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Demography and Clinical Consequences of Trauma-Related Amputations in the Emergency Department Short

Acil Servise Başvuran Travmatik Amputasyonların Demografik ve Klinik Sonuçları

Sedat Koçak[1], Birsen Ertekin[2], Esma Erdemir[1], Abdullah Sadık Girişgin[1], Başar Cander[1]
[1]Department of Emergency Medicine, Meram Faculty of Medicine, Konya University, Konya, Turkey
[2]Department of Emergency, Beyhekim State Hospital, Konya, Turkey

Abstract

Objective: Total or subtotal traumatic extremity amputations constitute a considerable portion of trauma-related emergency department admissions. In this study, we aimed to establish the patients' age group, educational level and occupational group in which trauma-related extremity amputations are more frequently performed.

Material and Methods: Cases presenting to our Emergency Department between August 2006 and August 2008, in whom traumatic extremity amputations were performed were prospectively studied. The data that were recorded on a study form, which included age, sex, educational level, occupation, mechanism of the trauma and hospitalization duration, underwent evaluation.

Results: The data of 309 subjects were evaluated in this study. The mean age of the patients was 29±17.9, with 18.1% of the subjects being female and 81.9% being of male gender. 41.1% of the cases were laborers, 23.6% were self-employed in various fields, and 9.4% were farmers. With respect to the method of trauma in the majority of the amputations, industrial injuries accounted for 65.7%, finger jamming (door-related) accounted for 17.2%, and home injuries accounted for 8.7%. Finger amputation was identified in 93.4%, toe amputation in 4.4%, and "others" in 2.2%.

Conclusion: Traumatic amputation concerns particularly children, youths, and people of low educational level with an active work life. The most frequently affected body parts are the fingers. *(JAEM 2013; 12: 205-10)*

Key words: Trauma, amputation, emergency medicine

Özet

Amaç: Total veya subtotal travmatik ekstremite amputasyonları travma ile ilişkili acil servis başvurularının önemli bir bölümünü oluşturmaktadır. Bu çalışmada, hastaların yaş, meslek, eğitim düzeyleri ve travma ile ilişkili ekstremite amputasyonlarından hangisinin en sık görüldüğünü tespit etmeyi amaçladık.

Gereç ve Yöntemler: Çalışmada Ağustos 2006-2008 tarihleri arasında acil servise başvuran travmatik ekstremite amputasyonlu olgular prospektif olarak incelendi. Yaş, cinsiyet, eğitim düzeyi, meslek, travma mekanizması ve hastanede kalış süresi değerlendirildi.

Bulgular: Bu çalışmada 309 olgu değerlendirildi. Hastaların yaş ortalaması 29±17,9 iken bunların %18'i kadın ve %82'si erkek idi. Olguların %41,1'i işçi, %23,6'sı serbest meslek ve %9,4'ü çiftçi idi. Amputasyonlar oluş mekanizması açısından değerlendirildiğinde, iş kazaları %65,7, parmak sıkışması (kapıya) %17,2 ve ev yaralanmaları %8,7 oranında sorumluydu. %93,4'lük parmak ampütasyonunun, %4,4'ünü ayak amputasyonu ve %2,2'sini de diğerleri oluşturmaktaydı.

Sonuç: Travmatik amputasyonlar başta çocuklar, gençler, aktif bir çalışma hayatı olan ve eğitim düzeyi düşük insanlarda daha sık görülmektedir. En sık etkilenen vücut parçası olarak parmaklar tespit edilmiştir.

(JAEM 2013; 12: 205-10)

Anahtar kelimeler: Travma, amputasyon, acil tıp

Introduction

Traumatic amputation warrants special attention as it causes aesthetic and functional defects and loss of workforce, in addition to psycho-social consequences. The loss of a part of a person's body and normal appearance, loss of one's job and loss of social environment, having to live one's remaining life being dependent on others, all constitute more serious psychosocial trauma than physical trauma. On the other hand, major amputations can be life-threatening. In 2005, it was reported that 1.6 million people with extremity amputations lived in the USA and 45 percent of them had suffered traumatic amputation (1). A two-fold increase has been estimated in the number of traumatic and non-traumatic amputee patients in the projection for the year 2050 in the above-mentioned study. Furthermore, it has been emphasized that one has to pay attention to the necessity of concentrating on the causes, results and preventive measures in order to avoid accidents. The majority

