Mini Review
Volume 6:5, 2021

Journal of Diabetic Complications & Medicine

ISSN: 2475-3211 Open Access

Through-Knee Amputation (Knee Disarticulation): A Mini Review of Current Literature

Fatih Barishan*

Department of Orthopaedics and Traumatology, Division of Podiatric Surgery, Seyrantepe Hamidiye Etfal Training and Research City Hospital, Istanbul, Turkey

Abstract

The indications for amputation include vascular or diabetic indications, such as infection, tissue loss, pain and ischaemia; as well as non-vascular indications, such as trauma, malignancy and congenital malformation. Below-knee amputation (BKA) is not always possible and a proximal amputation is sometimes required. In these instances, an above-knee amputation is routinely performed. A through-knee amputation is not an alternative to BKA and AKA in current daily practice. There is stronger evidence in literature supporting that; "Surgeons can perform TKA as a primary alternative to AKA in patients when BKA is not feasible."

Keywords: Through-knee amputation • Knee disarticulation • Above-knee amputation • Transfemoral amputation

Introduction

The indications for amputation include vascular or diabetic indications, such as infection, tissue loss, pain and ischaemia; as well as non-vascular indications, such as trauma, malignancy and congenital malformation.In the United States, it is estimated that almost two hundered thousand upper or lower limb amputations have been performed annually. For every 100,000 people in Europe and Australia, between seven and 41 persons undergo a major amputation every year due to diabetes or vascular disease [1]. This surprisingly high prevalence is expected to increase in parallel with the aging population and the associated increase in predisposing vascular conditions, such as atherosclerosis and diabetes. It is estimated that the projected number of Americans living with limb loss will be doubled by 2030. There are four levels of major lower extremity amputation: through-hip, above-knee, through-knee, and below-knee. Knee or above amputation candidate patients may have had previous major or minor lower limb surgery, such as revascularisation, reconstruction surgeries of limb, salvage attempts or lower limb amputations more distal to the knee. A through-knee amputation (TKA), also referred to as 'knee disarticulation', is the surgical removal of the lower half of the leg through the knee joint with the femur intact. Above-knee amputations are amputations of all levels through the femur for all aetiologies. Through-knee amputation is a disabiliating functional alternative to above-knee amputation (AKA). However, below-knee amputation (BKA) is not always possible and a proximal amputation is sometimes required. In these instances, an above-knee amputation is routinely performed [2]. BKA, TKA and AKA procedures were preferably performed in clinical practice according to local guidelines and on indication. The BKA procedure was to be performed in vascular disease patients who were leg-prosthesis candidates and who had sufficient skin perfusion (> 40 mmHg and > 55 mmHg in diabetics) below the knee, whereas TKA was to be performed in patients who were not prosthesis candidates, but with sufficient skin perfusion below the knee. The AKA procedure was to be performed if BKA and TKA were not possible, e.g., due to insufficient skin perfusion or wound problems around the knee [3]. The through-knee amputation must be more assessed to better guide the surgeon's decision-making and counsel patients when deciding on what final amputation level is best suited to the individual patient. Both surgeries are appropriate for people requiring a major lower limb amputation. However, surgeons tend to perform an above knee amputation despite the potential functional advantages that a longer, more powerful, end weight-bearing, through knee residuum offers a prosthetic or non-prosthetic user. As a result, through-knee amputations represent less than 2% of all amputations in the United States [4].

Surgical technique

Through-knee like lower extremity amputations have been performed since the seventeenth century [5]. The umbrella term 'through-knee amputation' commonly in use to refer to all variations including: Standard through-knee (through-knee, knee disarticulation); Modified through-knee [6]; and Gritti-Stokes [7] and Nellis/Van De Water [8]. Revised design of this amputation has improved healing rates and prosthetic fit, and variations of the through-knee amputation have been developed. TKA is believed to be prone to wound complications. The bulbous femoral condyles require longer musculocutaneous flaps [9]. In addition, the shape of the stump is difficult to fit for a prosthesis. To overcome this disadvantage, Mazet and Hennessy [10] in 1966 suggested several modifications, characterized by creation of a conically shaped femoral stump by removal of the medial and lateral femoral condyles and posterior surface. This technique is deemed to have an acceptable wound healing rate and an increased chance of prosthetic gait [11]. Modified techniques, such as that of Mazet, Burgess and Youkey, involve removing the patella and trimming the femoral condyles to achieve a less bulbous residual end [12]. With Gritti-Stokes and Nellis/Van De Water amputations, the patella is attached to the distal end of the femur [13]. The surgeons' routinely preferred technique for TKA relies on adequate coverage using a gastrocnemius myofasciocutaneous flap without osseous cuts. To achieve adequate coverage, the posterior flap should be equal or greater in length to the diameter of the knee joint. Surgeons retain the patella and stabilize the patellar tendon to the cruciate ligaments routinely in general practice. Finally, the flap is brought anteriorly, and the gastrocnemius fascia is sewn into the anterior knee joint retinaculum.

