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Podiatric Medicine and Surgery Journal Club

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Podiatric Medicine and Surgery Journal Club

Abstract

The general purpose of this and future journal club columns is to facilitate the review of specific research studies and to discuss implications of each study for clinical practice as it relates to the lower extremity. Each column will be dedicated to a specific topic relevant to the treatment of a Foot and Ankle pathology. Each article chosen and reviewed will reflect the most recent advancements in Foot and Ankle Surgery and Medicine. We hope that you, the reader, find value and pleasure in the articles reviewed.

Keywords

orthoplastics

Conflict of Interest Statement

None of the authors have conflicts to disclose.

REVIEW

Podiatric Medicine and Surgery Journal Club

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Abstract

The general purpose of this and future journal club columns is to facilitate the review of specific research studies and to discuss implications of each study for clinical practice as it relates to the lower extremity. Each column will be dedicated to a specific topic relevant to the treatment of a Foot and Ankle pathology. Each article chosen and reviewed will reflect the most recent advancements in Foot and Ankle Surgery and Medicine. We hope that you, the reader, find value and pleasure in the articles reviewed.

Keywords: Orthoplastics

1. Introduction

An estimated $28–96.8 billion is spent yearly on acute and chronic wounds in the United States.[1] Unfortunately, far too many of these acute and chronic wounds will result in major amputation. In 2005, over 150,000 patients underwent lower extremity amputation in the United States with 60% of those secondary to diabetes, while more recent estimates are over 185,000.[2] These amputations result in morbidity, loss of function, loss of independence, reduced quality of life, and higher mortality rates. Some still advocate for primary amputation despite these findings reporting a shorter recovery time and quicker return to ambulation; however, studies have shown that only 47–67% of patients are able to rehabilitate to functional levels.[3] In order to prevent these unnecessary and devastating primary amputations, many institutions have invested time and resources into developing multi-disciplinary Limb Salvage Programs. These teams typically include plastic surgery, vascular surgery, podiatric surgery, orthopedic surgery, infectious disease, endocrinology, and wound care. They come together for the common goal of extremity preservation. Studies have shown that this multi-disciplinary approach to limb salvage and reconstruction leads to about 70–80% reduction in major amputations.[4,5]

More recently, these programs began focusing more specifically on the combination of two specialties, Orthopedics and Plastics, to achieve the same common goal. "Orthoplastic" surgery amalgamates the strengths of orthopedic and plastic surgery to maximize outcomes of complicated lower extremity reconstruction cases. Orthopedic principles are utilized to properly reconstruct the musculoskeletal system for adequate function and ambulation. Plastic surgery techniques focus on delicate manipulation of tissues, minimizing disruption to important neurovascular structures and providing a well-vascularized wound bed or surgical site to maximize healing potential. Typical cases usually involve some combination of significant soft tissue deficit, bone loss secondary to infection, cancer or trauma, and musculoskeletal deformity. These cases are only made more complicated by patients with multiple medical comorbidities like diabetes, chronic kidney disease, and vascular disease. The marriage of these two specialties could be the future of limb salvage.

We present to you a sampling of journal articles that focus on the concept of Orthoplastics and the various

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techniques that can be employed for the purpose of creating a functional limb for ambulation. The six journal articles presented herein are:

Study A: A Systematic Review and Meta-Analysis of Perforator-Pedicled Propeller Flaps in Lower Extremity Defects: Identification of Risk Factors for Complications. Plastic and Reconstructive Surgery.

Study B: A Single-Stage Operation in the Treatment of Chronic Osteomyelitis of the Lower Extremity Including Reconstruction with Free Vascularized Iliac Bone Graft and Free-Tissue Transfer.

Study C: A Single-Stage Operation in the Treatment of Chronic Osteomyelitis of the Lower Extremity Including Reconstruction with Free Vascularized Iliac Bone Graft and Free-Tissue Transfer.

Study D: Orthoplastic Management of Open Midfoot Injuries: Is Functional Limb Salvage Possible.