Correspondence to / Yazışma Adresi: Birsen Ertekin, Department of Emergency, Beyhekim State Hospital, Konya, Turkey
Phone: +90 332 353 94 27 e.mail: biceacil@hotmail.com

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of amputations are caused by preventable injuries. Moreover, it is of great importance, since the re-implantation of a properly preserved and transferred part at a specialized centre is possible. Determining the factors causing traumatic extremity amputations and the parameters that may affect the treatment success will serve as a guideline in establishing the precautions and making the choice of treatment.

Cases with extremity amputation isolated or accompanied by other traumas who had presented to the emergency unit due to various traumatic causes were dealt with epidemiologically. In the study, the etiological factors and demographic characteristics that cause traumatic amputations were investigated. In this way, an attempt was made to determine the issues to be taken into account regarding preventive measures.

Material and Methods

In this observational prospective study, cases with traumatic amputation who had presented to the emergency department of our university hospital between August 2006 and August 2008 were studied. All partial or total extremity amputations (with or without bone loss) caused by traumatic situations such as occupational injuries, home injuries and traffic injuries were included. Approval for the study was obtained from the Local Ethics Board of our University. A written informed consent was obtained from all cases or their immediate relatives. Patients who did not consent to participate in the study, patients with incomplete or contradictory information from registration forms and patients without any intervention during the first presentation that had been referred from other healthcare facilities were excluded from the study.

Statistical analysis

A special form was prepared at the beginning of the study and this form was filled separately for every patient when they presented to our emergency department. The demographic features of the patients, the modes of trauma, the amputation area, interventions performed, diagnosis, duration of hospitalization, and the results were recorded. The variables were described as means±standard deviations, median values or percentages. For comparison of more than two groups, the Oneway Anova and the Tamhane (as a post-hoc test) tests were used for the parametric data, and the Kruskal-Wallis test was used for non-parametric data. The differences between the two groups were compared using the Mann-Whitney U test. In addition, the Chi-square test for the categorical variables and the Spearman's correlation coefficient for determining the linear relationship were used. Statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS)™ for Windows version 15.0 program. P values of less than 0.05 were considered statistically significant.

Results

The number of cases with trauma who had presented to our clinic between August 2006 and August 2008 was 11.452. Among these, 511 (4.5%) cases underwent an extremity amputation at some level. Of the 511 cases, 309 with reliable data were included in the study. Two hundred and fifty-three (81.9%) cases were male and 56 (18.1%) were female. Overall, the mean age of the amputee patients was 28.9±17.9 (95% CI: 26.9-30.9; median 27 [range 1-82]) years. The number of children aged ≤18 years was 96 (31.1%). The age and sex distribution of the cases can be seen in Table 1. Although the majority of the cases were male, it was found that the incidence in female patients was significantly higher in the group aged ≤18 years ($p<0.001$).

A review of the educational status of the cases revealed that 149 (48.2%) had completed primary school, 87 (28.2%) secondary school, 16 (5.2%) high school and 5 (1.6%) university; the remaining 52 (16.8%) were either attending primary school or were pre-school-aged children (≤11 years). In the statistical evaluation (except for the pre-school aged children), the amputation rate in primary school graduates was significantly higher than that of graduates of secondary school and higher ($\chi^2=6.5$, $p=0.011$). According to data from the Turkish Statistical Institute, the ratio of primary school graduates to graduates of secondary school and higher was estimated to be one in the general population. Therefore, when the population where the study was carried out was taken into account, the same result was obtained ($\chi^2=6.5$, $p=0.011$). On the other hand, it was determined that the self-employed, retired, and civil servant groups composed the majority of those with secondary or higher education level. ($\chi^2=23.1$, $p<0.001$).

