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Original Article

Level of surgery does not affect the reamputation rates in patients with diabetic foot ulcers requiring amputation of the ankle or foot

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Abstract

Aim: In this retrospective study, we aimed to evaluate the effect of amputation level on reamputation rates and need for additional surgeries in patients with type 2 diabetes mellitus.

Material and Methods: Patients who were amputated at the foot and ankle level for diabetic foot ulcers between 2010 and 2019 at our institution were retrospectively evaluated. Amputation types (proximal to distal; Syme, Boyd, Chopart, Lisfranc, Transmetatarsal), previous amputations, need for additional surgeries and reamputations were noted. The effect of amputation level on reamputation and reoperation rates was statistically evaluated.

Results: Thirty-one patients (27 male, 4 female) with mean age of 65 years (range 45-84) were included. Reamputation rates for Syme, Boyd, Chopart, Lisfranc and Transmetatarsal (TMA) amputations were 50%, 55%, 50%, 66% and 75% respectively. Fifty percent of the cases in the Syme group, 78% in the Boyd group, 75% in the Chopart group, 83% in the Lisfranc group and 75% in the TMA group required repeating surgeries. There was no significant difference in terms of reamputation and reoperation rates between amputation levels.

Conclusion: If the level of amputation is determined based on viability of the skin flap that would be required for soft tissue cover and confirmed intraoperatively by inspecting the perfusion of the stump, the amputation level does not have influence on reamputation rates at the foot and ankle. When performing this irreversible procedure, the patient must be well informed about the possible functional outcomes, prosthesis options and reamputation rates.

Keywords: Amputation; ankle; diabetic foot; foot ulcers

INTRODUCTION

A significant portion of patients with refractory foot ulcers might require amputation in order to limit the local infection and permit independent ambulation. Although amputation may be indicated in patients with decubitus ulcers, chronic osteomyelitis, infected prosthesis and deformity, the most common etiology is compromised tissue perfusion as in diabetes mellitus or peripheral arterial disease (1).

Number of patients with diabetes has risen from 108 million in 1980 to 422 million in 2014, and its prevalence from 4.7% to 8.5%. (2). Studies have estimated that 6.5 million people in Turkey are affected by this disease (3). Foot ulcers are the most frequent reason for hospitalization in diabetic patients. This complication causes a significant rise in mortality and morbidity, and 15% of these patients eventually require amputation despite all efforts. (4-6). An infected foot ulcer or a previous amputation are risk factors for amputation in the ipsilateral and contralateral lower extremity (7). Diabetic patients with major amputation have 30-50% mortality rate in the following 2-4 years (8).

Amputations of the lower extremity are described as major or minor based on level of resection. Those at and above the ankle joint are grouped as major, whereas more distal ones are defined as minor. Although metabolic demands and oxygen consumption increase significantly, stump-related complications are seen less and prosthesis fitting is easier with more proximal amputations (9-12). When the indicated level of surgery is not clear, the tendency with the surgeons is to proceed with a more proximal amputation to prevent repeating surgeries and reamputation (4, 7). Opponents of this perspective advocate that an amputation must be performed as distal as possible since

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distal amputations have advantages of better functional outcome (4,8), end weight-bearing and supposedly better proprioception (6, 8, 9). Recently, this notion is challenged with the development of new generation high-performance prosthetic feet which provide a motion arc and functional level superior than that can be achieved with a longer stump, further complicating the decision making (4).

In our study, we aimed to evaluate the effect of amputation level on reamputation rates and need for additional surgeries in patients with type 2 diabetes mellitus.

