ADITUM

Journal of Orthopaedic Research and Surgery

Open Access Review Article

# Early Surgical Wound Complications Following Total Knee Arthroplasty– Risk Factors and Management.

**Thiago Vivacqua[1]*, Rodrigo Resende[2], Idemar M. da Palma[2], José Leonardo Rocha de Faria [3], Douglas Pavão[3], Rodrigo Albuquerque[2,3]**

[1]Clinical Fellow, Fowler Kennedy Sports Medicine Clinic, Western University.

[2]Rios D`Or Hospital.

[3]National Institute of Traumatology and Orthopaedics of Brazil

**Article Info**

**Received:** December 31, 2021
**Accepted:** January 13, 2022
**Published:** January 18, 2022

***Corresponding author:** Thiago Vivacqua, Clinical Fellow, Fowler Kennedy Sports Medicine Clinic, Western University.

**Citation:** Thiago Vivacqua, Rodrigo Resende, Idemar M. da Palma, José Leonardo Rocha, Douglas Pavão, Rodrigo Albuquerque. "Early Surgical Wound Complications Following Total Knee Arthroplasty– Risk Factors and Management''. J Orthopaedic Research and Surgery, 1(3); DOI: http;//doi.org/03.2022/1.1027.



.

## Abstract:

Surgical wound complications after a total knee replacement may lead to disastrous consequences if not recognized and properly managed at its earliest stage. The objective of this manuscript is to describe patient risk factors and surgical approaches to manage potential early postoperative wound complications following total knee arthroplasty. Furthermore, this manuscript aims to report alternatives therapeutic options for each one of the described complications providing surgeons a set of treatment guidelines depending on each of those potentials early post-operative side effects.

**Key words:** Knee, surgery, arthroplasty, wound complications, risk factors, treatment

## Introduction:

Surgical wound complications represent an impediment to a successful total knee arthroplasty (TKA) in up to 0.33% of patients[1]. Such complications may occur in the early postoperative period what can and include: superficial skin necrosis, deep necrosis, persistent drainage and wound blisters[2]. The development of these complications can lead to deep wound infections and consequent acute periprosthetic infection[2]. Post- operative surgical wound complications are associated with a prolonged hospital length of stay increasing patient morbidity and health care costs.

The objective of this manuscript is to describe patient risk factors and technical issues related to early wound complications following total knee arthroplasty. Furthermore, a set of guidelines in order to assist surgeons when facing such oftentimes hazardous situations following TKA.

### 1. Patient Risk Factors

There two main categories of patient risk factors: modifiable and non-modifiable. They are presented and discussed below.

### 1A. Modifiable risk factors

Modifiable patient risk factors such as anemia, diabetes mellitus, obesity, smoking, rheumatoid arthritis, and nutritional disorders, are associated with healing problems and surgical wound complications after a TKA[4]. Inflammatory joint diseases have an increased risk for surgical wound complications when compared to primary osteoarthritis[5]. Drugs like oral corticosteroids, modifying rheumatic disease drugs and/or non-steroidal anti-inflammatory drugs, may interfere with surgical wound healing response. Disease- modifying biological agents should typically be discontinued two weeks prior to surgery[5].

Patients with preoperative chronic anemia with or without inflammatory joint disease have an increased risk for wound complications following TKA[6]. Nicotine abuse leads to vasoconstriction of the microcirculation with decreased tissue oxygen supply and increased risk of wound complications in patients undergoing total knee arthroplasty (TKA) and total hip arthroplasty (THA)[7]. Quit smoking or using nicotine substitutes

between six to eight weeks before THA or TKA significantly decreases the risk of wound complications when compared to patients without any intervention at all[8].

Obesity is related to decreased venous flow leading to increased interstitial pressure and may be related to the risk of wound blisters after TKA[9]. Preoperative nutritional assessment can be evaluated by serum albumin levels, white blood cell count and transferrin level. Wound complications are correlated to albumin < 3.5 g/dl, serum transferrin < 200 mg/dl and white blood cell count <1500/mm [10].

Diabetic patients have an increased risk of wound complications due to changes in collagen synthesis and a lower oxygen supply to connective tissues. Diabetes medications and glucose level must be carefully reviewed and optimized preoperatively[11]. Finally, patients previously medicated with heparin are associated with the development of hemorrhagic blisters following lower limb orthopedic open approaches. This association must be known preoperatively, and medication should be interrupted depending on additional risk factors[12].