Balance of soft tissues on biomechanical effects

The theoretical advantage of disarticulation is the creation of a large surface area capable of distributing the load of weight bearing. The transosseous amputees (like AKAs) would not be able to end bear in a prosthesis, so they created traditional total surface bearing amputation stumps, attempting, when possible, to create a cushioned myofasociocutaneous soft-tissue envelope. Similarly, the prosthetists who fit their patients with prostheses were familiar enough with the socket accommodations to use a total surface bearing prosthetic socket. AKA can also be performed in all patients with no potential for a leg prosthesis. Theoretically the capacity of the soft-tissue envelope in the transfemoral amputations is lesser than the end-bearing capacity of the knee disarticulations [14]. That biomechanical benefit in TKA reduced metabolic expenditure during ambulation from a longer lever arm and enhanced stability from preserved adductor muscle insertion. Previous studies have

***Address for Correspondence:** Fatih Barishan, Department of Orthopaedics and Traumatology, Division of Podiatric Surgery, Seyrantepe Hamidiye Etfal Training and Research City Hospital, Istanbul, Turkey Tel No: -+905319137599; E-mail: drbarishan@hotmail.com*

Received 13 August, 2021; **Accepted** 27 August, 2021; **Published** 05 September, 2021,

consistently demonstrated that with more proximal amputations, there is a higher energy expenditure with ambulation, an increase in gait asymmetries, and a decrease in self-selected walking speeds. The longer residual limb provides a longer moment arm for gait and maintains the native insertion of the adductor musculature, preserving myodesis function in leg swing and sitting positioning [15]. Gait analysis studies have been performed analyzing the gaits of various amputation levels (BKAs, TKAs, and AKAs. Self-selected walking speeds decrease as amputation levels move more proximal, resulting from decreased cadence and reduced stride length. A through knee amputation provides decreased metabolic cost of ambulating as compared to a higher level of amputation while allowing for direct load transfer of body weight into the prosthesis. As a result, as the amputation level moves distal in the lower extremity, functional outcome and walking independence improve [16]. After a lower extremity amputation, some authors sports that it was not the level of the amputation that affected their perceived result, but rather it was dependent on comfort of the residual limb, condition of the contralateral limb, prosthetic comfort, function, and appearance, social factors, and ability to exercise recreationally. This gives more credence to the concept that regardless of the level of amputation, the most important factor when determining amputation level is the soft tissue envelope.

Discussion

Indications for re-amputations were wound rupture, wound necrosis and infection when soft tissue debridement was considered insufficient following clinical assessment. A literature review reported healing rates between 60% and 90% after TKA procedures [17]. Incidence of return to theatre and revision to above-knee amputation remains an issue with through-knee amputation, and it is unknown how all postoperative outcomes compare between above-knee amputation and through-knee amputation. Types of outcome measures like prosthetic limb fitting assessments, wound healing, mobility with a prosthesis, Prosthetic Patient Satisfaction, Walking speed, Pain (postoperative, phantom limb and pain associated with prosthetic limb-wearing), patient survival not clearly determined in current literature between TKA and AKA or BKA [18]. Some studies show that TKA demonstrated similar postoperative morbidity and mortality compared with AKA. Wound infection and risk of dehiscence were equivalent. TKA did demonstrate a higher rate of reoperation; however, neither TKA nor reoperation predicted postoperative mortality [19]. Patients in stable physiologic condition without active infection can safely undergo elective TKA to maximize rehabilitation potential [20]. Taylor [16] analyzed over six hundred major lower extremity amputations and identified important factors that may affect post amputation quality of life. Patients who were non ambulatory before surgery had an almost 10 times greater likelihood of not wearing a prosthesis. AKA also demonstrated one of the strongest associations with failure of prosthesis use, followed by old age (older than 70 years). Risk factors for failure to live independently after amputation were old age (older than 70 years), AKA, and dementia. In 1940, Rogers published a landmark paper describing the advantages of TKA. Rogers reported enhanced stability and increased proprioception after TKA over AKA, which allows better control of balance with prosthetic ambulation. The outcomes of over four hundred amputations for arterial insufficiency. Almost one quarter of those were TKAs. Their study demonstrated that mortality and prosthetic gait of TKA were nearly equivalent with those of BKA. Hagberg et al. proved increased prosthesis use in lower level amputation (100% in BKA, 70% in TKA, 56% in AKA). All authors of these reports unequivocally advocated consideration of TKA as a primary alternative to AKA in patients when BKA is not feasible [11]. Morse [18] reported re-amputation rates of 19% and none of revised cases. Kock [9] reported revision rates up to 8% after AKA.

