

Title: Safety and effectiveness of negative pressure therapy on free flaps following lower limb reconstruction: a systematic review

Authors: Juan Enrique Berner^{1,2}, Patrick Will^{3,4}, Luke Geoghegan⁵, Luigi Troisi⁶, Jagdeep Nanchahal⁷, Abhilash Jain^{5,8}

Affiliations:

1. The Newcastle upon Tyne Hospitals NHS Foundation Trust. Newcastle upon Tyne, United Kingdom
2. Kellogg College, University of Oxford. Oxford, United Kingdom
3. BG Klinik Ludwigshafen. Ludwigshafen am Rhein, Germany
4. Ruprecht Karl University of Heidelberg. Heidelberg, Germany
5. Imperial College Healthcare NHS Trust. London, United Kingdom
6. University Department of Hand Surgery and Rehabilitation, San Giuseppe Hospital, IRCCS MultiMedica Group. Milan, Italy.
7. The Kennedy Institute of Rheumatology. Nuffield Department of Orthopaedic, Rheumatology and Musculoskeletal Sciences, University of Oxford. Oxford, United Kingdom.
8. Nuffield Department of Orthopaedic, Rheumatology and Musculoskeletal Sciences, University of Oxford. Oxford, United Kingdom

Corresponding author:

Mr Juan Enrique Berner MD MSc MRCS

Address: Kellogg College, University of Oxford. Oxford, United Kingdom. OX2 6PN.

Telephone: +447427074300

E-mail: juan.berner@nhs.net

Disclosure: All authors have no conflict of interest.

The study presented in this correspondence article were originally submitted for publication as part of a larger piece¹. Following peer-review and editorial appraisal it was decided to remove NPT articles from the main manuscript for the sake of clarity and is therefore being submitted as a separate manuscript.

A protocol for this systematic review was registered with PROSPERO (CRD42019154393)

Dear sir,

We have recently investigated the safety and effectiveness of extrinsic compression on lower limb free flaps¹ and in this literature review explored the use of negative pressure therapy (NPT) on lower limb free tissue transfers.

A PRISMA compliant, PROSPERO registered (CRD42019154393) systematic review was conducted, looking at the use of negative pressure dressings immediately applied after soft tissue transfer to the lower extremities. A search strategy was designed with the aid of an experienced librarian including: “free flap”, “free tissue flap”, “free tissue transfer”, “microsurgical flap” and “perforator flap”; combined with “bandage*”, “compress*”, “wrap*”, “flap training” and “dangling”, “negative pressure”, “vacuum assisted”, along with “lower extremity” and associated terms. EMBASE and MEDLINE databases were systematically searched on the 27th of January 2020 for eligible studies, including randomised and non-randomised controlled trials, cohort and case-control studies, case series and case reports. No filters or limitations for publication time and language were used.

Title and abstract screening followed by full text reviews (JB and LT) and data extraction (PW and LG) was conducted in parallel by two independent authors, with a third senior author (AJ) available to discuss disagreements. Demographic information outcomes and reported complication were retrieved from the eligible articles for analysis. A formal risk of bias assessment for each included article was also conducted.

A total of 847 entries were obtained from the systematic searches, of which 498 were retrieved from MEDLINE and 349 from EMBASE. Following identification of 223 duplicate items, 624 publications were reviewed further. Of these, only 8 met the pre-defined inclusion criteria (Figure 1).

The final list of eligible articles, which included publications between 2008 and 2018 are shown in Table 1. A total of 104 free flaps for lower limb reconstruction were reported among eligible studies. For all these articles NPT was applied intraoperatively and set to continuous suction. Five articles used this technique to secure split skin grafts over muscle flaps, Koulaxouzidis et al. utilised TNP over temporoparietal fascial free flaps covered by skin grafts, and two further articles published by the same research group utilised this modality over fascio-cutaneous flaps. Among all of these, there were only 3 (2.9%) complete flap failures reported for lower limb cases. However, these studies did not include any comparison arms that could prove substantial benefit over standard postoperative management. All the included articles had moderately to high risk of bias.

Topical negative pressure therapy may facilitate wound management by controlling exudate, oedema and odour, and may also accelerate the healing process for chronic wounds². Although no benefits have been found for its use as a temporary dressing for lower limb open fractures between debridement and definitive soft tissue cover³, it may facilitate split skin graft take and reduce local wound healing complications⁴, while providing a consistent compression. Our data show that following application of TNP over free flaps free flap failure rate is no different from large lower limb trauma series⁵.

Even though our results suggest that the use of NPT is safe, we were not able to find reports of any clinical benefits associated with this intervention. Further conclusions are limited by the quality of the included studies, consisting in non-randomised cohort studies and case series with moderate to high risk of bias. Further studies comparing the use of NPT against standard dressings are needed to answer,

ideally using a randomised two-arm study design are needed to better understand the benefits that this approach could have compared to conventional dressings.

Acknowledgements

The authors would like to acknowledge Tatjana Petrinic, Bodleian Health Care Librarian, for her aid in designing the systematic search strategy used in this study.