1B. **Non-modifiable risk factors**

Age represents a non-modifiable risk factor associated with the development of blisters after TKA. Wound blisters can be classified as hemorrhagic or serous (Figure 1). Hemorrhagic blisters (HB) typically have a longer re-epithelialization time and are associated with severe trauma to skin cells. HB is associated with a sub dermic blood accumulation creating a cleavage plane between the epidermis and dermis. Differently, serous blisters (SB) are characteristically present with serous exudate accumulates in the epidermis layer, so these often have a shorter re-epithelialization time[9,13]. SB have an average epithelialization time of 12 days, while HB require 16 days[9]. Aging is associated with loss of collagen and elastin in connective tissue, as well as vascular atrophy, compromising the competence of the dermis in cases of increased interstitial pressure. Thus, elderly patients undergoing TKA surgery have an increased risk of developing blisters following the procedure[13].

**1. Risk factors related to the surgical procedure**

Tourniquet deflation at the end of the TKA is a critical moment for the development of postoperative blisters. In cases where the dressing is performed before releasing the tourniquet, blood flow return associated with dressing mechanical pressure might increase shear forces between the dermis and epidermis increasing the risk for postoperative wound blisters. Tourniquet release before applying the dressing was associated with a lower incidence of blisters after TKA[14,15]. Antimicrobial adhesive (Ioban, 3M®) is used to reduce the risk of infection after arthroplasty, but this benefit has as yet not been validated in the literature[16]. Improper removal of antimicrobial adhesive at the end of the surgical procedure can result in shear forces between the dermis and epidermis, which in turn may favor the development of post-operative wound blisters [17].

When planning the location of the surgical incision for TKA, surgeons must be aware that the anterior vascular supply of the knee runs from medial to lateral. A more lateral incision tends to preserve a better arterial blood flow to the anterior knee subdermal tissue, decreasing the risk of post-operative wound necrosis [11]. Subcutaneous dissection above the fascia preserves the subdermal vascularization of the anterior region of the knee, thus reducing the risk of superficial wound necrosis (Figure 2)[11]. In patients with previous incisions of the knee, a distance of 5 to 7cm between them must be respected to avoid vascular compromise of the epidermis. Oblique incisions can be included in a vertical incision[18]. Surgical incision vertices should be V-shaped (V sign). In the case of incisions with the U-shaped vertices (U sign), the incision must be elongated avoiding excessive skin tension[19]. An appropriated preoperative plan of surgical incision can reduce the risk of superficial and deep surgical wound necrosis.

**2. Management of acute wound complications**

The presence of serosanguineous drainage 72 hours after the TKA is defined as a persistent wound drainage[20]. In this scenario, the patient must not be discharged, and some additional postoperative actions should be taken. Restricted range of motion, compressive dressing, suspension of anticoagulation medication and negative pressure therapy (NPT) are alternatives in order to control persistent wound drainage. If drainage persists between 5-7 days postoperatively acute infection should be considered. Therefore, the patient must return to the operating room for irrigation, debridement, and procurement of samples for culture and biopsy [21]. The presence of purulent discharge from the knee capsule or any communication with superficial layers implies the necessity for deep joint debridement and exchange of modular components. In this scenario the patient should not be discharged and associated intravenous antimicrobial therapy is mandatory until results of samples culture and biopsy are available[21].

The management of a postoperative blister adjacent to a surgical wound remains controversial. When intact, the blister fluid is considered sterile. However, following rupture a local polymicrobial contamination was described during the epithelialization period[9,22]. After blister rupture, an intravenous antimicrobial prophylaxis can prevent superficial surgical wound infection. The use of systemic antibiotics with topic silver sulfadiazine is suggested associated to a low-compressive dressing[23].

The treatment of patients with soft tissue necrosis adjacent to the surgical wound depends on the size of tissue damaged and any possible sign of local infection. Patients with superficial necrosis of the surgical wound must be immobilized and their range of motion restricted in order to reduce wound tension. Edges debridement with necrotic tissue removal must be performed using an aseptic technique. After this step, re- epithelialization can occur by secondary intention or surgical tension-free suture can be perfomed[24]. NPT represents an adjuvant option to remove recurrent fluid, stimulating microcirculation and improving a local oxygen flow. Therefore, NPT is a useful additional option in patients who a complete wound suture was not achieved[25].

