

## Indications, complications, and revisions of amputations in Turkey

### *Türkiye’de amputasyonların endikasyonları, komplikasyonları ve revizyonları*

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#### Abstract

**Aim:** The objective of this study is to determine the incidence of indications for amputations, major amputation related complications and revision numbers in Level I trauma center; which consists burn care unit, hyperbaric oxygen unit and hand surgery department in Turkey.

**Materials and Methods:** Amputation procedures were retrospectively reviewed and evaluated according to the amputation levels, etiology, and demographic data. Major complications that require surgical intervention, type of surgical intervention for these complications and interval between index surgery and first complication related surgery were recorded. Re-amputations were evaluated according to interval between index and revision surgery, revision indication, and revised level.

**Results:** A total of 558 amputations were performed for 476 patients (367 male, 109 female) in five-year period. The most common indication of amputation was diabetic complications, 250 amputations for 215 diabetic patients (44.8%) were performed. Peripheral arterial disease and trauma were the second and third common indications. The most common indication for upper extremity amputation was trauma. The most common amputation levels were hand amputations in the upper extremity, and below-knee amputation in the lower extremity. Fifty-seven of the surgical procedures were re-amputations and the interval between index surgery and revision amputation was 5.0±15.8 months. The most common indication for revision amputation was diabetic complications. Complications that required surgical intervention were infection in 46 patients, local soft tissue necrosis in 28 patients, and wound dehiscence in 2 patients.

**Conclusions:** This is the first study investigating amputation etiology from high capacity hospital in capital city of Turkey that can demonstrate the whole country. The most common indications in this study were diabetic foot, PAD, and trauma as it is in developed countries. The results of this study can be the first step of multicenter epidemiological studies about amputations.

**Keywords:** Amputation, Turkey/Epidemiology, indications, limb amputations.

#### Öz

**Amaç:** Bu çalışmanın amacı, Türkiye’deki amputasyon endikasyonlarının insidansını, amputasyon sebepli majör komplikasyonları ve revizyon sayılarını yanık merkezi, hiperbarik oksijen ünitesi, el cerrahisi kliniği olan birinci seviye travma merkezinde belirlemektir.

**Gereç ve Yöntemler:** Amputasyonlar geriye dönük olarak incelendi ve amputasyon seviyeleri, etiyoloji ve demografik verilere göre değerlendirildi. Cerrahi gerektiren komplikasyonlar, bu cerrahilerin çeşitleri, revizyon cerrahisinin zamanı ve ilk cerrahi kaynaklı komplikasyonlar kaydedildi. Yeniden amputasyonlar revizyon cerrahisi zamanına, revizyon endikasyonuna ve revize edilen seviyeye göre değerlendirildi.

**Bulgular:** Beş yıllık dönemde 476 hastaya (367 erkek, 109 kadın) toplam 558 amputasyon yapıldı. En sık amputasyon endikasyonu diyabetik komplikasyonlardı, 215 diyabetik hastaya (%44,8) 250 amputasyon uygulandı.

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*Periferik arter hastalığı ve travma ikinci ve üçüncü sık endikasyonlardı. Üst ekstremitte amputasyonu için en yaygın endikasyon travmaydı. En sık görülen amputasyon seviyeleri üst ekstremitede yapılan el amputasyonları ve alt ekstremitede diz altı amputasyon olarak bulundu. Cerrahi işlemlerin 57'si yeniden amputasyondur ve ilk cerrahi ile revizyon amputasyonu arasındaki süre  $5,0 \pm 15,8$  aydır. Revizyon amputasyonunun en sık endikasyonu diyabetik komplikasyonlardı. Komplikasyonlar 46 hastada enfeksiyon, 28 hastada lokal yumuşak doku nekrozu ve 2 hastada yara ayrılmasıydı.*

**Sonuç:** *Bu çalışma, Türkiye'nin başkentinde bulunan yüksek kapasiteli ve tüm ülkeyi temsil edebilecek bir hastanede amputasyon etiolojisini araştıran ilk çalışmadır. Bu çalışmada en sık endikasyonlar, gelişmiş ülkelerde olduğu gibi diyabetik ayak, PAH ve travmadır. Bu çalışmanın sonuçları, amputasyonlarla ilgili çok merkezli epidemiyolojik çalışmaların ilk adımı olabilir.*

**Anahtar Sözcükler:** *Amputasyonlar, Türkiye/Epidemiyoloji, endikasyon, ekstremitte amputasyonları.*

## Introduction

Amputation is one of the major surgical procedures in orthopedic practice and has historically been used for treatment of limb threatening conditions from very early times (1, 2). The most common indication of amputation in the lower extremities is complications associated with diabetes mellitus, while in the upper extremities is trauma (3, 4). With the development of modern medicine, it has become more possible to preserve limb functions for the medical professionals. However, due to the aging population the number of amputations performed increases every year. It is expected that the number of amputations will triple by 2050 (3, 5). If the viability of the extremity cannot be provided by modern medicine, amputation is still a surgical option for the patient to return to daily life (2, 6).