Study E: Salvage arthrodesis for infected ankle fractures with segmental bone-loss using Ilizarov concepts: a prospective study.

Study F: Definition of Bone Transport from an Orthoplastic Perspective.

Further suggested reading is provided following the study reviews.

Study A: A Systematic Review and Meta-Analysis of Perforator-Pedicled Propeller Flaps in Lower Extremity Defects: Identification of Risk Factors for Complications. Plastic and Reconstructive Surgery

Reviewed by: Aaren Harrington DPM

Level of Evidence: Level IV

Question: What are the significant risk factors for complications in patients undergoing a perforator-pedicled propeller flap in the lower extremity?

Methods: Medline, Pubmed Central, Embase and Cochrane databases were searched from 1991 to 2014 for articles describing perforator-pedicled propeller flap failure in lower extremity defects. 40 articles were included and a fixed-effects meta-analysis using inverse variance method for pooled relative risk was conducted.

Results: 428 perforator-pedicled propeller flaps on 428 patients with lower extremity defects were assessed. Of all the potential risk factors recorded, it was found age over 60 years old, diabetes, and arteriopathy were the only significant risk factors for complications in this type of flap. Smoking showed a near significant risk, however, it was noted in the article that this should be interpreted with caution. Factors such as acute vs. chronic, bone fracture, location, surface area, depth of flap used, pedicle and rotation did not have significant risk for complications.

Limitations: This was an observational study with a limited number of publications on the topic to draw from. Many of the studies also included different types of flaps and there may be confounding factors associated with different locations of flaps within the lower extremity. Finally, some studies were missing important patient information as well as procedural information on how the surgery was performed.

Conclusion: The most significant risk factors for complications or failure of this type of flap in the lower extremity is age over 60 years old, diabetes, and arteriopathy. Patients that fall in these categories should be carefully assessed for potential flap complication, and other procedures may yield better results in these populations.

Importance: This study clearly and plainly demonstrates what significant risk factors need to be considered in procedural selection for patients with lower extremity defects. This study not only points out the significant potential risk factors as noted above, but also shows factors that do not confer a significant increased risk in flap complication or failure.

Citation: Bekara F, Herlin C, Mojallal A, Sinna R, Ayestaray B, Letois F, Chavoin JP, Garrido I, Grolleau J, Chaput B. A Systematic Review and Meta-Analysis of Perforator-Pedicled Propeller Flaps in Lower Extremity Defects. *Plastic and Reconstructive Surgery.* 2016 Jan; 137(1): 314−331.

Study B: A Single-Stage Operation in the Treatment of Chronic Osteomyelitis of the Lower Extremity Including Reconstruction with Free Vascularized Iliac Bone Graft and Free-Tissue Transfer

Reviewed by: Ryan Thurston DPM

Level of Evidence: Level IV

Question: Can patients with chronic osteomyelitis be treated successfully with a single-staged procedure composed of debridement and closure utilizing free-flaps of both soft tissue and bone where necessary?

Methods: Four patients with chronic osteomyelitis that were previously-confirmed via radiographic and bacteriologic analyses underwent a single operation of two stages: first, radical debridement of infected bone and non-viable soft tissue; and second, reconstruction of the bone defect with a free vascularized iliac bone graft and soft-tissue coverage. 3 of the patients were placed in external fixators. Culture specific antibiotics were given for a minimum of 9 days and a maximum of 14 days. Mean follow up was 70 months.

Results: Mean length of hospital admission was 16 days. All patients were mobilized in crutches.

Patients without ex fix were able to bear weight fully after 3 months, and those with ex fix had them removed at 3 months in two of the patients and 7 months with one patient. Ulceration or fistulization did not recur. All patients were able to walk normally without pain or crutches at the end of the course.

Limitations: This was a very small case series with only 4 patients. The study was also from the late 1990s and it doesn't take into account the advancement of surgical techniques since that time.

Conclusion: Treatment of chronic osteomyelitis with debridement and coverage with a bone graft and skin flaps in a single-stage is a viable treatment option.