Disclosure

All authors have no conflict of interest.

The study presented in this correspondence article were originally submitted for publication as part of a larger piece¹. Following peer-review and editorial appraisal it was decided to remove NPT articles from the main manuscript for the sake of clarity and is therefore being submitted as a separate manuscript.

Funding disclosure

No funding received

References

1. Berner JE, Will P, Geoghegan L, Troisi L, Nanchahal J, Jain A. Safety and effectiveness of early compression of free flaps following lower limb reconstruction: a systematic review. *J Plast Reconstr Aesthetic Surg.* 2020;0(0). doi:10.1016/j.bjps.2020.05.011
2. Liu Z, Dumville JC, Hinchliffe RJ, et al. Negative pressure wound therapy for treating foot wounds in people with diabetes mellitus. *Cochrane Database Syst Rev.* 2018;2018(10). doi:10.1002/14651858.CD010318.pub3
3. Costa ML, Achten J, Bruce J, et al. Effect of negative pressure wound therapy vs standard wound management on 12-month disability among adults with severe open fracture of the lower limb the wollef randomized clinical trial. *JAMA - J Am Med Assoc.* 2018;319(22):2280-2288. doi:10.1001/jama.2018.6452
4. Petkar KS, Dhanraj P, Kingsly PM, et al. A prospective randomized controlled trial comparing negative pressure dressing and conventional dressing methods on split-thickness skin grafts in burned patients. *Burns.* 2011;37(6):925-929. doi:10.1016/j.burns.2011.05.013
5. Haykal S, Roy M, Patel A. Meta-analysis of Timing for Microsurgical Free-Flap Reconstruction for Lower Limb Injury: Evaluation of the Godina Principles. *J Reconstr Microsurg.* 2018;34(4):277-292. doi:10.1055/s-0037-1621724

Figure Legends

Figure 1: PRISMA flow diagram

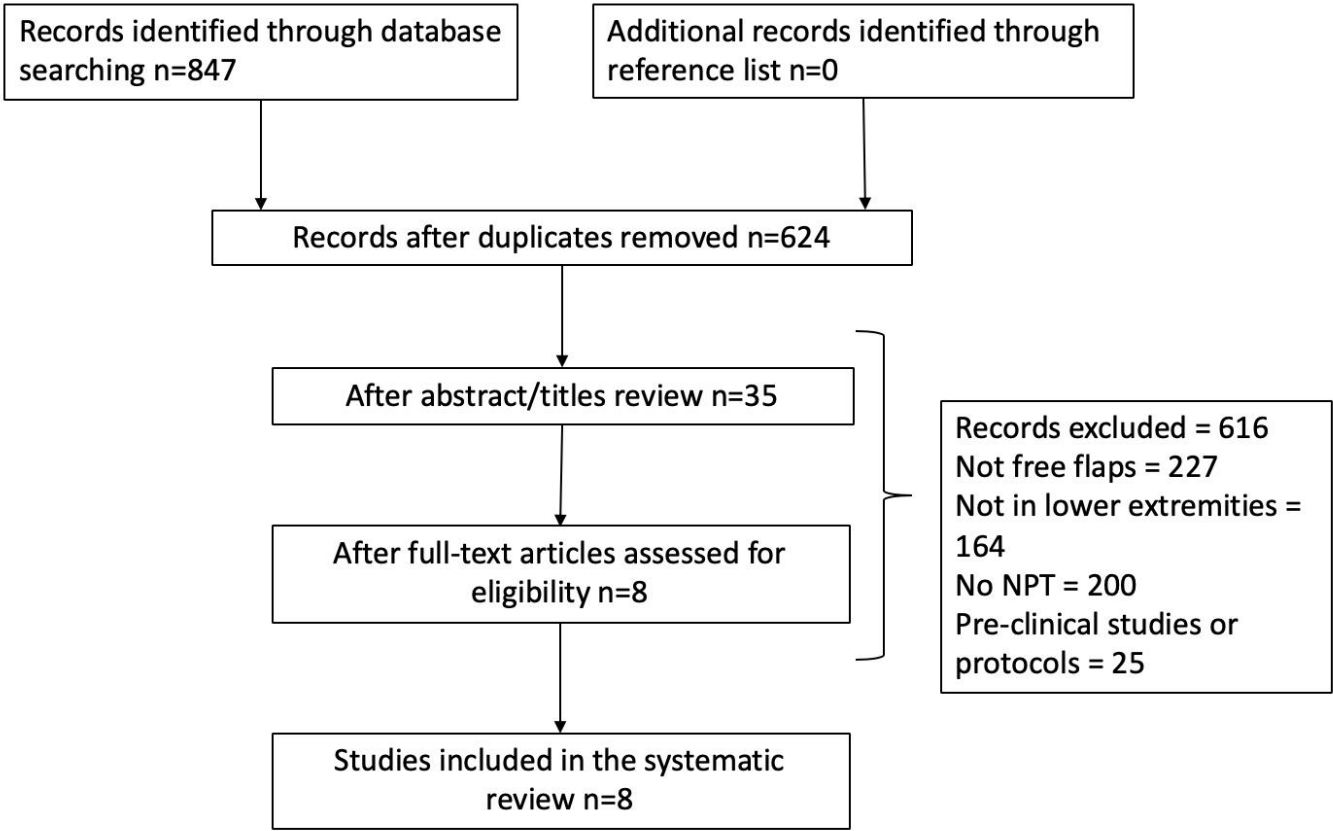


Table 2: Included studies in systematic review.