Local skin grafts are another reasonable surgical means for patients where tension-free suture was not feasible. To perform this technique, it is necessary to have an intact fascia and a soft tissue infection must be excluded[24]. The ipsilateral superolateral thigh is a common source for harvesting a skin graft often providing one with an appropriate graft length. The donor site usually heals by second intention without side effects. NPT can be used as an adjuvant method improving local granulation and reducing fluid

accumulation[24].

The use of a fasciocutaneous flaps represents an alternative with less morbidity than muscle flaps. Cases of superficial wound necrosis where there has not been sufficient granulation tissue can be addressed using fasciocutaneous flaps. Post- operative success depends on the blood flow remaining after superficial and deep tissue layers after fasciocutaneous graft transplants. Fasciocutaneous flap originates from the posterior calf are based on the popliteal artery descending cutaneous branch, which may cover an area greater than 8 x 17 cm. A Doppler preoperative assessment should be performed considering anatomical variations described in up to one third of patients[27]. Knee medial superficial necrosis can be addressed with the saphenous fasciocutaneous flap, supplied by the saphenous artery, a branch of the descending genicular artery. This technique can be performed to cover an area of approximately 6 x 10 x 15cm[28].

Deep wound necrosis, bone or prosthetic implant exposure are often associated with local bacterial contamination. In this scenario, the gastrocnemius muscle flap as a well vascularized graft provides local antimicrobial input in lesions limited to the proximal third of the tibia[29]. The medial portion of the gastrocnemius muscle has an independent vascular supply (middle sural artery) and is longer and more mobile than the lateral portion. The rotational mobility of the medial gastrocnemius flap allows to cover wound necrosis located in the proximal third of the tibia, medial articular interline, medial tubercle and the patella, covering an area of up to 49 $cm^2$. A free skin flap is then transferred after granulation tissue been achieved[29,30].

The gracilis muscle flap is an option for reducing donor side morbidity and can be performed through the same surgical incision as the previous TKA, with an estimated length of 6 x 20 cm. Its vascularization comes from the medial branch of the medial femoral circumflex artery[31]. In cases of deep wound necrosis including the joint capsule, or extensor mechanism, muscle flaps from the medial vastus, lateral and gastrocnemius muscles can be considered. Musculocutaneous flaps to manage wound complications after TKA are described in Table 1.

| | Description | Coverage | Vascularization |
|---|---|---|---|
| **Fasciocutaneous flaps** | Saphenous | 6 x 10 x 15 cm | branch of the descending genicular artery* |
| | Posterior calf | 8 x 17 cm | popliteal artery descending cutaneous branch |
| **Musculocutaneous flaps** | Medial portion of the Gastrocnemius** | Limit of 49$cm^2$ | middle sural artery |
| | Gracilis | 6 x 20 cm | medial branch of the medial femoral circumflexartery |

**Table 1**. Musculocutaneous flaps options to manage wound complications after TKA. *Saphenous artery. **Direct and independent vascularization.

Vascularized free flap transfer techniques are an option for cases where muscle or fasciocutaneous flaps are not appropriate or when other treatment techniques for surgical wound complications have previously failed. In this clinical scenario, the preoperative planning must consider skin thickness, size, contour of the region to be grafted, and the graft vascular supply[33]. The latissimus dorsi free flap provides excellent coverage for the anterior region of the knee and can be used for extensive skin necrosis. Its vascular pedicle originates from the thoracodorsal artery, a branch of the subscapular artery. Thus, the vascular pedicle longer than 12 cm must be anastomosed proximally to the descending genicular artery, a branch of the superficial femoral artery[34].

The free miocutaneous rectus abdominals flap muscle is based on the pedicle of the deep inferior and superior epigastric arteries. Its flat shape represents a reasonable option based on the anterior knee anatomy. Possible donor side effects include abdominal muscle weakness or abdominal herniation.

For obese patients, other vascularized free flap options should be considered[35,36]. Finally, a free vascularized flap from the lateral proximal region of the thigh with vascular pedicle from the lateral femoral circumflex artery, can also be used.[37] In cases with a small area to be addressed, the radial fasciocutaneous flap from the volar region of the forearm, vascularized by the radial artery, represents an additional option[38].