Of the cases, 127 (41.1%) were laborers, 73 (23.6%) were self-employed, 29 (9.4%) were farmers, 12 (3.9%) were housewives, 6 (1.9%) were retired, 4 (1.3%) were civil servants, 19 (6.2%) were students and 39 (12.6%) were preschool-aged children (≤5 years old). When we evaluated the rate of the occupational distribution excluding the number of students and children, 50.6% of the cases were laborers, 29.1% were self-employed, 11.6% were farmers, 4.8% were housewives, 2.4% were retired, and 1.6% were civil servants. Regarding the relationship between occupation and amputation, individuals with an active work life (laborer, farmer, self-employed) had a significantly higher risk than others ($\chi^2=130.9$, $p<0.001$).

Distribution of trauma causes has been presented in Figure 1. In cases under 18 years of age, the causes of amputation have also been displayed in Table 2. When the evaluation was performed for age and gender, door-related amputation rates were significantly higher in females ($p=0.01$) and children ($p<0.001$). The majority (31 of 42, 74%) of these amputations had occurred in children aged ≤5 years. Injuries with mole guns were significantly higher in the group aged >60 years ($p<0.001$). While finger jamming was the most com-

Table 1. Distribution of traumatic amputation cases according to age and gender groups

Age groups	Female	Male	Total	%
0-5	23	16	39	12.6
6-12	5	14	19	6.1
13-18	5	33	38	12.3
19-24	4	32	36	11.7
25-34	5	53	58	18.8
35-44	6	54	60	19.4
45-54	4	24	28	9.0
55-64	2	18	20	6.5
65+	2	9	11	3.6
Total	56	253	309	100

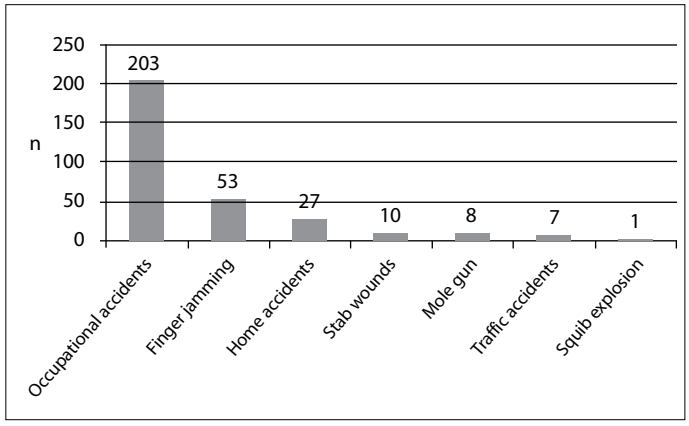

Figure 1. Etiology in traumatic amputee patients

Table 2. Distribution of the causes of traumatic amputations in the group under 18 years old

Causes/Age	0-5y	%**	6-12y	%**	13-18y	%**	Total	%**
Work-related	*4	4.2	*8	8.3	27	28.1	39	40.6
Household	4	4.2	3	3.1	3	3.1	10	10.4
Door-related	31	32.3	7	7.3	4	4.2	42	43.8
Mole gun	-	-	-	-	-	-	-	-

*Indicates the children permitted to work illegally at an early age or children not working but injured in the workplace due to lack of proper supervision.
**Percentages may not correspond to total because of rounding

mon etiology among women (53.6%, 30/56), occupational injury was the most common among men (73.9%, 187/253). The mean duration between the injury time and time of admission to our clinic was 55.3±37.1 (95% CI: 51.1-59.4; median 45) minutes. 71.8% of the patients had presented within the first hour and 95.2% within the second hour of the incident.

The total number of partial or total amputations in the 309 cases was 412; of these, 191 (46.4%) were fingers of the right hand, 194 (47.1%) were fingers of the left hand, 15 (3.6%) were toes of the left foot, 3 (0.7%) were toes of the right foot and 9 (2.2%) comprised "other" parts (i.e. wrist, elbow and below knee). There was no relationship between the localization of the amputation and the patients' age, sex, time of arrival to our emergency department, clinics in which they had undergone consultation and the length of stay in t hospital ($p>0.05$). Of the 300 cases that had suffered from finger and toe amputation, the reason for the amputation in 201 cases was an occupational injury (67%).

