Characterization of a Portuguese Major Amputee Population: 5 Years of a Physical and Rehabilitation Medicine Amputee Unit

Caracterização de uma População Portuguesa de Amputados Major: 5 Anos de uma Unidade de Amputados de Medicina Física e de Reabilitação

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Abstract

Introduction: *Knowledge of the amputee population is relevant for health care planning, namely rehabilitation services and demand for prosthetic devices. In Portugal, there is not enough knowledge concerning these data.*

We aim to characterize a sample of five-year cases from an Amputee Physical and Rehabilitation Medicine Unit of a Portuguese Tertiary Hospital.

Methods: *All records from 2015-2020, were reviewed. Only major limb amputees were included. Descriptive and subgroup analysis was performed.*

Results: *From 737 patients, 620 were included. The majority (69%) were men, with an average age of 55.5 ± 20.5 years at the time of their first major amputation. Amputation level was transtibial (TT) in 53%, transfemoral (TF) in 43%, with hip disarticulation, transradial, transhumeral and shoulder disarticulation ranging from 0:2% - 1.6%. The most common causes were dysvascular (64%) and traumatic (18%). Four out of 5 hip disarticulations were due to malignancy. More than half (54%) of vascular amputees were followed in the Diabetic Foot Clinic.*

The major re-amputation rate was 14%, including proximal and contralateral [10% for TF, 16% for TP]. The time between first major amputation and re-amputation was 1.6 ± 2.4 years. Overall mortality was 24%: 38% of deaths occurred in the first year and 76% in 5-years. Considering only vascular causes, mortality rose to 33% and re-amputation in first year was 20%. Prosthetics attribution rates were 77%-90% for unilateral lower limb (LL) amputees and 73% for upper limb amputees. Bilateral LL amputees (n=70) were BiTF, BiTT and TF+TT, with 5%, 84% and 63% prosthetics rates, respectively. Traumatic amputations had the highest prosthetics rate (96%). In total, 78 patients did not fulfill the criteria to initiate prothetization, among the stated reasons were bilateral amputation, balance or contralateral limb alterations and neurologic disturbances.

Conclusion: *We managed to achieve a characterization of a large case series of an Amputee population followed in a PRM Unit of a Portuguese Universitary General Hospital, focusing on the cause, level of amputation, re-amputation, prosthetics and mortality rates. This sample may contribute to a better knowledge of our amputee population, allowing for an improved approach to their medical care process and consequently a better-quality Amputee Rehabilitation.*

Keywords: *Amputees/rehabilitation; Amputation, Surgical; Amputation, Traumatic; Artificial Limbs; Portugal; Rehabilitation Centers.*

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Resumo

Introdução: O conhecimento da população de amputados é extremamente relevante para o planeamento em saúde, nomeadamente de serviços em reabilitação e atribuição protésica. Em Portugal não existe um conhecimento detalhado dos dados epidemiológicos relacionados com amputação de membros.

O nosso objetivo é a caracterização da casuística de 5 anos de uma Unidade de Amputados de Medicina Física e de Reabilitação de um hospital terciário português.

Métodos: Todos os registos de 2015-2020 foram revistos. Apenas amputações *major* foram incluídas. Foi realizada análise descritiva e de subgrupo.

Resultados: Dos 737 pacientes, 620 foram incluídos. Uma percentagem de 69% foram homens, com 55,5±20,5 anos há primeira amputação *major*. Nível de amputação foi transtibial (TT) em 53%, transfemural (TF) em 43%, com desarticulação da anca, transradial, transumeral e desarticulação do ombro entre 0,2%-1,6%. As causas mais comuns foram vascular (64%) e traumática (18%). Quatro das 5 desarticulações da anca foram causadas por malignidade. Dos amputados vasculares, 54% eram seguidos na Unidade de Pé Diabético.