Advantages and disadvantages

Advantages of TKA over AKA include the presence of an end-weight-bearing stump, enhanced stability from preserved adductor muscle insertion, reduced metabolic expenditure during ambulation from a longer lever arm, and simplified creation of the lighter prosthetic device given the decreased number of articulations. In addition, superior rehabilitation potential and improved postoperative quality of life have been reported. Despite these benefits, TKA represents only <2% of all major lower extremity amputations in the United States. Fear of poor wound healing and potential stump breakdown in longer soft tissue flaps needed to cover epicondyles of the distal femur are possible preconceived misconceptions. Historically, outcomes after TKA are acceptable. Despite this, through-knee amputation may have the following potential advantages for patients over above-knee amputation because: the surgery is less traumatic, and the cartilage barrier is maintained which reduces the risk of infection or bone spurs; the long end-bearing lever arm creates a strong residual limb with a reduced propensity of developing hip flexion contracture; the longer residuum provides a stable sitting platform, more efficient transfers, and reduced energy requirements; and the residuum supports superior ambulatory stability, prosthetic sockets are more comfortable and pressure inside the socket is reduced. However, through-knee amputation may have the following potential disadvantages for patients when compared to above knee amputation because: the prosthesis can have a poor cosmetic finish and issues with socket fit can occur; the positioning of the prosthetic knee when it is attached to the end of the socket causes asymmetrical knee levels; It has a reputation for delayed wound healing despite documented evidence of successful healing.

TKA demonstrated similar postoperative morbidity and mortality compared with AKA in literature. Also wound infection and risk of dehiscence were equivalent at those. Patients in stable physiologic condition without active infection can safely undergo elective TKA to maximize rehabilitation potentials. A benefit of performing a through knee amputation is that it is a less traumatic amputation level with less soft tissue dissection, less blood loss, and no osseous cuts. The follow-up surgical care also demonstrates resistance to infection and postoperative complications when performed with posterior myocutaneous flaps. A study suggests that TKAs have fewer revision surgeries than either below knee amputations or AKAs. It was also noted that there is less incidence of heterotopic ossification in TKAs, possibly because of the intact cortices and (with viable gastrocnemius being a prerequisite for the amputation level) less injured muscle. The frequently cited reasons for TKAs being favored are due to the end-bearing nature of the amputation level, the soft tissue balancing about the femur, the long lever arm for wheelchair transfers, the ease of surgical procedure, and the favorable platform for wheelchair sitting. The favorable soft tissue balancing results in fewer hip flexion contractures and less abductor drift.

Conclusion

Few orthopaedic residents currently have the opportunity to attend amputee clinics where they can observe the end result of the surgery. The modern patient care model is just as challenging for our physical medicine and prosthetist colleagues who are not familiar with technical aspects of a myofasciocutaneous flap to create a soft-tissue envelope. In daily practice consultant orthopaedic/vascular surgeons or their trainees perform the amputation procedures. Primary surgeons tend to refer to re-amputations (all limb-shortening procedures) following the index amputation to tertiary referral hospitals.

Abbreviations

TKA: Through-knee amputation

AKA: Above-knee amputation

BKA: Below-knee amputation

References

1. Behrendt, Christian-Alexander, Birgitta Sigvant, Zoltán Szeberin and Barry Beiles et al. "International variations in amputation practice: a VASCUNET report." *Eur J Vasc Endovasc Surg 56* (2018): 391-399.

