Primary amputation after trauma: profile of a hospital in the Mid-West of Brazil

Amputação primária no trauma: perfil de um hospital da região centro-oeste do Brasil

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Abstract

Background: We live in a period of epidemic of trauma. Amputation due to trauma affects a young and economically active population, with costly socioeconomic consequences, becoming a public health problem.
Objective: To investigate the series of amputations performed at Santa Casa de Campo Grande Hospital between 2005 and 2008.
Methods: Prevalence, descriptive, longitudinal and retrospective study. Convenience sampling was used to conduct a systematic review of medical records of patients undergoing lower and/or upper limb amputations whose diagnosis was trauma incompatible with reconstruction. Patients who arrived at the emergency department with amputated limbs were excluded from the study. We assessed the level of amputation, age, sex, and MESS score for amputation after trauma. The chi-square test and Fisher's exact test were used considering a 95% confidence interval.
Results: One hundred and eight amputations were performed in the period. Patients' two to 78 years; mean age was 36.7 ± 12 years, and median age was 35 years. Most patients were males (72%). The most frequent level of amputation was minor amputations (toes and fingers). The most common cause of amputation was injury resulting from traffic accidents.
Conclusions: In agreement with the literature, trauma amputations affect a young and productive population, with prevalence of traffic accidents with associated orthopedic and neurological injuries.

Keywords: amputation; disarticulation; trauma.

Resumo

Contexto: Vivemos num período de epidemia do trauma. A amputação de indicação traumática incide em uma população jovem e economicamente ativa com repercussão onerosa no âmbito socioeconômico, tornando-se um problema de saúde pública.
Objetivo: Conhecer a casuística de amputações traumáticas realizadas na Santa Casa de Campo Grande-MS, entre 2005 e 2008.
Métodos: Estudo de prevalência, descritivo, longitudinal e retrospectivo. Amostragem de conveniência, realizada com revisão sistemática de prontuários de pacientes submetidos a amputações de membros inferiores e/ou superiores cuja indicação foi trauma incompatível com reconstrução. Foram excluídos os pacientes que já chegaram amputados no pronto-socorro. Avaliaram-se nível de amputação, faixa etária, sexo e escala do sistema MESS para indicação de amputação traumática. Utilizaram-se o teste quiquadrado e o teste exato de Fisher, considerando um intervalo de confiança de 95%.
Resultados: Foram realizadas 108 amputações no período, na faixa etária de dois anos a 78 anos, com média de 36,7 ± 12 anos e mediana de 35 anos. Houve predomínio do sexo masculino em 72% da casuística. O nível de amputação mais executado foi de amputações menores (pododáctilos e quirodáctilos). A causa mais frequente foi lesão decorrente de acidente de trânsito.
Conclusões: As amputações traumáticas atingiram uma população jovem e produtiva, conforme corroborado pela literatura, com predomínio de acidentes de trânsito com lesões ortopédicas e neurológicas associadas.

Palavras-chave: amputação; desarticulação; trauma.

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Introduction

Amputation of a limb is one of the oldest therapeutic techniques in medicine[1]. In the case of amputations indicated because of severe damage to nerves, soft tissues and bones, it had been expected that the end of large-scale wars would reduce their incidence[2]. However, what actually occurred was a reversal, in which traumas caused by military conflicts were overtaken by those of a civil nature, in particularly traumas resulting from traffic accidents, followed by urban violence[1-3].

Trauma is the major pandemic of the modern era and, by all appearances, it has come to stay. The number of victims increases every day and the characteristics of these victims are worrying, since they include young, economically active, adults[2]. The magnitude of the consequences is a function of the number of victims, with significant social impact when there are sequelae, such as amputation of a limb due to the injuries suffered[2].

The improving economic situation of the populations of developing countries, such as Brazil, and increases in automobile industry production, in turn associated with an ever-growing number of vehicles in circulation, are coming at the cost of an absurd increase in the number of accidents, which often involve severe traumas of the lower limbs.

On the other hand, there is little apparent action in terms of health promotion to prevent future accidents. When prevention is left to the responsibility of citizens' awareness of traffic legislation and the penalties for infractions, and enforcement is scant, traffic becomes a hostile environment. The vicious circle therefore continues in hospitals and emergency care services, increasing the burden on already stretched healthcare budgets.