MATERIAL and METHODS

Following approval from the institutional review board (Decision number 2020-1/52), records of patients who were amputated at the foot and ankle level for diabetic foot ulcers between 2010 and 2019 at our institution were retrospectively evaluated. Amputation types (proximal to distal; Syme, Boyd, Chopart, Lisfranc, Transmetatarsal), previous amputations, need for additional surgeries and reamputations of the involved extremity were noted. Patients with previous amputations or debridement, patients who did not require additional surgeries but deceased before the beginning of the study were excluded. Only cases with index amputation (first amputation of the involved extremity) were included. Viability of the skin flap that would be required for soft tissue cover after resection of the necrotic and infected segments was the primary indication to determine the level of amputation. All operations were performed by the same surgeon. The final decision on amputation level was made intraoperatively by inspecting the perfusion and bleeding of the stump, with emphasis on amputating as distal as possible in regard to soft tissue coverage. The layers were closed in the regular fashion and tight dressing was applied to prevent edema and stump slacking. Hemovac drain was placed for Syme, Boyd and Chopart amputations. Patients were started on low molecular weight heparin.

The extremity was elevated above the heart level with the knee in extension. Dressings were changed and drains were removed on postoperative day one. The stump was inspected for edema by palpation and inspection. The patient was discharged on day 1 if general condition permitted. None of the patients required close monitoring due to increased edema.

The effect of amputation level on reamputation and reoperation rates were statistically evaluated. Categorical variables were compared using Pearson's chi-squared test and Fisher-Freeman-Halton test. $p<0.05$ was considered as significance levels. Statistical analyses were performed with IBM SPSS ver.23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.)

RESULTS

Thirty-one patients (27 male, 4 female) met the inclusion criteria. Mean age was 65 years (range 45-84). One patient with TMA, 3 patients with Lisfranc, 1 patient with Chopart, 3 with Boyd and 1 patient with Syme amputation had chronic renal failure and required hemodialysis prior to index amputation. Patients' amputation levels, reamputations and debridement numbers are presented in Table 1. Reamputation rates for Syme, Boyd, Chopart, Lisfranc and Transmetatarsal (TMA) amputations were 50%, 55%, 50%, 66% and 75% respectively. There was no significant difference in terms of reamputation rates between amputation levels.

Table 1. Reamputation and reoperation rates of different surgical procedures

Amputation Level	Debridement	Reamputation	Reoperation*
Syme N: 8		N: 4 50%	N: 4 50%
Boyd N: 9	N: 2	N: 5 55%	N: 7 78%
Chopart N: 4	N: 1	N: 2 50%	N: 3 75%
Lisfranc N:6	N: 1	N: 4 66%	N: 5 83%
TMA N:4	N: 0	N: 3 75%	N: 3 75%
		P>0.05	p>0.05

N: Number Of Patients, p: Statistical Significance.
*Reoperation refers to cases who required either reamputation or debridement

When patients were evaluated for need of reoperation (including both reamputation and debridement), 50% of the cases in the Syme group, 78% in the Boyd group, 75% in the Chopart group, 83% in the Lisfranc group and 75% in the TMA group required repeating surgeries. There was no significant difference in terms of reoperation rates between amputation levels.

DISCUSSION

Several techniques are described for amputation at the foot and ankle level. In the 18th century, Francois Chopart defined the amputation of the foot through the talonavicular and calcaneocuboid joints. James Syme in his 1843 dated article reported the procedure where ankle is disarticulated, malleoli tips are removed till flush with Plafond and a long plantar flap is rotated anteriorly. (13). TMA was first described by McKittrick on a patient with diabetic foot ulcer back in 1949 (14).

In our study, 50% of the patients with Syme amputation required reamputation. This rate is higher than previously reported in the literature. In their patient series, Finkler et al. noted 12% reamputation rate, whereas Braaksma et al., in their systematic review of 919 cumulative patients with heterogeneous age and etiology, found 20% reamputation rates. (8,9). Fifty-five percent reamputation rate of Boyd amputations in our series is similar to other studies on

diabetic patients. Tosun et al. reported that 50% of the cases with Boyd procedure required reamputation (6). In the literature, reamputation rates of Chopart and TMA vary between 17-60% (4,15,16) and 10-61 (4,14,17-20), respectively. In our study, 50% and 75% of patients amputated at those levels required reamputation. A direct comparison of these last two patient groups might be misleading because of low number of patients included (4 patients each).