Indications for amputations include trauma, diabetes complications, peripheral arterial disease (PAD), infection, malignancy, thermal injury, and congenital or severe deformity (1, 7, 8). Although indications differ in developed countries and developing countries, the most often indication for amputation is diabetic complications throughout the world. Also, there are some regional changes in amputation indications all over the world and there is limited data on amputation indications in Turkey (1, 4, 7, 9-11). Additionally, revisions that require amputation or incidence of major complications of amputation have never been studied in Turkey.

There is no study that evaluates countrywide indications, complications, and revisions of amputation in Turkey. The objective of this study is to determine the incidence of indications for amputations, major amputation related complications and revision numbers in our Level I trauma center; which consists of burn care unit, hyperbaric oxygen unit and hand surgery department for both civilians and military forces.

## Materials and Methods

Patients who underwent amputation between January 2014 and January 2019 in our department were included in this retrospective study. Amputation levels, etiology, and demographic data (age, gender) were evaluated for all patients. Indications were divided into seven major categories: diabetes complications, PAD, trauma, infection, malignancy, thermal injury and severe deformities. Furthermore, major complications that require surgical intervention, type of surgical intervention for these complications and interval between index surgery and first complication related surgeries were recorded. If the surgery was a revision amputation, interval between index and revision surgery, revision indication, and revised level was recorded. Descriptive statistics for discrete data, namely frequency, percentage, mean  $\pm$  standard deviation for continuous variables were used using the SPSS 18.0 program.

The research protocol was approved by the local scientific research ethics committee (19.05.2020/2020-214).

## Results

A total of 558 amputations were performed in 476 patients (367 male, 109 female) in five-year period. The most common indication for amputation was diabetic complications, 250 amputations for 215 patients (44.8%) were performed. PAD and trauma were the second and third common indications: 116 amputations (20.7%) for 90 patients and 110 amputations (19.7%) for 99 patients, respectively (Table-1, 2).

Sixty-eight upper extremity amputations were done (12%). The most common indication for upper extremity amputation was trauma (44 amputations for 43 patients), followed by PAD (10 amputations for eight patients). One patient had four extremity amputations due to septic circulatory disorder.

**Table-1.** Amputation levels according to indications.

	Lower Extremity						Upper Extremity					
	Foot-Finger	Syme	Below knee	Knee	Above knee	Hip	Hand Finger	Wrist	Below elbow	Elbow	Above elbow	Shoulder
Diabetes	112	2	113	-	23	-	-	-	-	-	-	-
PAD	37	-	45	1	23	-	10	-	-	-	-	-
Trauma	16	1	28	2	18	1	34	-	6	1	3	-
Infection	25	-	8	-	1	-	-	1	1	-	-	1
Tumor	-	-	3	-	2	3	1	-	-	-	-	-
Thermal	5	-	5	-	-	-	-	-	3	-	4	-
Deformity	10	1	3	1	1	-	3	-	-	-	-	-
Total	205	4	205	4	68	4	48	1	10	1	7	1

**Table-2.** Detailed indications for trauma, infections, and thermal injuries.

Trauma	40 bomb attack (36%), 22 industrial injuries (20%), 21 gunshots (19%), crush (13%), 10 traffic accidents (9%), 2 farm injuries (1%), 2 falls from height (1%)
Infection	30 osteomyelitis (81%) 4 Septic circulatory disorder (10%), 2 septic orthopedic implants (5%), 1 necrotizing fasciitis (3%)
Thermal injury	9 electric burns (53%), 5 burns (29%), 3 frostbite (18%)