There is a need for more effective preventative policies that stir up greater commotion in society about the truth that is hidden from the public at large, with the exception of healthcare workers and the victims of sequelae they treat.

In this sad situation, and despite all the advances of medicine, there is still an elevated incidence of primary amputations in trauma care[2]. It falls to us physicians to keep amputation indications to the absolute minimum necessary, which is a very difficult task to accomplish, since it involves multiple aspects. In order to manage these severe traumas, it may be necessary to adopt a set of criteria such as the *Mangled Extremity Severity Score* (MESS)[4,5], which is a scale of injury severity designed to support therapeutic decisions.

If our understanding of these events is to be improved, it is necessary to conduct epidemiological studies in the many different services working in Brazil and worldwide, in order to collect data on which to base preventative planning to reduce indications of limb amputation to the absolute necessary, bearing in mind that the procedure has an economic impact that is no is less than its psychosocial impact. In view of the scarcity of studies of this type, particularly here in Brazil, this study was conducted to add to the body of scientific research and keep alive discussions on the need to trace the profile of patients who undergo primary amputations caused by traumas of the extremities. Therefore, the primary objective of this article was to trace the epidemiological profile of primary amputations, i.e. those cases in which no attempt was made to salvage the limb, because of vascular trauma in upper and lower limbs, carried out at the largest hospital, and the only one to treat this level of complexity, in a region with two million inhabitants, between January of 2005 and December of 2008.

Methods

This predominantly descriptive, longitudinal and retrospective study is based on a systematic review of medical records for patients who underwent primary amputations of upper or lower limbs between January of 2005 and December of 2008, harvesting data such as age, sex, history of the trauma and workup conducted. Details were recorded on mechanism of trauma, associated traumas, diagnostic methods employed, time between first being seen at a hospital and being seen by the vascular surgeon, reasons why no attempt was made to save the limb and the resulting indication of primary amputation. These data were then analyzed to verify whether they correlated with the use of a decision-making scale on whether to indicate a primary amputation or to attempt to salvage the limb. The literature describes many such scales, but for this study the MESS scale was chosen (see discussion section), since this scale is used both by the orthopedic and the vascular surgery departments at the hospital in question.

Patients who had already had amputations when they arrived at the emergency room were excluded from the analysis.

The descriptive data analysis consisted of identifying maximum and minimum values and calculating means and standard deviations. The chi-square test was used to analyze the significance of distributions of frequencies by sex and age group. The predefined significance level for rejection of the null hypothesis was 5% ($p < 0.05$), where applicable.

Results

During the period studied, 122 procedures were conducted on 108 patients with ages varying from 2 to

78 years, with a mean of 36.7 ± 12 and median of 35. Stratification of patients by the age groups used in the MESS showed that the majority were less than 30 years old, as shown in Table 1. Males predominated, accounting for 72% of the sample, compared with 28% females (a ratio of 2.6:1) (Figure 1). There was no significant association between sex and age group (Table 1).

Figure 2 shows the distributions of numbers of primary amputations.

The traumatic amputation decision-making process was followed by the vascular surgeon, very often in conjunction with the orthopedist, and covered the following items, based on the MESS scale (see the discussion section):

- Mechanism of trauma;
- Duration of ischemia and results of search for signs of irreversible ischemia;
- Comorbidities with elevated risk of secondary amputation (advanced age, diabetes, etc.);
- Conditions for functional recovery (details of injuries to bones, muscles, nerves and blood vessels);
- Possibility of, and availability of material for, vascular repair: calibers, graft donor site, adequate coverage of bypass/interposition by skin and/or soft tissues, quality of graft when necessary (extension, whether wall is intact and caliber);
- Degree of contamination and risk of infection; and
- Hemodynamic and cardiopulmonary status demanding that life be preserved in detriment to the limb.

Almost all of these items were present in the primary amputation cases described here, or the decision to amputate was based on them.

The overwhelming majority of the extremity traumas leading to primary amputations were traffic accidents, followed by burns, electric shock and iatrogenic trauma (Figure 3).

Two of the trauma amputation cases were caused by electric shock and one by extensive burn injuries to a foot.