Importance: This article illustrates that it is possible to treat osteomyelitis surgically in a single procedure rather than in a multi-staged approach which could decrease overall costs and effects on the patient.

Citation: Rhomberg M, Frischhut B, Ninkovic M, Schwabegger AH, Ninkovic M. A single-stage operation in the treatment of chronic osteomyelitis of the lower extremity including reconstruction with free vascularized iliac bone graft and free-tissue transfer. *Plast Reconstr Surg.* 2003 Jun; 111(7):2353−61; discussion 2362−3.

Study C: Healing Heel Ulcers in High-Risk Patients: Distally Based Peroneus Brevis Muscle Flap Case Series

Reviewed by: Eileen Farley DPM

Level of Evidence: Level IV

Question: Is a peroneus brevis muscle flap appropriate for wound closure in high-risk patients with diabetes and peripheral vascular disease?

Methods: A case series of 17 patients with full thickness heel ulcerations is presented. Preoperatively, patients demonstrated 1 distal runoff via the peroneal artery, as confirmed by angiogram. Serial wound bed preparation was performed preoperatively until the ulcerations were deemed free of gross infection or necrotic tissue by the performing surgeon. Intraoperatively, the peroneus brevis muscle was isolated from the longus, with special care taken to preserve the superficial peroneal nerve. The dissected muscle was detached from its origin and pivoted to cover the ulceration. The flap was secured and flow was verified via intraoperative Doppler examination. Finally, Integra Bilayer was applied to the flap, along with injection of cBMA and VAC placement. Of note, external fixation was applied within the same procedure.

Results: Average time to removal of fixator was approximately similar of time to flap healing at an average of 10.3 weeks. Flap survival was noted to be 100%. No subsequent amputations or reports of osteomyelitis were observed.

Limitations: This study demonstrates a high selection bias of patients. Additionally, the study was inherently nonrandomized secondary of referral of patients to the surgeon's services.

Conclusion: Peroneus brevis muscle flaps are reliable in closing heel ulcerations, even in high-risk patients previously presented with major amputation. Multifactorial treatment approach with orthobiologics optimizes flap survival in those with comorbidities such as diabetes and peripheral vascular disease.

Importance: Escalation up the reconstruction ladder does not need to remain a linear stepwise fashion. Advancing treatment to flap coverage may reduce time to healing of ulceration, which inherently may reduce further complications, such as the development of osteomyelitis.

Citation: Nguyen T, Rodriguez-Collazo ER. Healing Heel Ulcers in High-Risk Patients: Distally Based Peroneus Brevis Muscle Flap Case Series. *J Foot Ankle Surg.* 2019 Mar; 58(2):341−346. https://doi.org/10.1053/j.jfas.2018.07.010. Epub 2018 Dec 21.

Study D: Orthoplastic Management of Open Midfoot Injuries: Is Functional Limb Salvage Possible

Reviewed by: Aaren Harrington DPM

Level of Evidence: Level IV

Question: Can functional limb salvage be done in patients follow high energy midfoot fractures through orthoplastic methods?

Methods: A retrospective review of open midfoot fractures over a 2 year period using the EQ-5D score to compare.

Results: Out of 15 patients admitted for open midfoot fractures, all injuries were related to high energy injuries and all required a debridement with stabilization in the form of an external fixator or K wires as the initial procedural treatment. Of the 11 patients in the limb salvage group, 8 were recorded as being able to avoid amputation; no information was provided for the other 3.

Limitations: In this study, limitations include a small sample size, only 15 patients, as well as a poorly defined follow up. No mean value of follow up was provided and only 8 of the 11 limb salvage patient's had significant follow up.

Conclusion: Although limb salvage is possible in a most cases of open midfoot injury, primary amputation should be discussed with all patients as the process of limb salvage is longer and likely will require more surgical procedures.

Importance: This article shows that limb salvage is possible after significant midfoot injuries, it may not

always be the best option and other options such as primary amputation should be discussed with the patient, depending on how committed they are prepared to be for the long road of limb salvage.