A possible explanation for the high number of reamputations in our study is that we included only patients with diabetic foot ulcers. Prognosis of diabetic patients is far worse than those with traumatic amputations or secondary to deformity, and mortality and morbidity is high. Majority of the studies in the literature report the outcome of patients with mixed etiologies (21). In Tosun et al.'s study, the reported 50% reamputation rate for Boyd rise to 64% if only cases with diabetic or peripheral occlusive diseases are included (6).

Another methodological factor which is likely to influence our results is the exclusion of deceased patients. In the other studies in the literature, excitus patients were included in the group that did not require reamputation, as if those patients would not require reoperation if they had survived the study period. The reported 10% and 60% reamputation rates for TMA and Chopart in Brown et al.'s study rise to 15% and 100% if deceased patients are excluded (4). Similarly, reamputation rates for Syme procedure in Finkler et al.'s study is doubled (8).

Although it is not possible to prove with the current study design, the authors believe that the major factor for high reamputation rates is the lack of preoperative patient care. Because of limited space in our tertiary institution and high number of patients with infected foot ulcers, patients are admitted to orthopedics ward just before surgery and discharged on the first postoperative day. However, blood sugar regulation, immune competency and malnutrition are shown to effect operation success. Many of the studies with exceptional low reamputation rates have strict patient selection criteria (Total albumin > 3.0-3.5 g/dL, total protein > 6g/dL, total lymphocytes > 1500, ankle-brachial index 0.5, 2-30 mm HG and transcutaneous oxygen pressure at room air, no renal failure, blood glucose between 110-150 mg/dL) and patients whose metabolic status cannot be raised to aforementioned standards are amputated at the transtibial level (6,12,22). In their study, Tosun et al. performed Boyd amputation only in cases which had well-regulated blood sugar and normal albumin and lymphocyte counts (6).

Results of our study do not justify performing an amputation at a higher level to avoid stump-related complications as far as the ankle and foot regions are concerned. We found similar rates of reamputation and reoperation rates regardless of amputation level. A direct comparison with the literature is not possible due to methodological differences and heterogeneous grouping of surgical procedures in previous studies. Brown et al reported the reamputation rates of TMA, Chopart, and partial/total calcanectomy patients in 64 patients and reported highest rate of reamputation with Chopart, but did not perform a statistical analysis. Izumi et al, in their series of 277 Patients, conducted a stratified analysis to compare the reamputation risk based on level of amputation. However, they grouped TMA, Chopart and Lisfranc amputations as midfoot amputations and placed Syme and Boyd amputations in the major amputations group together with below-knee and above-knee amputations.

Inclusion of patients with the same etiology and separate evaluation of amputations at ankle level (Syme and Boyd) are the strengths of our study. The major limitations are the retrospective design and the fact that we did not evaluate several factors such as preoperative metabolic condition of the patient which could affect wound healing. Another major limitation independent from study design is the low number of patients with Syme and Boyd amputations. Ankle amputations are the least performed procedures because of concerns over wound healing, the need for a long viable calcaneal skin flap, and possible migration of the heel pad after surgery (12). Because of their low numbers, they are usually grouped together with transtibial amputations and their individual reamputation rates are seldom reported (7,23,24). The reason for the low number of cases in our series was not due to technical difficulties, but due to the fact that viable calcaneal and plantar flaps are not present most of the time.

CONCLUSION

Opting for a more proximal amputation to avoid wound healing problems and reamputation is not justified at foot and ankle level since they all have similar reamputation rates. When performing this irreversible procedure, the patient must be well informed about the possible functional outcomes, prosthesis options and reamputation rates. A mutual agreement between the surgeon and the patient is likely to provide better patient compliance and prevent unrealistic expectations.

Competing interests: The authors declare that they have no competing interest.

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REFERENCES

1. Westberry DE, Carpenter AM, Tisch J, et al. Amputation Outcomes in Congenital Pseudarthrosis of the Tibia. J Pediatr Orthop 2018;38:475-81.
2. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4.4 million participants. Lancet. 2016;387:1513-30.