The level of amputation was stratified as major amputations (upper limbs, transfemoral, transtibial and disarticulations at hip, knee or ankle/foot) or minor amputations (forefoot, toes, fingers, etc.). To improve the analysis, procedures were also subdivided by type into upper limbs (1.85% prevalence, excluding fingers), hip

Table 1. Frequencies of primary amputation cases by age group and sex, Hospital Santa Casa de Campo Grande-MS, Brazil, 2005-2008.

Age group	Sex				Total	
	Males		Females			
	n	%	n	%	n	%
Up to 30	38	48.7	14	46.7	52	48.1
31 to 50	27	34.6	10	33.3	37	34.3
Over 50	13	16.7	6	20	19	17.6
Total	78	72	30	28	108	100

Chi-square test: p = 0.7386.

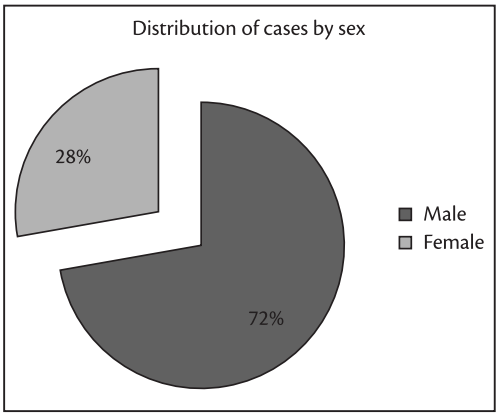

Figure 1. Distribution of amputation cases by sex, Hospital Santa Casa de Campo Grande, MS, Brazil, 2005-2008.

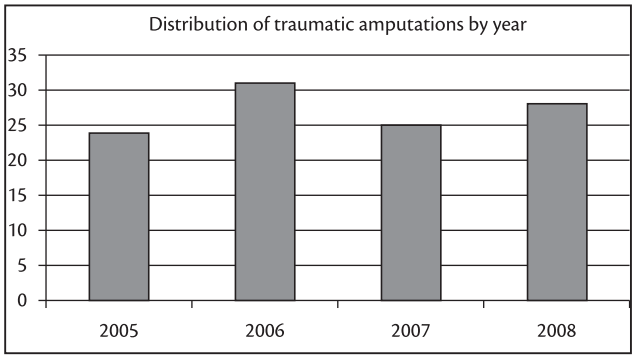

Figure 2. Distribution of traumatic amputations by year from 2005 to 2008, Hospital Santa Casa de Campo Grande, MS, Brazil.

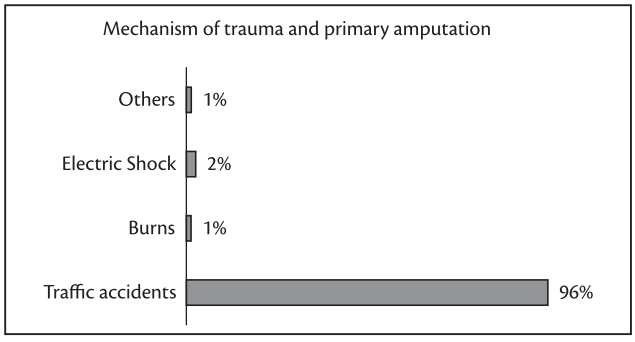

Figure 3. Mechanisms of trauma as etiology of primary amputations, Hospital Santa Casa de Campo Grande, MS, Brazil, 2005 to 2008.

disarticulation (0.09%), transfemoral amputations (13.8%), knee disarticulations (0.09%), transtibial amputations (21.3%) and operations on the foot, such as disarticulation at ankle/foot, partial foot amputation (26.8%) and amputation/disarticulation of hallux and/or toes and fingers, accounting for 34.2% of procedures (Figure 4).

Seventeen patients underwent more than one amputation (at a different level and/or of a different limb) during the same hospital stay, whether due to infection of a limb remnant or ischemia secondary to proximal thrombosis.

Each mangled limb, the subject of this sample, was categorized in terms of data such as concomitant injuries suffered by the limb (vascular, orthopedic, neurological and combinations), factors related to patients (age, clinical comorbidities and smoking) and the trauma (mechanism of injury, specific injuries, shock, hypothermia and time between trauma and receiving care), which would indicate unfavorable prognosis for attempts at saving the limb.

