency of lesions much higher than that described in the literature. By describing a recent period, we have a current view of reality, which translates what is happening at this time in relation to these accidents.

Other limitations of the present study include the fact that it was performed at a referral center in microsurgery and reimplants, so the number of more severe lesions will be overestimated. Minor lesions, which do not require a specialized team approach, end up being treated in less complex services, so it is estimated that the actual number of these lesions is considerably higher. The present study was also restricted to data from medical records, which did not contain data that could have functional relevance (such as dominance and the anatomical level of the lesion). And a functional evaluation of the patients was not performed after their rehabilitation.

Conclusion

Circular saw injuries are very frequent in Brazil, and they cause serious wounds, often with permanent sequelae. The characteristics related to the period of the day in which the lesions occur and the age of the patients provide support for the direction of prevention policies. The severe pattern of injuries was well characterized, with amputations, complex lesions, and a clear predominance of the thumb, requiring improvements in the public system regarding emergency care for this severe type of injury, with the creation of more reference centers qualified for its treatment.

Authors' Contributions

Each author contributed individually and significantly to the development of this article. ALCF: writing of the article and review of the medical records; LK: writing of the article and search for bibliographic references; KCA: data collection and conception of the research; MRR: guidance, writing and review of the article.

Financial Support

This work was supported by the Instituto de Pesquisa e Ensino Home, Brasilia, DF, Brazil.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Fikry T, Saidi H, Latifi M, Essadki B, Zryouil B. La main traumatique par toupie: pour une meilleure prévention. Chir Main 2004;23 (02):96–99

2 Frank M, Lange J, Napp M, Hecht J, Ekkernkamp A, Hinz P. Accidental circular saw hand injuries: trauma mechanisms, injury patterns, and accident insurance. Forensic Sci Int 2010;198(1-3): 74–78

3 Frank M, Hecht J, Napp M, et al. Mind your hand during the energy crunch: Functional Outcome of Circular Saw Hand Injuries. J Trauma Manag Outcomes 2010;4(01):11
4 Hassine YH, Hmid M, Baya W. La main de toupie: à propos de 130 cas. Tunis Med 2016;94(12):1–10
5 Selig HF, Nagele P, Voelckel WG, et al. The epidemiology of amputation injuries in the Austrian helicopter emergency medical service: a retrospective, nationwide cohort study. Eur J Trauma Emerg Surg 2012;38(06):651–657
6 Sabongi RG, Erazo JP, Moraes VY, et al. Circular saw misuse is related to upper limb injuries: a cross-sectional study. Clinics (São Paulo) 2019;74:e1076