	Reference	Study type	Location of reconstruction	Free flap choice	Modality of compression	Flap failures	Other outcomes
	TNP						
1	Bannasch, et al., 2008	Case series	Lower extremity (n=5)	Gracilis, serratus and rectus abdominis flaps	NPT dressing applied intra-operatively (continuous 125 mmHg) over split skin graft	None	In one patient, despite flap survival, complications resulted in a below weeks later.
2	Nelson et al., 2010			Vastus lateralis flaps	NPT dressing applied intra-operatively (continuous 75 mmHg) over split skin graft	1 case	
3	Eisenhardt et al., 2010	Retrospective cohort	Lower extremity (n=26)	Gracilis, rectus abdominis and LD flaps	NPT dressing applied intra-operatively (continuous 125 mmHg) over split skin graft	2 cases due to DVT (7.69%)	In one case, intraoperative TNP alteration of implantable Doppler therefore removed. Two patients unstable skin grafts
4	Koulaxouzis et al., 2011	Case series		Temporoparietal fascial flaps	NPT dressing applied intra-operatively over split skin graft	None	No late revisions required
5	Dornseifer et al., 2016	Prospective cohort	Lower extremity (n=15)		NPT dressing applied intra-operatively (continuous 125 mmHg) over split skin graft	None	StO2 measurements using near-infrared spectroscopy and ultrasound doppler flow measurements were documented. Three patients dropped out due to thresholds during dangling regime therefore flap training was interrupted
6	Khan et al., 2017			Retrospective cohort	LD, ALT, TDAP, radial forearm flaps		
7	Bi et al., 2017	Retrospective cohort	Scalp (n=5), lower extremity (n= 11), upper extremity and hand (n=8)	LD, ALT, TDAP and radial forearm flaps	NPT dressing applied intra-operatively (continuous 125 mmHg)	None	-
8	Settembre et al., 2018	Case series	Lower extremity (n=5)	Omental flaps	NPT dressing applied intra-operatively (continuous 75 mmHg) over split skin graft	None	
POD: Post-operative day / NPT: Negative pressure therapy / DVT: deep vein thrombosis / ALT: anterolateral thigh / LD: latissimus dorsi / TDAP: thoracodorsal artery perforator / SCIP: superior gluteal artery perforator / StO2: Tissue oxygenation							
Full References:							
1.	Bannasch, H. <i>et al.</i> A critical evaluation of the concomitant use of the implantable Doppler probe and the Vacuum Assisted Closure system in free tissue transfer. <i>Microsurgery</i> . 34 , 179–185 (2010).						
2.	Nelson, J. A., Kim, E. M., Serletti, J. M. & Wu, L. C. A novel technique for lower extremity limb salvage: the vastus lateralis muscle flap with concurrent use of the vacuum-assisted closure system. <i>Microsurgery</i> . 26 , 427–431 (2010).						
3.	Eisenhardt, S. U. <i>et al.</i> The use of the vacuum-assisted closure in microsurgical reconstruction revisited: Application in the reconstruction of the posttraumatic lower extremity. <i>Microsurgery</i> . 34 , 179–185 (2010).						
4.	Koulaxouzis, G. <i>et al.</i> [Soft tissue reconstruction with a temporoparietal fascial flap (TPFF)]. <i>Der temporoparietale Faszienlappen zur Rekonstruktion von Weichteildefekten</i> . 24 , 179–185 (2011).						
5.	Dornseifer, U. <i>et al.</i> Perfusion Controlled Mobilization after Lower Extremity Free Flaps-Pushing the Limits of Time and Intensity. <i>J. Reconstr. Microsurg.</i> 33 , 179–185 (2017).						
6.	Khan, M. & Pestana, I. Use of negative pressure wound therapy in fasciocutaneous free-tissue transfer. <i>J. Am. Coll. Surg.</i> 225 , S168 (2017).						
7.	Bi, H., Khan, M., Li, J. & Pestana, I. A. Use of Incisional Negative Pressure Wound Therapy in Skin-Containing Free Tissue Transfer. <i>J. Reconstr. Microsurg.</i> 34 , 200–205 (2018).						
8.	Settembre, N., D'oria, M., Saba, C., Bouziane, Z. & Malikov, S. Negative Pressure Wound Therapy to Promote Fixation and Remodeling of Omental Flap in Patients with Revascularization. <i>Microsurgery</i> . 52 , 313.e5-313.e8 (2018).						