Stump repair was performed on 142 (46.0%) cases in the emergency unit. One hundred (32.4%) received only dressing for their wounds and tetanus prophylaxis. Ninety-one of these cases were hospitalized in the involved clinics (orthopedics, plastic surgery). Re-implantation was carried out in 29 (9.4%) cases in the emergency operating room and 38 (12.3%) underwent primary repair accompanied by other interventions (tendon and fracture repair, cast splint, etc.). Primary repair and re-implantation rates were higher in the group aged ≤18 years than the other age groups ($p<0.001$). Furthermore, the primary repair rate was higher in females than males ($p=0.37$). Management of all the patients has been summarized in Figure 2. All of the 91 cases were discharged after treatment. While the mean follow-up period of the cases in the emergency unit was 1.2 days, it was 3.8 (median: 3 days) days in the other clinics.

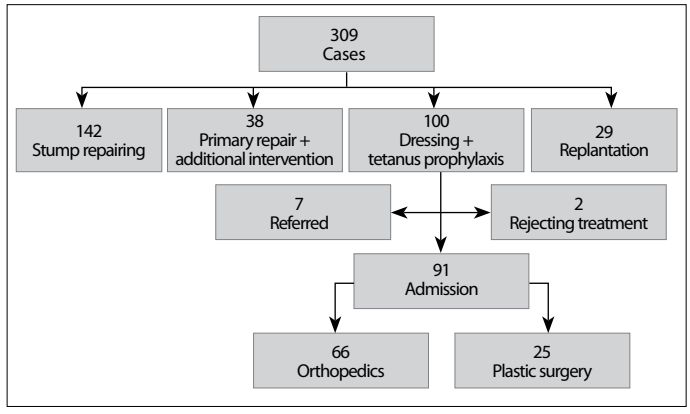

Figure 2. Management of the cases with traumatic amputations in emergency service

Discussion

The number of epidemiological studies including all types of traumatic amputations is rather limited. Many of the epidemiological studies of traumatic amputations have been related to occupational aspects or injuries in a more specific field of work (2). While some studies have investigated traumatic amputations caused by a certain machine or instrument (i.e. lawnmower, electrical saw and various cutting instruments), the majority have investigated injuries to certain parts of the body (i.e. hand, foot, lower and upper extremity amputations) (3-5). No matter the cause, traumatic amputations have destructive effects on individuals. In particular, total extremity losses with no opportunity for re-implantation are a serious source of psychosocial problems in the individual and society, in addition to the aesthetic and functional imperfection, there is a loss of workforce and increased healthcare expenses (6, 7).

Asplund et al. (8) established the traumatic amputation incidence as 5.21 (100.000 people/year) in their study carried out between 1998 and 2006. Moini et al. (9) reported the rate of extremity amputation as 0.92% among trauma cases presenting between 2000 and 2004. Atroshi and Rosberg (10) reported the incidence of upper extremity amputation and devascularization injuries as 1.9 (1.7-2.1) (per 100.000 population/year) in 10 years. Dillingham et al. (11) established the major amputation incidence as 1.07 and the minor amputation incidence as 4.7 (per 100.000 population/year) in 1993. We found the incidence of amputation cases among all trauma cases as 4.5% in our study over a two-year period. This rate is rather high compared to other studies. It has been considered that this can be attributed in part to the region our hospital serves, which is an industrial area with a large labor force. The risk of occupational injuries is rather high in the region, and it is a tertiary healthcare facility to which such cases are frequently referred.

When the age and sex distribution of our amputation cases was evaluated, it could be seen that most of the cases were young adults and more than 4/5th of the cases were males. According to a survey in 2007 carried out by the Turkish Statistical Institute, while 2.9% of the employees in a workplace had reported an occupational injury in the previous 12 months, this rate was 3.6% among men and 1.3% among women (12). Totally, 86.8% of the cases who had suffered an occupational injury were men. Similar results were obtained from the other epidemiological studies. In the study of Dillingham et al. (11), 57.1% of the cases were between 15-44 years of age and 83.5% were

male. In their study investigating finger amputations caused by occupational injuries, Sorock et al. (13) found the annual rate as 9.3/100.000, and the incidence rate in males was 14.7% and that in females was 1.9%. In the study by Boyle et al. (14) on work-related amputations, it was determined that 86% of the participants were male and 75% were between 15-44 years of age. Moini et al. (9) reported that 87.2% of the cases were male and the mean age was 29. This is consistent with the fact that traumatic amputations are generally caused by occupational injuries, especially in heavy labor, when machinery is involved, and in youths, young adults and male occupations. Furthermore, it was demonstrated that males constituted a considerable risk group for traumatic amputations.