A taxa de re-amputação *major* foi 14%, incluindo proximal e contralateral [10% para TF, 16% para TP]. O tempo entre primeira amputação major e re-amputação foi 1,6 ± 2,4 anos. A mortalidade global foi de 24%: 38% das mortes ocorreram no primeiro ano e 76% nos 5 anos. Considerando apenas a causa vascular, a mortalidade subiu para 33% e a re-amputação ao primeiro ano foi 20%. A taxa de atribuição de prótese variou entre 77%-90% para amputados de membro inferior (MI) unilateral e 73% para amputados de membro superior. Amputados de MI bilateral (n=70) foram BiTF, BiTT and TF+TT, com taxas de protetização de 5%, 84% e 63%, respectivamente. Amputações traumáticas tiveram a taxa de protetização mais alta (96%). No total, 78 pacientes não cumpriram critérios para iniciar protetização, alguns dos motivos apontados foram amputação bilateral, alterações do equilíbrio ou do membro contralateral e distúrbios neurológicos.

Conclusão: Descrevemos uma extensa casuística referente a uma população de amputados, seguida na consulta de um dos grandes hospitais universitários portugueses. A caracterização desta série focou-se essencialmente em dados como a causa, nível de amputação e taxas de re-amputação, protetização e mortalidade. Esta amostra, que julgamos muito representativa, pode contribuir para um melhor conhecimento de alguns dados da população de amputados em Portugal, permitindo uma mais racional abordagem do seu processo assistencial e consequentemente a uma melhor qualidade dos cuidados nesta importante área da MFR

Palavras-chave: Amputados/reabilitação; Amputação Cirúrgica; Centros de Reabilitação; Membros Artificiais; Portugal.

Introduction

Amputation is the loss - either surgical, traumatic, or congenital - of a body segment, frequently subsequent to an external lesion, procedure or aggression. The loss of a limb represents an irreparable damage that significantly affects the human being, and the patient's functional status and quality of life, leading to restrictions and new adaptations.[1-3]

Amputations can be divided into minor and major amputations. Major amputations comprise below-knee amputations and higher in the lower limb and are associated with higher disability and mortality rates.[4-6]

Most amputations occur as a result of peripheral artery disease (PAD), either on its own or in conjunction with uncontrolled diabetes *mellitus* (DM). Other causes include trauma, cancer, infection, and congenital factors.[1,7,8]

In the United Kingdom, approximately 10% of lower limb amputations (LLA) are attributed to trauma, while malignancy accounts for around 3%.[8,9] However, thanks to advancements in treatment methods, the number of amputations by these causes has been decreasing.[10]

'Dysvascular' amputations represent more than 90% of LLA in Western Europe.[4] Distinguishing its two primary causes (DM or PAD) as the main contributor is difficult, if not impossible since the two frequently occur together: almost half of the patients with PAD have DM.[11,12]

Approximately 25% of individuals aged 65 and above suffer from PAD,[13] often accompanied by other health issues like smoking, DM, end-stage kidney disease and coronary artery disease, which further elevate the chances of requiring amputation. For example, individuals with DM face a risk of LL amputation 10 to 20 times higher than that of the general population.[8,14] Moreover, these comorbidities also lead to worse functional outcomes and higher mortality rates after amputation.[5,15]

Ideally, amputation surgery should be considered as a final resort.[7] Despite improvements in perioperative risk assessment and care, amputations still carry a significant risk of mortality, especially for patients with PAD, with rates as high as 48% within one year following a major limb amputation.[8,10] It is crucial to have a comprehensive understanding of perioperative, preoperative, and postoperative management.

According to the guidelines provided by the National Institute for Health and Care Excellence (2012), individuals with peripheral arterial disease should only be considered

for amputation if they have critical limb ischemia and all attempts at revascularization have been unsuccessful.[8,16] The International Working Group on The Diabetic Foot, adds as further indications PAD accompanied by debilitating pain and severe infection that cannot be effectively managed through conservative measures.[17]

The choice of optimal amputation level is challenging, many patients and even clinicians would prefer a more conservative approach.[18,19] However, multiple factors should be considered when deciding the level of the amputation.