2. Aulivola, Bernadette, Chantel N Hile, Allen D. Hamdan and Malachi G. Sheahan et al. "Major lower extremity amputation: outcome of a modern series." *Arch Surg. 139* (2004): 395-399.

3. Schmiegelow, Morten T, Nikolaj Sode, Troels Riis and Jes Bruun Lauritzen et al. "Re-amputations and mortality after below-knee, through-knee and above-knee amputations." *Dan Med J 65* (2018): 65.
4. Albino, Frank P, Rachel Seidel, Benjamin J Brown and Charles G Crone et al. "Through knee amputation: technique modifications and surgical outcomes." *Arch Plast Surg 41* (2014): 562.
5. Kirkup, J. "A history of limb amputation London." *Springer 1* (2007): 135-5.
6. Mazet JR, Robert, and Charles A. Hennessy. "Knee disarticulation: a new technique and a new knee-joint mechanism." *JBJS 48* (1966): 126-139.
7. Stokes, William. "On supra-condyloid amputation of the thigh." *Medico-Chirurgical Transactions 53* (1870): 175.
8. Nellis, Noel, and Joseph M. Van De Water. "Through-the-knee amputation: an improved technique." *Am Surgeon 68* (2002): 466.
9. Kock, Hans-Juergen, Jan Friederichs, Alexander Ouchmaev and Joachim Hillmeier, et al. "Long-term results of through-knee amputation with dorsal musculocutaneous flap in patients with end-stage arterial occlusive disease." *World J Surg 28* (2004): 801-806.
10. Morse, Bryan C, David L. Cull, Corey Kalbaugh and Anna L. Cass et al. "Through-knee amputation in patients with peripheral arterial disease: a review of 50 cases." *J Vasc Surg 48* (2008): 638-643.
11. Burgess, Ernest M. "Disarticulation of the knee: a modified technique." *Archives of surgery 112* (1977): 1250-1255.
12. Pinzur, M., and BK. Potter. "Knee disarticulation: surgical management." *Atlas of amputations and limb deficiencies, 3rd edn*. AAOS, Rosemont (2004): 517-524.
13. Nijmeijer, Rachelle, Henricus GJM Voesten, Joannes HB Geertzen, and Pieter U. Dijkstra. "Disarticulation of the knee: Analysis of an extended database on survival, wound healing, and ambulation." *J Vasc Surg 66* (2017): 866-874.
14. Scott, SWM, S. Bowrey, D. Clarke and E. Choke et al. "Factors influencing short-and long-term mortality after lower limb amputation." *Anaesthesia 69* (2014): 249-258.
15. Tennent, David J., Elizabeth M. Polfer, Nicole M. Sgromolo and Chad A. Krueger et al. "Characterization of disability following traumatic through knee and transfemoral amputations." *Injury 49* (2018): 1193-1196.
16. Taylor, Spence M., Corey A. Kalbaugh, Dawn W. Blackhurst and Steven E. Hamontree et al. "Preoperative clinical factors predict postoperative functional outcomes after major lower limb amputation: an analysis of 553 consecutive patients." *J Vasc Surg 42* (2005): 227-234.
17. Lim, Sungho, Michael J. Javorski, Pegge M. Halandras and Bernadette Aulivola et al. "Through-knee amputation is a feasible alternative to above-knee amputation." *J Vascular Surg 68* (2018): 197-203.
18. Polfer, Elizabeth M., Benjamin W. Hoyt, Adam J. Bevevino and Jonathan A. Forsberg et al. "Knee disarticulations versus transfemoral amputations: functional outcomes." *J Orthop Trauma 33* (2019): 308-311.
19. Murakami, Tsurayuki, and Kevin Murray. "Outcomes of knee disarticulation and the influence of surgical techniques in dysvascular patients: a systematic review." *Prosthet Orthot Int 40* (2016): 423-435.
20. Crane, Hayley, Gemma Boam, Daniel Carradice and Natalie Vanicek et al. "Through-knee versus above-knee amputation for vascular and non-vascular major lower limb amputations." *Cochrane Database of Systematic Reviews 1* (2021).

How to cite this article: Barishan, Fatih."Through-Knee Amputation (Knee Disarticulation): A Mini Review of Current Literature". *J Diabetic Complications Med* 6 (2021):155.