**Table-3.** Population characteristics of amputations.

Indication	Revision amputations							Primary amputations					
	n	Gender	Age (Range)	Height (cm)	Weight (kg)	BMI	Revision time (days)	n	Gender	Age (Range)	Height (cm)	Weight (kg)	BMI
Diabetes	36	28 M; 8 F	66.6 (40-82)	165.4	86.6	31.6	6.1	214	152 M; 62 F	65.4 (33-89)	166.7	85.6	30.8
PAD	16	14 M; 2 F	58.3 (32-86)	164.3	80.1	29.7	2.6	100	77 M; 23 F	61.7 (32-90)	165.1	80.6	29.4
Thermal	2	2 M; 0 F	34 (16-52)	177.5	74	23.6	5.0	15	15M; 0 F	31.0 (16-52)	171.2	80.2	27.4
Trauma	2	2 M; 0 F	21.5 (21-22)	179.5	78	24.1	4.0	108	102 M; 6 F	32.1 (1-73)	169.2	81.6	28.4
Infection	1	1 M; 0 F	28	176	76	24.5	24	36	23 M; 13 F	53.0 (19-82)	167.3	79.9	28.7
Tumor	0	-	-	-	-	-	-	9	8 M; 1 F	53.7 (23-72)	167.7	78.4	27.6
Deformity	0	-	-	-	-	-	-	19	16 M; 3 F	13.2 (1-34)	166.2	78.1	28.3

The most common amputation level was hand (distal to the wrist joint) with 48 procedures in the upper extremities. Ten below-elbow and seven above-elbow amputations were performed. Shoulder, elbow and wrist disarticulation were performed once. All ten amputations performed for PAD were distal to the wrist joint (Figure-1).

In the lower extremity, the most common amputation levels were below-knee (205 amputation), and foot amputations (distal to talocrural joint) (205 amputation). Above-knee amputation was performed for 68 patients, and followed by four hip, four knee disarticulation and four Syme amputation. All patients with diabetic complications had lower extremity amputations.



**Figure-1.** Clinical image of below-elbow amputation of 26-year-old male during other extremity soft tissue reconstruction.

Fifty-seven of the surgical procedures were revision amputation, which could be defined as amputation at a higher bone level. Interval between index surgery and revision amputation was  $5.0 \pm 15.8$  months (range 1-120 months) and average age of the patients' was  $60.8 \pm 17.1$  (48 male, 9 female) (Table-3).

The most common indication for revision amputation was diabetic complications (36 patients), followed by 16 PAD. The most common procedures were below knee amputation of foot amputee ( $n=22$ , 38%), and above knee amputation for below knee amputee ( $n=14$ , 23%). One patient with below-elbow amputation was revised by above-elbow amputation. Four of the revision amputation was complicated with stump infection. Two of these patients were treated by revision of the levels, one patient needed vacuum assisted closure and one patient was treated with multiple debridement (Figure-2).

Complications that required surgical intervention were infection in 46 patients, local soft tissue necrosis in 28 patients, and wound dehiscence in 2 patients. Average age of these patients was  $56 \pm 18.7$  and average time between index

amputation and the first complication operation was  $27.5 \pm 25.2$  days (range 5-180). Primary cause that required revision surgery was diabetic complications; 46 diabetic patients suffered complications. Nineteen patients had revision surgery because of PAD, while revisions were done for 16 trauma patient, 3 infection patients, and 2 thermal injury patients. For this group, re-amputation was utilized for 33 patients, local soft tissue debridement and revisions were utilized for 31 patients, and 12 patients were treated by multiple debridement or vacuum assisted closure.



**Figure-2.** Diabetic foot. Clinical image after finger amputation before below-knee amputation.

## Discussion

Although there are many studies that investigate indications of amputations from different countries and regions, there is no comprehensive study about amputation indications in Turkey (1-4). The largest one in Turkey is a local study from Van (1). Different from this local study this is the first study in a resourceful hospital that serves in the capital city of the country and accepts patients from all over the country.

The rate of amputation was 3 fold higher among males than females in this study. The ratio is similar with the previous reports. Higher incidence among males is due to the high

incidence of vocational or motor vehicle accidents among men. Furthermore, diabetes and PAD are generally more common among males (1, 4, 8, 12).

Indications for amputation include diabetic complications, trauma, peripheral arterial diseases, infections, thermal injuries, malignancies, and severe deformities. Diabetic foot is the most common indication in Western countries while trauma is still the most common indication in undeveloped countries or regions (1, 3, 4, 12). The result of this study demonstrates similar results with developed countries. In this study diabetic foot is the most common indication for amputation (44.8%), followed by PAD (20.7%), trauma (19.7%).