The great majority of concomitant injuries were orthopedic, accounting for 93.5% of cases, the overwhelming majority of which were Gustilo IIIC open fractures/luxations. There were multiple traumas involving head, chest and abdomen in 1.85% of cases.

With regard to factors related to the patients, 17.6% were more than 50 years old, and there were clinical comorbidities such as diabetes, heart failure, lung disease and obstructive peripheral vascular disease that could not be fully analyzed because these data were rarely recorded on the medical records.

Factors related to the traumas were more likely to have been recorded. Hypovolemic shock was recorded in 9.3% of the sample. Hypothermia was not recorded on any records and the mean time between trauma and receiving specialist care was 5.3 ± 1.8 hours.

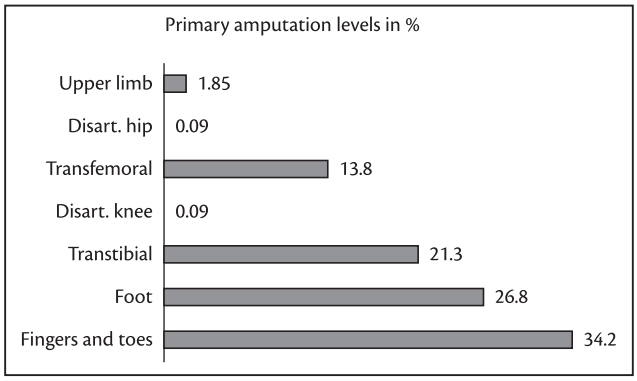

Figure 4. Frequencies of primary amputation levels, Hospital Santa Casa de Campo Grande, MS, Brazil, 2005 to 2008.

Mean hospital stay was 23.7 ± 7.8dias, with a median of 29 days and mode of 28 days. With regard to morbidity and mortality, there was one death (a multiple trauma patient who underwent amputation at the left forearm and disarticulation of the left hip because of injuries sustained when a truck rolled over) and two cases of sepsis.

According to the criteria that make up the MESS points scale (see below in the discussion section), for which the cutoff points are totals of seven or greater, we observed that 13 of the 68 cases for which data were available would score five points, but these were cases in which the trauma had caused extensive loss of soft tissues and laceration of distal arteries making vascular reconstruction impossible. The affected extremity in these cases was either the distal leg or the foot.

The decision to amputate was taken in conjunction with the orthopedist in 96.7% of cases. Other indications identified were lack of suitable vascular graft material (because of length or an injured donor site) in two cases, injuries with skin degloving, major loss of material to cover a vascular bypass/interposition, associated with extensively contaminated comminuted fractures with unfavorable orthopedic prognosis, in 47% of cases. Extended duration of ischemia prior to examination by a specialist also played a significant role, particularly among multiple trauma victims, with blunt vascular traumas who underwent laparotomy, thoracotomy and/or neurosurgery before the need for vascular intervention was assessed. By this point the limb, or foot, or hand, already showed signs of rigidity, accompanied by coldness and paralysis, making intervention unviable. This situation was described in around 30% of cases. In 11% of the sample the orthopedist listed injuries to the tibial nerves as an indication and in two cases the vascular surgeon could have attempted revascularization.

Discussion

In the majority of cases, the trauma mechanism in mangled extremity syndrome is blunt, with associated injuries that make it impossible to attempt revascularization, which is why traumatic amputation is indicated. Penetrative traumas involving major tissue loss, such as those caused by high-velocity projectiles, are also described in the literature, but we did not see any such cases.

Limb amputation is the last resort when faced with a chronic-degenerative disease involving ischemia and cell death of an extremity or when faced with a process involving massive destruction that prevents circulation from being reestablished. The purpose of this intervention

is to avoid the ischemia that occurs in trauma cases together with its consequences[1,6,7].

In the first case, adopting preventative and therapeutic methods early on can contribute to reducing the number of amputations[8], although their total number has been rising as a function of increasing human longevity[9] and a result of the increasing prevalence of diabetes mellitus, obesity, metabolic syndrome and dyslipidemia, all of which are associated with poor quality of life (stress, inactivity, poor nutritional education and smoking) and with increased risk of chronic degenerative diseases, such as nephropathies, systemic arterial hypertension, lung diseases and cardiovascular diseases[7,10-14].