Citation: Budair B, Odeh A, Bleibleh S, Warner R, Fenton P. Orthoplastic Management of Open Midfoot Injuries: Is Functional Limb Salvage Possible? *J Foot Ankle Surg.* 2021 May–Jun; 60(3):466–470. https://doi.org/10.1053/j.jfas.2020.05.021. Epub 2020 Sep 2.

Study E: Salvage arthrodesis for infected ankle fractures with segmental bone-loss using Ilizarov concepts: a prospective study.

Reviewed By: Gaurav Singh DPM

Level of Evidence: Level II

Question: Is bifocal bone transport effective in salvaging troublesome infected ankle fractures with bone loss?

Methods: In this study, 44 consecutive patients, treated between 2012 and 2017, of post-traumatic infected ankle fractures were enrolled and subjected to radical debridement and salvage arthrodesis. The patients were divided into two groups. Group 1 patients were treated either by acute shortening compression of the arthrodesis site with re-lengthening (ASRL) through the created proximal metaphyseal osteotomy ($n = 20$). Group 2 patients were treated with gradual bone transport (BT) through the proximal osteotomy with gradual closure of the distal ankle defect ($n = 24$). Objective grading of the outcomes was done according to the Hawkins criteria, while subjective grading was done by having the patients reported their satisfaction on a 1–5 points acceptance scale. T-test and the chi-square test were used for statistical analysis of the values generated.

Results: The mean follow-up was 36.95 ± 6.09 months in group 1 and 37.33 ± 4.74 months in group 2. Successful fusion was achieved in 43 of the 44 patients, with a statistically significant ($P < 0.05$) lesser needs for bone-grafting in favor of group 2. The acceptance scores were statistically significantly ($P < 0.05$) superior in group 2 (3.08 ± 1.1 points) than that group 1 (2.25 ± 1.4 points). Objective grading (Hawkins criteria) showed that results achieved were good in 32 cases, fair in 11 cases and poor in 1 case.

Limitations: Limited number of cases in the study. Authors used too strict of a selection criterion (cases with debilitating comorbidity, associated neurovascular injuries, smoking or ipsilateral lower limb fractures were intentionally excluded).

Conclusion: The authors concluded that applying Illizarov principles in managing infected ankle fractures with bone loss is effective. Bone transport is more comprehensive and acceptable than arthrodesis site with re-lengthening. Bone transport is further superior to the Illizarov technique because it can overcome a defect of any size, whereas ASRL technique can only be applied to defects less than or equal to 3 cm.

Importance: This study gives a superior alternative to management of infected ankle fractures with bone loss. In instances where you need a greater than 3 cm defect managed, bone transport is far superior since the limitation of the ASRL technique is that it can only be applied to a defect less than or equal to 3 cm. The bone transport technique also helps overcome limb shortening post salvage. This is one of the biggest drawbacks of other techniques in ankle salvage procedures.

Citation: Atef A, El-Rosasy M, El-Tantawy A. Salvage arthrodesis for infected ankle fractures with segmental bone-loss using Ilizarov concepts: a prospective study. *Int Orthop.* 2021 Jan; 45(1):233–240.

Study F: Definition of Bone Transport from an Orthoplastic Perspective

Reviewed by: Courtney Foote, DPM

Level of Evidence: Level III

Question: Can traditional "bone transport" techniques via distraction histogensis be used for the management of traumatic composite bone and soft tissue loss (TCBSTL) and what are the results of this technique?