Diabetic foot develops secondary to peripheral neuropathy and angiopathy and foot ulcerations and osteomyelitis are seen up to 25% amongst diabetes patients (8, 13, 14). Previous studies from developed countries reports diabetic complications as the major indication in the lower limb (3, 4, 15). In our study, all 250 amputations for diabetes mellitus were in the lower extremity. Patients with previous diabetes diagnosis were included in the diabetic complications group and patients without previous diagnosis were included in related groups such as infection or PAD. To minimize the effect of retrospective design of this study, all patients' records were searched over the national electronic health system especially for any admission to endocrinology, internal disease or vascular surgery departments.

Although extremity revascularization is the first treatment choice in PAD, up to 20% of PAD patients need amputation after vascular surgery (16-18). Overall incidence of PAD among amputation indications was 20.7% in this study. In our opinion the large hyperbaric oxygen treatment center in our hospital, which accepts patients from different parts of the country caused higher incidence of PAD than trauma. PAD with or without diabetes was found to be the one of the major reasons that cause re-amputation for previously amputated or contralateral extremity, and 8% of PAD amputation patients had prior major amputation (18-20). Sixteen patients had multiple amputations and half of these were done in two or more extremities. One patient who had Burger's Disease had 9 amputations in all four extremities. He had thumb, second and fifth finger amputations in right hand, thumb and

second finger amputations in left hand, and 4 revision amputations in the lower extremities. He had previous finger amputations in the lower extremities.

Trauma is the second common cause of limb loss (21, 22). Trauma accounts approximately 16% of all amputations, but especially in the upper extremity it is the most common indication for amputation (3, 5). In our study, 19.7% of amputations were made secondary to trauma. Traffic accidents, gunshot injuries, and fall accidents are the most common causes of trauma related amputations (21, 23). Similar common causes were found, but industrial accidents accounted for 19% of traumatic amputations in this study. Almost every industrial accident affected upper extremity (91%). Gunshot or explosive related injuries were the most common cause of traumatic amputations in this study due to the proximity of our country to the conflict areas (54%).

Another common indication for amputation is severe soft tissue infections or osteomyelitis and amputation was indicated approximately 7% for these patients (24, 25). In this study the most common infection related amputation indication was bacterial osteomyelitis, which accounted 81% of amputations. Overall incidence of infection in amputation indications in this study was 6.6%.

The other causes of amputation are congenital deformities, thermal injuries, and malignancies. Congenital deformities were the indication for 3.4% of the amputations and half of these patients had polydactyl (in 7 foot, and 3 hand). Thermal injuries consist of burns, electrical burns, and frostbite and account for 2-6% of amputations (26, 27). Seventeen patients were treated by amputation due to thermal injuries in this study during 5 years period. In this functional limb salvage era of musculoskeletal malignancies, amputation is still a surgical option for malignancies that wide resection cannot be enough for functional extremity or recurrence of the malignancy (28, 29). In this study only 1.6% of the amputations were done because of musculoskeletal malignancies.

Complications at the amputation stump and re-amputations are frequent after amputations. There is limited data about complications and revisions of amputation surgery in Turkey. Alivola et al. reported 20% amputation site complication ratio in lower limb amputations (21,30). Izumi

found re-amputation rate 26.7% at 1 year, and 60.7% at 5 years in their study including 277 diabetic patients. The most critical time for re-amputation was the first six months after index amputation in their study (31). The rate of surgical site complications that requires additional surgery was 13% in this study and all complication surgeries were done in the first six months similar with the literature. Almost half of these patients needed re-amputations. In this study 10% of the amputations were re-amputations and the most common patient group that needed re-amputation was diabetic patients followed by PAD.

The major limitation of this study is the retrospective design of the study that can lead misclassification of the indications. To avoid this limitation meticulous evaluation of endocrinology, internal medicine, vascular surgery, and infectious disease departments' records was done. Additionally, while assessment of revision surgeries, patients that admitted another center for re-amputation possibly could decline the revision numbers. The patients whose first surgery was done in different center that we done

re-amputation were assumed as equalized the numbers. Also, due to the retrospective design, metabolic status and data of additional treatments of all patients cannot be assessed. Another limitation was the lacking of multicenter assessment.

### Conclusion

This is the first study investigating amputation etiology from high capacity hospital in capital city of Turkey that can demonstrate the whole country. Although every effort aims to save the limb in any indication, amputation is not a rare surgery in orthopedic practice. The most common indications all over the world are diabetic foot, PAD, and trauma. The results of this epidemiological study can be the first step of multicenter epidemiological studies about amputations.

### Conflict of interest

The authors declared they do not have anything to disclose regarding conflict of interest with respect to this manuscript.

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