The worldwide incidence of limb amputations is estimated at more than one million per year[7] and the most common indications are caused by complications of diabetes and atherosclerotic disease[15,] although few studies have been conducted to determine the epidemiology of this population[6,16-19].

A greater number of publications on the subject will expand our knowledge of the profile of these patients, providing better prospects for effective prevention, which is the goal of public health[20].

This study, with its descriptive and retrospective design, was conducted in order to determine the prevalence of amputations at the hospital being studied together with their epidemiological profiles and the injury severity scores that supported, or not, the indication of primary amputation.

The main limitations of this study were the result of problems with data collection from medical records, which Almeida Filho and Rouquayrol[21] have shown is an inherent feature of retrospective studies, counteracting the advantages they offer of lower cost and faster execution[7].

Each mangled limb, the subject of this sample, was categorized in terms of data such as concomitant injuries suffered by the limb (vascular, orthopedic, neurological and combinations), factors related to patients (age, clinical comorbidities and smoking) and the trauma (mechanism of injury, specific injuries, shock, hypothermia, time between trauma and receiving care), which aid in establishing the prognosis of attempts to salvage the limb[22]. Patients who underwent limb salvage attempts, but were then subjected to delayed amputations were not the object of study and were excluded from the sample.

Lack of data on the records meant that it was impossible to fully ascertain the number of patients with diabetes, lung disease, heart disease, osteoporosis and peripheral vascular failure or the how many were smokers[2,4].

The epidemiological importance of these factors lies in the role that their presence in the trauma case may play in worsening the prognosis of attempts to salvage the limb, given their relationships with perfusion, healing and the resistance necessary for recovery or to cope with challenges such as infections[4].

Patients less than 50 years old comprised the majority of the sample, which coincides with the economically phase of life[23]. The predominance of males, at a ratio of 2.6:1, is similar to other published data[7,24].

The chi-square test revealed no significant association between sex and age group ($p = 0.7386$, Table 1), but female patients suffered fewer amputations, which is similar to data available in the literature[7,25].

Trauma amputations, which were less common in the past, have a major socioeconomic impact because they affect a young age group, predominantly males, during the most productive phase of life[2,4,7,26].

In this sample there were a large number of amputations or disarticulations of fingers and toes and these were more prevalent among children, which is in line with the literature that shows that in this phase of life, especially among preschool and school aged children, primary trauma amputations are the result of traumas to fingers and toes rather than to limbs[2,7,27].

Primary amputation is defined as amputation on admission with no attempt at revascularization. The decision-making process is extremely complex[4].

A number of factors should be considered when taking this decision and they can be classified as patient-related, trauma site-related or care team-related[4].

The decision to perform a primary amputation after trauma is never an easy one, but it must be taken with very good judgment, particularly when an attempt to save an extremity will involve risk to life.

Many different scales have been constructed with the intention of supporting decision-making on whether or not to amputate[4]. These scales grade a series of variables related to the trauma and when the total number of points passes a cutoff point, primary amputation should be given very serious consideration. However, none of the many scales available is considered ideal.

The most widely-used graded scale is the MESS (Chart 1), but the following scales are also described in the literature: *Mangled Extremity Syndrome Index* (MESI), *Predictive Salvage Index* (PSI), *Hannover Fracture Scale* (HFS), *Nerve Injury, Ischemia, Soft Tissue Injury, Skeletal Injury, Shock and Age of Patient Score* (NISSSA) and the *Limb Salvage Index* (LSI).[4]

Chart 1. Criteria used in the *Mangled Extremity Severity Score*.

Skeletal/soft tissue injuries	Score
Low energy: pistol gunshot, simple fractures, stab wounds.	1.
Medium energy: open fractures, luxation/dislocation.	2.
High energy: crush injuries, high velocity gunshot.	3.
Gross contamination or tissue avulsion.	4.
Limb ischemia	Score doubles if ischemia > 6 hours.
Pulse reduced or absent, but normal perfusion.	1.
Pulselessness, paresthesia, reduced capillary filling.	2.
Pulseless, cool, paralyzed.	3.
Shock	
BPS > 90 mmHg.	0.
Transient hypotension	1.
Permanent hypotension	2.
Age	
Age <30	0.
Age 30-50	1.
Age >50	2.