Similar to the situation in adults, epidemiological data related to traumatic amputations in children are relatively scarce and are limited to specific subjects. In their study, Dillingham et al. (11) determined an amputation rate of 10.7% in the 0-14 age group, and of 20.3% in the 15-24 agegroup. We found that 31.1% of the cases were under 18 years of age. These rates demonstrate that another group at great risk for traumatic amputations is children. Similar to the adult group, the male gender is also dominant in the group under 18 years of age. In the study by Trautwein et al. (15), male children constituted 70% of the cases under 18 years of age with traumatic amputations. Although this rate was similarly 65.6% in our study, we found a female preponderance statistically important in this age group.

There are only a few studies in the literature evaluating the correlation between educational level and the frequency of traumatic amputation. In the study by Boyle et al. (14) on work-related amputations, while 15% of the cases had a lower than high school level of education, 57% had completed high school education or its equivalent, and 27% were university graduates. Yet, in our study, the cases with an education level below high school had already constituted the majority of the cases (89%). It was established in the abovementioned report of the Turkish Statistical Institute in 2007 that the rate of an occupational injury among primary school graduates was 3.7% versus only 0.9% among the higher school graduates (12). Although there seems to be a correlation between traumatic amputations and the general education level in our country, it could be said that a low education level has a considerable effect on work injuries and consequently on the rate of traumatic amputations.

In their study investigating finger amputations in the workplace, Sorock et al. (13) reported that approximately 19.000 finger amputations occurred annually in the United States. According to the data Brown presented, 11.000 fatal and non-fatal amputation cases were documented each year between 1992 and 1999 (16). The 2007 report of the United States Department of Labor, which presents the statistics of non-fatal occupational injuries and ailments, reported 7.320 amputations (17). According to the data from the Turkish Social Security Foundation for 2003-2005, a mean 78.140 injuries occurred in the workplace annually during these 3 years. Any type of injury in all extremities accounted for an average of 61,468 of the injuries annually (18). Unfortunately, there are no records indicating how many of the injuries constituted amputations. Nearly half of the cases in our study were laborers and two-thirds of the incidents were occupational injuries. All these data suggest that laborers constitute the higher risk group for traumatic amputations, and serious attention is warranted to improve work safety.

Another striking cause of amputation is catching the extremity in a door. Conn et al. (19) determined in their research in 2001-2002 that, apart from work injuries, the most common (23.4%) cause of finger amputation was the result of the finger being jammed in a door. We found this rate as 17.1% in our study. Door jamming was also determined to be common among children (20). Of 96 cases under 18 years of age, the cause of amputation in about half the cases was door jamming, and the majority of them occurred in children under 5 years of age. Hostetler et al. (21) reported in their study on pediatric traumatic amputations that the most frequent cause of amputation in infants was door jamming (49.3%) and that it occurred mostly in infants between 0-5 years of age. Similarly, Doraiswamy et al. (22) determined in their study on isolated finger injuries that the most common (49%) cause was door jamming, and this was determined as the most frequent cause in the preschool pediatric group. Due to door-related jammed fingers being considerably frequent especially in pediatric finger amputations, it is essential that appropriate technology be developed in door and hinge systems in an effort to prevent it.

Although rare elsewhere, another causative factor in amputations in our region is the tool referred to as a "mole gun" (Figure 3). This simple and primitive tool, used especially for destroying moles that threaten agricultural crops, is made in small workshops. It consists of a gun barrel (generally a metallic pipe), a trigger mechanism, and gun powder and pellets are loaded into the barrel. Its trigger is set and it is placed as a trap in the suspected pathway of the mole. When a mole hits the trigger mechanism, the gun is ignited and the animal is destroyed. People are injured through negligence while setting the trigger. In our study, the mole gun injury was found to be a significant cause of amputation in advanced ages. We believe this can be attributed to the combination of decreased reflexes, decreased attention due to aging and low educational level, together with the inadequacy of legal regulations.