Although preservation of limb length is desirable it must be balanced against etiology. Excision of malignancy, infected and nonviable tissue and has to be prioritized, when sarcoma, osteomyelitis or vascular disease are present.[8]

Also opting for distal surgery as a strategy, and miscalculating healing capacity, may lead to subsequent re-amputation, multiple interventions and hospitalizations, with further decline in the physical, mental and functional health of amputees.[19,20]

Considering patient rehabilitation potential is another preponderant factor. When deciding on amputation level, surgical and prosthetic principles must be contemplated to optimize functional outcomes, prosthetic fitting, mobility, and quality of life. More proximal amputations, especially above the knee in LLA, increase difficulty in prothetization and require more energy expenditure in transfers and ambulation.[8]

The need for a multidisciplinary approach when caring for these patients, before, while and after the amputation process, is therefore definite. Based on this premise the Diabetic Foot Multidisciplinary Unit of the Hospital Geral de Santo António (HSGA) was created in 1987, a pioneer Unit in Portugal, that provides access-free appointments for the management of DM ulcers. Englobing endocrinology, vascular surgery, orthopedics and physical medicine and rehabilitation along with a nurse team and podology. As part of this Unit, is the Amputee Physical Medicine and Rehabilitation Appointment of the HGSA.

Recently, a notable positive decrease in the rate of major amputations has been observed in numerous European countries. For example in Germany, the annual rate of major amputation decreased significantly by 40% from 2005 to 2014, while the number of minor amputations increased.[11] In Spain, a more modest decrease of 1.85% in major amputations due to DM was seen from 2004 to 2012.[21] In the Portuguese population, there is a lack of knowledge of the amputee population.

Considering the high human and socioeconomic repercussions associated to major amputations, data given by epidemiology will allow for a better health care planning, allocation of resources (such as prosthesis and associated PRM services), prediction of tendencies and a deeper knowledge of the population and subsequently a better-quality Amputee Rehabilitation.

With this paper we aim to report a single-center experience, from the previously described specialized Amputee PRM Appointment Unit of a Portuguese Tertiary Hospital and characterize a 5-year patient sample while exploring the mortality and morbidity of this population.

Methods

All patient records of the Amputee PRM Appointment of HGSA, from 2015 until June 2021, were reviewed. Patients with at least one major limb amputation were included. Major amputation was defined as all amputations above the level of the wrist or tibiotarsal articulations, for upper limb amputation and LLA respectively.

Bilateral amputations were classified as bilateral transfemoral (BiTF), bilateral transtibial (BiTT) and associated transfemoral and transtibial (TF+TT).

Data on cause and level of amputation, re-amputation, prothetization and mortality were recorded. Descriptive analysis was performed with subgroup analysis for Causes and Level of Amputation.

Results

From a total of 737 patients followed in our Amputee PRM appointment, 615 were major amputations and thus included in the study.

As seen in Table 1, 69% were men, with a mean of 55.5 ± 20.5 years at first major amputation.

Amputation level was transtibial (TT) in 53%, and transfemoral (TF) in 43%, with hip disarticulation, transradial, transhumeral and shoulder disarticulation ranging from 0.2% - 1.6%. Upper limb amputees, including those with concomitant LLA, were a total of 22 patients and represented 3.6% of the overall major amputee population. Right and left side amputees were present in equal percentages (44%), bilateral amputees represent 11% of the population and only two patients were tetra-amputees.

The most common cause for amputation was dysvascular (64%) followed by traumatic cause (18%). Two hundred three of the 378 (54%) vascular amputees were previously followed in our Diabetic Foot Unit.

Forty-seven (8%) were neoplastic patients, in whom a more proximal level of amputation was observed – 36% were TF

Table 1 - Epidemiology and characterization of the PRM amputee sample, HGSA, 2015 -June 2021.