## Conclusion

Early surgical wound complications after TKA should have a multidisciplinary approach. A microsurgery or a plastic surgery team is helpful to assist in the decision- making process. Careful preoperative assessment and intraoperative management potentially decreased risks of postoperative ~~wound~~ and potential side effects. A prolonged hospital length of stay leads to patient psychological and social issues and increases ~~complications~~ public and private health system costs.

## Conflict of interests

The authors declare no conflict of interest.

Our acknowledgements and tribute to the late Dr. Victor Favilla who was a member of our staff and had suggested this manuscript.

## References

1. Galat DD, McGovern SC, Larson DR, Harrington JR, Hanssen AD, Clarke HD. Surgical treatment of early wound

complications following primary total knee ar- throplasty. J Bone Joint Surg Am 2009;91(1):48-54
2. Scuderi GR. Avoiding Postoperative Wound Complications in Total Joint Arthroplasty. J Arthroplasty 2018;33(10):3109-3112
3. Nedza SM, Fry DE, DesHarnais S, Spencer E, Yep P. Emergency Department Visits Following Joint 356 Replacement Surgery in an Era of Mandatory Bundled Payments. Acad Emerg Med 2017; 24:236–245
4. Moucha CS, ClyburnT, Evans RP, Prokuski L. Modifiable risk factors for surgical site infection. J Bone Joint Surg Am 2011;93(4):398-404
5. Goodman SM, Springer B, Guyatt G, et al. 2017 American College of Rheuma- tology/American Association of Hip and Knee Surgeons Guideline for the Periop- erative Management of Antirheumatic Medication in Patients with Rheumatic Diseases Undergoing Elective Total Hip or Total Knee Arthroplasty. J Arthroplas- ty 2017;32(9):2628-2638
6. Rohrich RJ. Current concepts in wound healing: update 2011. Plast Reconstr Surg. 2011;127 Suppl 1:1S-2S
7. Duchman KR, Gao Y, Pugely AJ, Martin CT, Noiseux NO, Callaghan JJ. The Ef- fect of Smoking on Short-Term Complications Following Total Hip and Knee Ar- throplasty. J Bone Joint Surg Am 2015;97(13):1049-1058
8. Møller AM, Villebro N, Pedersen T, Tønnesen H. Effect of preoperative smoking intervention on postoperative complications: a randomised clinical trial. Lancet 2002;359(9301):114-117
9. Sharma A, Subramanian P, Shah S, Remani M, Shahid M. Massive hemorrhagic blister formation following total knee arthroplasty. JRSM open. 2018 May;9(5):2054270418758569.
10. Greene KA, Wilde AH, Stulberg BN. Preoperative nutritional status of total joint patients. Relationship to postoperative wound complications. J Arthroplasty 1991;6(4):321-325
11. Vince K, Chivas D, Droll KP. Wound complications after total knee arthroplasty. J Arthroplasty 2007;22(4 Suppl 1):39-44
12. Roux J, Duong TA, Ingen-Housz-Oro S, et al. Heparin-induced hemorrhagic blis- ters. Eur J Dermatol 2013;23(1):105-107
13. Giordano CP, Koval KJ, Zuckerman JD, Desai P. Fracture blisters. Clin Orthop Relat Res 1994;(307):214-221
14. Heller S, Chen A, Restrepo C, Albert E, Hozack WJ. Tourniquet Release Prior to Dressing Application Reduces Blistering Following Total Knee Arthroplasty. J Ar-throplasty. 2015;30(7):1207-1210
15. Zhang W, Liu A, Hu D, Tan Y, Al-Aidaros M, Pan Z. Effects of the timing of tour- niquet release in cemented total knee arthroplasty: a systematic review and me- ta-analysis of randomized controlled trials. J Orthop Surg Res 2014;9:125
16. Webster J, Alghamdi A. Use of plastic adhesive drapes during surgery for pre- venting surgical site infection. Cochrane Database Syst Rev 2015;(4):CD006353
17. Polatsch DB, Baskies MA, Hommen JP, Egol KA, Koval KJ. Tape blisters that develop after hip fracture surgery: a retrospective series and a review of the liter- ature. Am J Orthop (Belle Mead NJ) 2004;33(9):452-456