3. Satman I, Omer B, Tutuncu Y, et al. Twelve-year trends in the prevalence and risk factors of diabetes and prediabetes in Turkish adults. Eur J Epidemiol 2013 ;28:169-80.
4. Brown ML, Tang W, Patel A, et al. Partial foot amputation in patients with diabetic foot ulcers. Foot Ankle Int 2012;33:707-16.
5. Richard JL, Schuldiner S. Epidemiology of diabetic foot problems. Rev Med Interne 2008;29:222-30.
6. Tosun B, Buluc L, Gok U, et al. Boyd amputation in adults. Foot Ankle Int 2011;32:1063-8.
7. Izumi Y, Satterfield K, Lee S, et al. Risk of reamputation in diabetic patients stratified by limb and level of amputation: a 10-year observation. Diabetes Care 2006;29:566-70.
8. Finkler ES, Marchwiany DA, Schiff AP, et al. Long-term Outcomes Following Syme's Amputation. Foot Ankle Int 2017;38:732-5.
9. Braaksma R, Dijkstra PU, Geertzen JHB. Syme Amputation: A Systematic Review. Foot Ankle Int 2018 ;39:284-91.
10. Waters RL, Perry J, Antonelli D, et al. Energy cost of walking of amputees: the influence of level of amputation. J Bone Joint Surg Am 1976;58:42-6.
11. Goktepe AS, Cakir B, Yilmaz B, et al. Energy expenditure of walking with prostheses: comparison of three amputation levels. Prosthet Orthot Int 2010;34:31-6.
12. Pinzur MS, Stuck RM, Sage R, et al. Rabinovich Z. Syme ankle disarticulation in patients with diabetes. J Bone Joint Surg Am 2003;85:1667-72.
13. Syme J. Surgical cases and observations. Amputation at the ankle-joint. 1843. Clin Orthop Relat Res 1990 ;256:3-6.
14. McKittrick LS, McKittrick JB, Risley TS. Transmetatarsal Amputation for Infection or Gangrene in Patients with Diabetes Mellitus. Ann Surg 1949;130:826-40.
15. Lieberman JR, Jacobs RL, Goldstock L, et al. Chopart amputation with percutaneous heel cord lengthening. Clin Orthop Relat Res 1993;296:86-91.
16. Chang BB, Bock DE, Jacobs RL, et al. Increased limb salvage by the use of unconventional foot amputations. J Vasc Surg 1994;19:341-8; discussion 348-9.
17. Mueller MJ, Allen BT, Sinacore DR. Incidence of skin breakdown and higher amputation after transmetatarsal amputation: implications for rehabilitation. Arch Phys Med Rehabil 1995;76:50-4.
18. Pollard J, Hamilton GA, Rush SM, et al. Mortality and morbidity after transmetatarsal amputation: retrospective review of 101 cases. J Foot Ankle Surg 2006;45:91-7.
19. Stone PA, Back MR, Armstrong PA, et al. Midfoot amputations expand limb salvage rates for diabetic foot infections. Ann Vasc Surg 2005;19:805-11.
20. Anthony T, Roberts J, Modrall JG, et al. Transmetatarsal amputation: assessment of current selection criteria. Am J Surg 2006;192:8-11.
21. Gormeli G, Gormeli CA, Karakaplan M, et al. The Amputation Endicated Extremity Can Be Recovered by Multidisciplinary Treatment: A Case Report and Review of Literature. [Multidisipliner Yaklaşımla Amputasyon Endikasyonu Olan Ekstremite Kurtarılabilir: Olgu Sunumu ve Literatür Derlemesi]. Med Science 2015;4:2281-8.
22. Wagner FW Jr. Amputations of the foot and ankle. Current status. Clin Orthop Relat Res 1977;122:62-9.
23. Larsson J, Agardh CD, Apelqvist J, et al. Long-term prognosis after healed amputation in patients with diabetes. Clin Orthop Relat Res 1998;350:149-58.
24. Gok U, Selek O, Selek A, et al. Survival evaluation of the patients with diabetic major lower-extremity amputations. Musculoskelet Surg 2016;100:145-8.