Variable	Total (n=615)
Age at Amputation (mean ± SD) (n=543)	55.5±20.5 y
Gender	
Female	192 (31%)
Male	423 (69%)
Diabetic Foot Clinic follow-up	224 (36%)
Level of 1st Major Amputation	
Transtibial	326 (53%)
Transfemoral	261 (43%)
Hip Disarticulation	5 (0.8%)
Transradial	10 (2%)
Transhumeral	4 (0.7%)
Shoulder Disarticulation	1 (0.2%)
Lower & Upper Limb	7 (1%)
Side of Amputation (n=600)	
Left	265 (44%)
Right	263 (44%)
Bilateral	70 (12%)
Tetra-amputation	2 (0.3%)
Cause of Amputation (n=588)	
Congenital	24 (4%)
Vascular	378 (64%)
Traumatic	105 (18%)
Neoplasia	47 (8%)
Infection	34 (6%)
Re-amputation (n=84)	**84 (13.7%)**
Contralateral	55 (65%)
Proximal	29 (35%)
Time 1st Amputation- Re-amputation (mean ± SD) (n=75)	1.6±2.4y
Bilateral Amputation (n=70)	
Transtibial	34 (49%)
Transfemoral	19 (28%)
Transtibial + Transfemoral	16 (23%)
Prothetization (n=603)	
No	112 (19%)
Yes	487 (81%)
LL yes, UL no	4 (0.7%)
Death by all causes	150 (24%)
Time 1st Amputation-Death (mean ± SD)	4.6±2.4y
Age at death (mean ± SD)	70.2±11.9y

LL – lower limb; UL – upper limb; SD – standard deviation

amputations and 4 out of the 5 hip disarticulations were due to malignancy. Infectious and congenital causes were present in lower percentages (6% and 4% respectively). There were two cases of tetra-amputations due to septic shock with need for intensive care. Most upper limb amputations were attributed to congenital, traumatic and neoplastic causes.

Eighty-four patients (14%) underwent major re-amputation surgery. Re-amputation rates were 10% for TF amputees and 16% for TTP amputees (Table 2). Of the 85 patients, 65% of were contralateral amputations and 35% were proximal re-amputations. The mean time between the first major amputation and re-amputation was 1.6 ± 2.4 years.

Overall mortality was 24% - 38% of deaths occurred in the 1st year after the primary amputation and 76% in 5-years after. Cumulative mortality is described in Table 3.

Mean time from first major amputation to death was 4.6 ± 2.4 years. Mortality rate was similar for TTP and TF amputees and, slightly higher in bilateral amputees (30%).

In the subgroup analysis performed by cause of amputation (Table 4), when considering only vascular cause, mortality rose to 33%, mortality at first year was 11% and the re-amputation rate was 20%, with a 12% re-amputation rate at first year. Congenital amputations presented with a 21% re-amputation rate. And in malignant amputations mortality was 30%.

Overall prosthetics attribution rates were 77%-90% for unilateral lower limb amputees and 73% for upper limb amputees. One hundred seventy eight out of the 230 transfemoral amputees were fitted, resulting in a 77% prosthetization rate, against 90% of transtibial amputees.

Considering cause (Table 4), vascular amputations had the lowest prothetization rate (74%) while traumatic amputations had the highest prosthetics attribution rate (96%).

Bilateral LLA (n=70) were BiTF (n=34), BiTT (n=19) and TF+TT (n=23), with 5%, 84% and 63% prosthetics rates respectively (Table 2).

A total of 112 amputees were not prosthetized. Of those, in 50 patients the process of prosthesis attribution was initiated but stopped due to intercurrences such as death,

Table 2 - Outcomes according to the level of amputation.

	TTP (n=267)	**TF** (n=230)	**Bilateral** (n=70)	**Upper limb** (n=14)
Prothetization	240 (90%)	178 (77%)	TTP 26 (84%) TF 1 (5%) TTP+TF 10 (63%)	11 (79%)
Mortality rate	68 (25.5%)	56 (24%)	22 (31%)	0
Reamputation rate	(n=326) 55 (17%)	(n=261) 27 (10%)	-	-

TTP transtibioperoneal; TF – transfemoral

Table 3 - Cumulative mortality (from amputation until June 2021).

Mortality	**Cumulative %**
[0-1] year	55 (37.7%)
]1-2] years	18 (12.3%)
]2-3]	17 (11.6%)
]3-4]	9 (6.2%)
]4-5]	10 (6.8)
>=5 years	37 (23.7%)

disease, physical deterioration, fitting intolerance. Meanwhile 78 patients (12.7%) did not fulfil criteria to initiate prosthetization. Most due to bilateral amputation limiting functional capacity (24 patients), balance or contralateral limb alterations (21 patients), cerebral stroke sequels (9 patients) or cognitive disturbance (6 patients). Four patients presented non-clinically stabilised cancer. Other, less frequent, motives for non prothetization were sacral ulcers, severe ADL dependence, concomitant UL amputation, amaurosis, stump alterations, respiratory/cardiac disturbance, lack of motivation and architectonic barriers.