18. Garbedian S, Sternheim A, Backstein D. Wound healing problems in total knee arthroplasty. Orthopedics 2011;34(9):e516-518
19. Scuderi GR. Minimally invasive total knee arthroplasty: surgical technique. Am J Orthop (Belle Mead NJ) 2006;35(7 Suppl):7-11
20. Parvizi J, Gehrke T, Chen AF. Proceedings of the International Consensus on Periprosthetic Joint Infection. Bone Joint J 2013;95-B(11):1450-1452
21. Simons MJ, Amin NH, Scuderi GR. Acute Wound Complications After Total Knee Arthroplasty: Prevention and Management. J Am Acad Orthop Surg 2017;25(8):547-555
22. Varela CD, Vaughan TK, Carr JB, Slemmons BK. Fracture blisters: clinical and pathological aspects. J Orthop Trauma 1993;7(5):417-427
23. Strauss EJ, Petrucelli G, Bong M, Koval KJ, Egol KA. Blisters associated with lower-extremity fracture: results of a prospective treatment protocol. J Orthop Trauma. 2006;20(9):618-622
24. Amin NH, Speirs JN, Simmons MJ, Lermen OZ, Cushner FD, Scuderi GR. Total Knee Arthroplasty Wound Complication Treatment Algorithm: Current Soft Tissue Coverage Options. J Arthroplasty 2019;34(4):735-742
25. Webb LX. New techniques in wound management: vacuum-assisted wound clo- sure. J Am Acad Orthop Surg 2002;10(5):303-311
26. Osei DA, Rebehn KA, Boyer MI. Soft-tissue Defects After Total Knee Arthroplas- ty: Management and Reconstruction. J Am Acad Orthop Surg 2016;24(11):769- 779
27. Shaw AD, Ghosh SJ, Quaba AA. The island posterior calf fasciocutaneous flap: an alternative to the gastrocnemius muscle for cover of knee and tibial defects. Plast Reconstr Surg 1998;101(6):1529-1536
28. Acland RD, Schusterman M, Godina M, Eder E, Taylor GI, Carlisle I. The saphe- nous neurovascular free flap. Plast Reconstr Surg 1981;67(6):763-774.
29. Panni AS, Vasso M, Cerciello S, Salgarello M. Wound complications in total knee arthroplasty. Which flap is to be used? With or without retention of prosthesis? Knee Surg Sports Traumatol Arthrosc 2011;19(7):1060-1068
30. Bos GD, Buehler MJ. Lower-Extremity Local Flaps. J Am Acad Orthop Surg 1994;2(6):342-351
31. Jung JA, Kim YW, Cheon YW. Reverse gracilis muscle flap: an alternative means of skin coverage for recurrent infection after TKA. Knee Surg Sports Traumatol Arthrosc. 2013;21(12):2779-2783
32. Whiteside LA. Surgical technique: vastus medialis and vastus lateralis as flap transfer for knee extensor mechanism deficiency. Clin Orthop Relat Res 2013;471(1):221-230
33. Economides JM, DeFazio MV, Golshani K, et al. Systematic Review and Com- parative Meta-Analysis of Outcomes Following Pedicled Muscle versus Fasciocu- taneous Flap Coverage for Complex Periprosthetic Wounds in Patients with Total Knee Arthroplasty Arch Plast Surg 2017;44(2):124-135
34. Nahabedian MY, Mont MA, Orlando JC, Delanois RE, Hungerford DS. Operative management and outcome of complex wounds following total knee arthroplasty. Plast Reconstr Surg 1999;104(6):1688-1697
35. Xing-Quan Z, Shao-Dong W, Qing-Yu F, Bao-An M. Versatility of rectus abdomi- nis free flap for reconstruction of soft-tissue defects in extremities. Microsurgery 2004;24(2):128-133
36. Nyame TT, Holzer PW, Helm DL, Maman DY, Winograd JM, Cetrulo CL Jr. SPLIT rectus abdominis myocutaneous double free flap for extremity reconstruc- tion. Microsurgery 2014;34(1):54-57
37. Kim SW, Kim KN, Hong JP, Park SW, Park CR, Yoon CS. Use of the chimeric anterolateral thigh free flap in lower

extremity reconstruction. Microsurgery 2015;35(8):634-639
38. Van Kampen RJ, Corten EM, Schellekens PP. The split radial forearm flap for lower leg defects. Ann Plast Surg 2014;73(5):535-539