BPS: Systolic blood pressure.

These scales, which have been analyzed by Razuk et al.[28], aid in deciding which procedure to employ, but the majority are subject to methodological failures that prevented them from being reproduced in independent studies.

Since this study was retrospective, the objective could not be to observe the MESS scale in use and make inferences about cases of primary amputation of mutilated extremities. Therefore, we opted to analyze whether the case records provided sufficient data to score the scale's criteria and whether the results were above or below the cutoff point suggesting a strong indication for the procedure analyzed.

The MESS was chosen because it was the most widely adopted in the literature reviewed, it requires few variables and appeared to be easy to apply. The cutoff points on the MESS are seven points or higher[4].

Just 68 of the cases studied had sufficient data to score the MESS criteria and in 13 of these the total score was below seven points. However, in these cases amputation was indicated due to peculiarities of the extremity that suffered the trauma (distal leg and/or foot) whose anatomic characteristics meant adequate vascular repair was not possible.

It is imperative to consider the largest possible number of factors when deciding to attempt to salvage a limb or to amputate, since prolonged attempts to salvage extremities with severe and complex injuries can be harmful to patients, particularly if all of the effort only leads to amputation later[4].

Combined injuries can affect the prognosis of limb salvage and these include: multiple fractures, Gustilo IIIC fracture, transection of the tibial or sciatic nerves, prolonged ischemia (> 6-12 h), infrapatellar arterial injury, venous ligature, extensive loss of soft tissues, insufficient soft tissue cover for vascular repair, severe wound contamination, hypovolemic shock combined with life-threatening injuries, crushing, elderly patients with comorbidities, delayed diagnosis, delayed surgery and delayed fasciotomy[2,4,5].

In these types of cases, North-American services have demonstrated it is more beneficial, in terms of reducing hospital and rehabilitation costs, time off work, and rates of complications, infections and, very often, deaths, to adopt an aggressive posture with a correctly indicated initial or primary amputation[29-31]. However, patients in the United States have better socioeconomic conditions allowing them access to advanced prosthetic technologies for limb remnants, which is not the case in Brazil, where the majority of people treated on the Brazilian National Health Service (Sistema Único de Saúde) have poor access to prostheses and rehabilitation, which, when available, may be of unsatisfactory quality.

Bondurant et al.[30], conducted a review of 53 mutilated lower extremities, and compared primary and delayed amputations in terms of morbidity and cost. Those who underwent primary amputation spent around half as along in hospital, at a cost of around 60%, as those who had delayed amputations. In terms of morbidity, none of the patients in the primary amputation group suffered sepsis or death, compared with six cases in the delayed amputation group.

Vascular repair with successful restoration of circulation does not necessarily guarantee that the limb will be saved or even that functional recovery is possible and both these factors should be considered when deciding what is the best therapeutic approach to vascular trauma in severely damaged limbs[4].

It should be mentioned that this sample also suffers from a selection bias caused by the convenience sampling frame, since the patients were treated at a tertiary hospital that concentrates severe cases and/or cases who arrive at the hospital having already exceeded the time limit for limb-saving revascularization. This bias is also affected by the fact that this is the only hospital within its area of coverage (containing a population of approximately two million inhabitants) that conducts highly complex operations and has emergency teams on call providing vascular surgery, orthopedics, general surgery, plastic surgery and neurosurgery. There are no other services or hospitals within a 400 km radius that have all of these specialists on duty. The State and Municipal bed control service only

directs complex traumas and vascular traumas to this hospital.

The results of this study allow for the conclusions that the incidence of primary amputations of extremities at the Hospital Santa Casa de Campo Grande, MS, was greatest among young adult males and that the primary cause was severe injuries suffered in traffic accidents.

Notwithstanding, further studies are needed focusing on the prevalence of these traumas and the procedures that they provoke and comparing preventative measures and improvements in the training of trauma care teams, reducing the number of amputations.

It is hoped that this will lead to more effective measures to reduce these undesirable rates.

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