Discussion

Our study showed a higher prevalence of the male sex among Portuguese amputees, in line with international literature reports.[17] More than half of our sample were transtibial amputees and the mean age at amputation 55 years old. Dysvascular cause was the most frequent, followed by traumatic and, in smaller percentages oncologic, infection and congenital causes, also in accordance with previous studies.[1,7,8]

Data on the Portuguese population is scarce. Nevertheless, the small rehabilitation sample studied, with psychosocial purposes, by Machado Vaz *et al* reflects this higher proportion of the male sex and higher prevalence of vascular amputation; but with transfemoral amputees representing the majority of their sample and an older mean age (above 65 years old).[1]

One limitation of our study is that our sample is restricted to amputees referred to the PRM appointment. As such, the incidence or risk factors for amputation in the overall population are impossible to analyze. Horta *et al* studied, in 2003, the Portuguese diabetic foot population of our Unit, and found that neuropathic feet were more prevalent than ischaemic, however, ischemic foot patients were

Table 4 - Outcomes according to the cause of amputation.

	Congenital (n=24)	**Vascular** (n=378)	**Traumatic** (n=105)	**Neoplasia** (n=47)	**Infection** (n=34)
Prothetization	20 (83%) 2 (8%) LL yes UL no	274 (74%)	98 (96%) 2 (2%) LL yes UL no	39 (85%)	31 (91%)
Mortality rate	0	125 (33%)	4 (4%)	14 (30%)	4 (12%)
1st year Mortality	-	43 (11%)	1 (1%)	8	2
Reamputation rate	5 (22%)	75 (20%)	1 (1%)	1 (2%)	2 (6%)
1st year Reamputation	-	47 (12%)	-	1 (2%)	1 (3%)

LL – lower limb; UL – upper limb

significantly more prone to major amputation than neuropathic ones. The major amputation rate was 5.2%, all preceded by an ulcer or foot infection.[22]

This also confers to our data a selection bias. For instance, mean age and mortality rates may be underestimated and prothetization rates may be overestimated, given that older patients with lower rehabilitation potential may not be referred to the PRM appointment. Moreover, an underestimation of the traumatic amputation rates may be present since these patients tend to be managed by private health insurance.

When considering amputation level, more than half of our patients were transtibial amputees. The transtibial level is considered the highest level of lower limb amputation that offers the possibility of restoring nearly normal function.[8] In fact 90% of our transtibial amputees were prosthetized, in line with this rationale.

Transfemoral amputees represented 43% of our sample. Amputations performed above the knee result in higher energy expenditure during walking and around 60% are too physically weak to use a prosthesis safely, resulting in poorer functional outcomes.[23] Still, in our PRM appointment, a higher-than-expected rate was achieved, and prosthesis attribution was of 77% in TF amputees. Moreover, bilateral LL amputees, particularly BiTT had an 84% prosthetic rate.

As for upper limb amputees, this is a particular population and represented 3.6% of the total major amputations. Prosthetic usage rates, vary according to the level of amputation, ranging from 9% to 81%.[24] Our study evaluated prosthetic attribution only, and not usage, finding a 70% attribution rate that fits in this wide range. Comfort, weight, and function have been listed as the critical factors for the use decision.