Methods: This is a retrospective evaluation of patients with reconstructable TCBSTL of the lower extremity that were treated with either gradual or acute "bone transport" using distraction histogenesis and external fixation. All patients were treated at a single institution between 2000 and 2017 by the same surgical team. Patients that were not candidates for reconstruction, were intolerant to external fixation or could be managed with simpler reconstructive protocols were excluded from this study. Acute Shortening and Re-lengthening (ASRL) was reserved from patients with smaller defects with patent lower extremity vascularity. Gradual Distraction-Compression (GDC) was used in cases where ASRL was not feasible due to the size of the defect or vascular compromise. Of the 150 cases included in this study, 103 were treated with GDC and 47 were treated with ASRL. Patients underwent the same post-operative protocol regardless of the technique used. Cases were considered "satisfactory" if they achieved positive results with all of the outcome measures listed, including: evidence of bony union, less than 5 degrees of residual deformity, less than 2.5 cm residual limb length discrepancy (LLD), no recurrent infection, adequate soft tissue healing without any exposed bone,

sufficient adjacent joint range of motion with less than 5 degrees of contracture, no pain or mild residual pain, sufficient return to activity/work and high patient-reported satisfaction.

Results: One-hundred and fifty patients were included in this study with an age range of 12−64 years and 81:19 male to female ratio. GDC was performed in 68.7% of the cases and ASRL was performed in 31.3% of the cases. Adjunctive procedures included autogenous iliac crest bone graft (42 cases, 28%), split thickness skin graft (6 cases, 4%) and dock site revision at the end of bone transport (114 cases, 76%). Patients completed a follow up which ranged from 24 to 118 months (average of 35 months). All patients in this study exhibited mild superficial pin site infection which were treated successfully with daily pin care and oral antibiotics. There were no cases of recurrent deep infection throughout the follow up period. Limb length discrepancy resolved in 141 of the cases (94%). Fracture union was achieved in all cases. There were no cases of vascular compromise. No patients required amputation for a 100% limb salvage rate. Nine cases had unsatisfactory results (6%) due to residual limb length discrepancy, joint stiffness and persistent pain. The results were satisfactory in 94% of the cases.

Limitations: This study was retrospective in nature and therefore, there could be inherent selection bias present. This was mitigated by clearly defined inclusion and exclusion criteria. The results of the bone transport techniques used in this study were not compared to a control group, gold standard, or differing treatment protocol. Since this study is not comparative in nature, it is difficult to perform any cost-benefit analysis. The two modes of treatment included in this study, GDC and ASRL, had significantly different indications. Rightfully so, GDC and ASRL were not compared in this study. Combining the outcome measures and data of both techniques could skew the results in this study; however, this would be difficult to assess. If future comparative studies were pursued, it may be beneficial to use only one of the modes performed in this study to allow for more accurate comparison of treatment protocols. A randomized control trial (RCT) comparing bone transport to other means of reconstruction would be the best way to evaluate the efficacy of this technique; however, this may not be feasible. Retrospective evaluation comparing two different treatment protocols would be sufficient to better assess this technique and expand on the results of this paper. Ideally future studies would include the previously described outcome measures as well as time to union, time to return to work, total number of operations and total operative costs.

Conclusion: Bone transport is a powerful technique to treat TCBSTL in the lower extremity without the need for free tissue transfer or microsurgical expertise.

Importance: Most studies involving reconstructive surgery of the lower limb focus on treating the significant soft tissue loss or damage leaving the osseous component grossly unaddressed. Without studies that encompass the importance of bony reconstruction, surgeons and patients are left with fewer treatment options that are fraught with complications leading to inadequate results and possible amputation. This article presents two means of bone transport, acute and gradual, that can be used in the treatment of TCBSTL with satisfactory results. Hopefully, this article can inspires future comparative studies involving this treatment protocol.

Citation: El-Rosasy M, Mahmoud A, El-Gebaly O, Rodriguez-Collazo E, Thione A. Definition of Bone Transport from an Orthoplastic Perspective. *International Journal of Orthoplastic Surgery*. 2019; 2(2):62-71.

Conflict of interest

None of the authors have conflicts to disclose.

Further Suggested Reading

1. Nussbaum SR, Carter MJ, Fife CE, et al. An economic evaluation of the impact, cost, and medicare policy implications of chronic nonhealing wounds. *Value Health*. 2018;21:27−32.
2. Dillingham TR, Pezzin LE, Shore AD. Reamputation, mortality, and health care costs among persons with dysvascular lower-limb amputations. *Arch Phys Med Rehabil*. 2005 Mar;86(3): 480−486.
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