With respect to the affected parts of the body, the incidence of finger involvement was striking. 93.5% of our cases involved either the fingers of the right (46.4%) or left hand (47.1%). This rate was 95% in the study by Boyle et al (23). In the study by Dillingham et al. (24), 63.6% of all traumatic amputations involved the fingers. Conn et al. (19) investigated traumatic amputations that were not related to occupational injuries, and determined that the fingers were affected in 90.9% of cases. It is obvious that the fingers are affected considerably, be it in occupational-related injuries or not. Fingers are considered to be at the greatest risk given their promi-

Figure 3. Mole gun

nence in both anatomical structure and function. Moreover, since the majority of the amputations occur in the work environment, greater attention should be paid to precautions such as the necessity of wearing gloves, use of the appropriate tools and equipment, in-service training, laborer health insurance, and establishment of work safety regulations.

The severity of amputation takes over as a factor affecting the hospitalization period. In the study by Dillingham et al. (11), while the hospitalization period of the cases with major amputations was 28 days, this period decreased to 5 days in minor amputations. Most of the cases in our study had minor amputations, and their mean hospitalization period was 3.8 days. It appears that the rate of cases discharged directly home following the first intervention is related to the severity of the amputation. In the study mentioned above, the rate of cases discharged directly home after a major amputation was 60%, while this was 96.5% following a minor amputation (11). Hostetler et al. (21) reported that, while the rate of discharge following treatment in the emergency unit was 86.9% in the 0-2 age group, in which partial amputations occurred more often (43.8%), the rate was 70.7% in the 13-17 age group, in which total amputations were seen more frequently. Similarly, Conn et al. (19) reported the rate of cases treated in the emergency unit and discharged as 78.6%. This rate was 67.63% in our study, regardless of the age group and the amputation level. The higher hospitalization rate in the young adult age group could be related to this group being the most affected group. When it is considered that nearly half of the cases were referred to our clinic, it highlights that the Emergency Department undertakes a considerable task in managing traumatic amputations.

Study Limitations

The obtained results may have been affected by demographics. In addition, the amputation levels of the extremities, the dominant sides, the patients' actual health status, medicines used, and the presence or absence of alcohol or drug addiction were not investigated. In work-related amputations, the professions and the causative tools or machines were not evaluated. Moreover, points such as the results of re-implantations, complications, loss of workforce and costs were not taken into consideration in this study.

Conclusion

Although traumatic amputations constitute a comparatively small portion of all traumas, their treatment is remarkable, since it affects especially children and young adults and those active in the workforce. Males are affected four times more often than females. Occupational injuries are among the leading causes of traumatic amputations. It is essential that sufficient personal and environmental safeguard measures be taken, and attention should be paid to raising the level of public awareness. Since the re-implantation success rate is low, preventing the necessity of amputation gains greater importance. Door jamming is a major cause of hand injuries and finger amputations in non-work-related traumatic amputations, especially in women and children. A technological development in door and hinge systems to decrease these types of injuries to the lowest possible level is essential. The most frequently affected anatomical zone in all age groups is the fingers; thus strategies and equipment to protect this region must be developed.

Conflict of Interest

No conflict of interest was declared by the authors.

Peer-review: Externally peer-reviewed.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Selçuk University Meram Faculty of Medicine (Approval number: 2009/212).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Author Contributions

Concept - S.K.; Design - S.K., B.E.; Supervision - S.K., B.E., E.E.; Funding - B.E., E.E.; Materials - E.E.; Data Collection and/or Processing - B.E., E.E.; Analysis and/or Interpretation - S.K., B.E., E.E., A.S.G., B.C.; Literature Review - B.E., E.E., A.S.G.; Writer - S.K., B.E.; Critical Review - A.S.G., B.C.; Other - S.K., B.E., E.E.

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Hasta Onamı: Yazılı hasta onamı bu çalışmaya katılan hastalardan alınmıştır.

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