The overall prosthetic attribution rate of our appointment was 80% and in the dysvascular population, a 74% rate was achieved. Comparing studies are lacking, however, Chahrour *et al* state a 90.5% fitting rate.[7]

As seen in our study, only 12.7% of the amputees did not initiate the process, the stated motives fit in what are thought to be negative factors for prothetization – contralateral advanced ischemic disease, dyspnoea, severe neurologic disturbance, unresolved stump problems, visual loss, important physic/psych deficiencies and lack of motivation.[25]

We consider these percentages to be "close to optimal prosthetic attribution rates" which can be attributed not only to our selected population, but also to the implementation of a previous rehabilitation program, and to a careful and experienced consideration of indications for prothetization, that ponder not only ambulation capacity but also pain control and aiding transfers and mobility. Rehabilitation tailored to amputees has shown to be effective in enhancing the utilization of prosthetics and mobility, even among elderly patients.[26,27]

The second phase of our study analyzed re-amputation and mortality rates as unfavorable outcomes. Amputees are considered stable 1 year after surgery, this, however, does not mean resolution of all complications, morbidity and mortality following amputation.[8]

The care of the remaining limb goes beyond managing postoperative wounds and emphasizing the importance of caring for the opposite limb is crucial. There is an increased risk of osteoarthritis and, especially in patients with DM or DAP, of further proximal or contralateral limb amputation.[2,7,8]

Few studies have reported re-amputation rates after major LLA. Reported values range between 7%,[2] 9%-20%,[5] and 26%[4] for ipsilateral re-amputation rates after major LLA. Norvell *et al*, in dysvascular amputation, observed a risk of requiring at least one re-amputation of 25% in TT and 9% TF. Our re-amputation rate fits in the reported range. Considering both ipsilateral and contralateral amputation, 14% of major LLA underwent major re-amputation surgery, 20% in the dysvascular population.

Congenital amputations are also named as congenital limb deficiencies or malformations. In our population, only 24 patients were congenital amputees, however an important re-amputation rate (of 20%) was observed. In congenital limb deficiencies, surgical and re-amputation decision is an individualized process and may be needed due to associated anomalies and projection of growth, and limb discrepancy and remaining limb functionality.[28]

Mean time until overall re-amputation was 1.6 year. During this period, individuals often face frequent visits for wound care, experience mobility restrictions, and are highly dependent of assistance. These can result in further physical deconditioning, muscle loss and joint stiffness, ultimately limiting their ability of ambulation or for prothetization after a second amputation procedure.[29]

As already stated, historically, mortality rates after major LLA are another concern in this fragile population and reported long-term mortality rates are variable. Recent meta-analyzes and systematic reviews estimate mortality rates for major LLA to be 47%-48% and 52%-80% at one and five-years follow-up, respectively.[10,30] Our study did not consider immediate post-op mortality that, along with our selected population, may justify our overall lower mortality rate of 24%.

In our neoplastic population, higher levels of amputation were seen, similar to the described for the British population.[31] Moreover, the re-amputation rate was almost negligible, which could mean that when faced with a tumor a more conservative and prioritizing tumor excision approach is chosen. Patients amputated by neoplastic causes also presented with lower mortality rates than vascular patients, therefore we highlight the importance of a reinforced rehabilitation effort in these populations.

Several studies indicate that older age, end-stage renal disease and more proximal levels of amputation are associated with higher mortality rates.[4,10,30]

Curiously, when focusing for example in our dysvascular population, the 1st year mortality and the 1st year re-amputation rate (11% and 12% respectively) are almost complementary with the 26% of non-prosthetized dysvascular amputees. Amputees with complicated wound cicatrization, at risk of re-amputation, or fragile, with uncertain survival, are in fact, the patients that do not benefit from the prosthesis attribution. Thus, further studies of predictors for 1st year re-amputation or mortality are relevant to select when not to immediately proceed with prosthetics attribution.

Conclusion

We described a sample of the Portuguese PRM Amputee population focusing on cause, level of amputation, re-amputation, prosthetics and mortality rates.

Despite the progress made in revascularization techniques and medical treatments, major amputations continue to be a frequent occurrence. Better knowledge of the amputee population allows for an improved approach the amputation process and subsequent rehabilitation, along with the proper prescription of prosthetics that can greatly enhance patient functionality. Knowing re-amputation and mortality risks for our population, alerts to the importance of focusing on residual limb management, conducting regular fitting assessments, and educating patients about long-term skin care that can significantly reduce complications following amputation.

Ideally all amputees would be prosthetized, however, negative factors for successful prothetization should be considered and prosthesis attribution should be pondered individually, after optimization and an enhanced rehabilitation program.

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