

Landmark Papers In Reconstructive Lower Limb Trauma Surgery Have Raised More Questions Than They Have Answered

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Abstract

Lower limb reconstructive techniques and practices are continually advancing and changing. In this article I present a timeline whereby landmark papers and work has not only formed the basis of practice, but altered the way in which it is delivered.

INTRODUCTION

Trauma surgery is a complex, multi-faceted and multi-disciplinary specialty. Simply it can be defined as the surgical procedure or procedures required for the best needs of the injured patient. The Oxford English Dictionary describes "landmark" as "an important stage in something's development"; a landmark paper therefore is seminal towards the development of trauma surgery.

Lower limb reconstruction is an important and emotive topic in exigent and emergency surgery. Extensive soft tissue and bony injuries have long been problematic for orthopaedic and plastic surgeons alike, in the planning of reconstructive surgery. I will use papers that have been important in the thinking and development of this surgery, concentrating on soft tissue coverage, to illustrate my hypothesis in agreement with the title.

LOWER LIMB RECONSTRUCTION

Until the late 19th century mortality from open fractures was high. This was mainly due to sepsis after infection. Theodor Billroth reported in 1881 that 46 of 93 patients he treated with an open fracture in Zurich died. In the Franco-Prussian war, the death rate for open fractures rose to 77%.

A growing understanding of bacterial contamination, antiseptics, aseptic surgery, and the advances in fracture and soft tissue management greatly reduced the mortality of open fractures.

World War II figures from DeBakey and Simeone in 1946 reported on a 64% limb salvage for repair. Rich et al in 1970

report an 87% limb salvage rate in the Vietnam War. Recent figures from Trooskin et al (6) in 1993 on civilian war in America have reported a 100% limb salvage rate.

Classifications of the injured limb have been developed to assist in its assessment. These include the Limb Salvage Index, Mangled Extremity Severity Score and the Predictive Salvage Index.

The most commonly used is the Gustillo classification. Some form of lower limb reconstruction is usually required on grade IIIB injuries and above.

Lower limb reconstruction requires implementation of the reconstructive ladder to best close the defect. For the purpose of this discussion I will be highlighting literature concerned with the use of local and free flaps.

"Plastic surgery is a constant battle between blood supply and beauty" (Gillies and Millard 1957).

Anatomy forms the basis of reconstructive surgery, and in particular the anatomy of cutaneous perforators and vascular territories of the skin. In the 16th century Vesalius published seven illustrated works "On the Fabric of the Human Body" which set out to map the anatomy of the human body (16). An "anatomy race" was sparked with its leader and pioneer being John Hunter in the 18th century. This coincided with the infamous body snatchers and the forcing of the anatomy act in the 19th century. In 1889 Manhot produced his treatise on the "Skin and Arteries of the Body" (4). This landmark work stood the test of time until the next major work by Salmon in the 1930's, which revisited Manhot's

work with the aid of radiology. Work in the 1970's, and more specifically the work of Ponten (1) in conjunction with technological advances, inspired Taylor and Palmer (4) to further build on previous work on mapping the vascular territories of the human body, and facilitate reconstructive surgery. In this paper dye injection studies, radiographic perforator mapping studies, isolated limb studies and cross sectional studies were performed. The results managed to map and compare territories supplied by source arteries in deep tissue and the overlying skin and soft tissue. Perimeters were found to overlap and the composite unit supplied by the source artery was named an "angiosome" from the Greek "angio" meaning vessel and "somite" meaning segment of the body. The other observation that was made was that of a dominant axis of vessels running parallel to the body surface, which supplies direct vessels to the skin. The depth varies in different regions and is crucial to know before designing a skin flap.

This paper managed to correlate previous works, provide some hard facts behind techniques in use, and provide a springboard for further work. No more so than the work of Whetzel et al (7) who specifically looked at the arterial fasciocutaneous vascular territories of the lower limb in detail to help design viable fasciocutaneous flaps.

The term "flappe" is Dutch and comes from the 16th century. It means "something that hangs broad and loose on one side". Work and refinement into flap surgery spans many centuries, even before anaesthesia. In 600 B.C. Sushruta Samita described operations for nasal reconstruction (15). Flap surgery advanced, and the first recorded muscle flap was the pectoralis minor muscle flap by Louis Ombredanne of Paris in 1906. In that same year Tanzini introduced the latissimus dorsi muscle flap. In 1912 Professor Stefano d'Este introduced the first myocutaneous flap (15).

Flaps can be classified in three ways: its blood supply (Cormack and Lamberty, Mathes and Nahai), the tissue transferred, or on the location of the donor site.

Previously, most lower limb flaps were based on skin flap design, which severely limited both the size and its applications as the length:width ratio was in the order of 1:1. In 1981 Ponten (1) described fasciocutaneous flaps with a ratio of 1:3. This breakthrough in lower limb reconstruction was based on anatomical observations made earlier in the century. It was noted that dissection in fascial planes was relatively avascular, the vessels penetrating the fascia did so

proximally, the axis of vessels followed that of the extremity, and that venae comitantes accompany vessels thereby allowing a good arterial and venous supply. These allowed Ponten to push the boundaries and create the fasciocutaneous flap.

Barclay et al (2) sought to recreate the validity of Ponten's work post their own anatomical dissection and patient series. They also raised the issue of the cross leg flap used more extensively prior to Ponten's "super" flaps, and before the advent of free flap surgery as a viable alternative not to be forgotten in reconstructing a lower limb defect. The question was rightly raised on whether the morbidity or hospital stay is different in comparison to free flap surgery. On average it was proven not to be (3).

Cormack and Lamberty (5) looked to further refine the debate and classify flaps according to their blood supply based on the works of Taylor (4), Barclay (2,3) and Ponten (1).

In recent times the improvement in technique and understanding of microvascular surgery has led to advances within this field in lower limb reconstruction. This is currently pioneered by Fu-Chan Wei. He has explored the value of routine angiography in traumatic lower limb reconstruction (8), and has pushed the boundaries with one stage reconstruction using osteoseptocutaneous flaps. He continues to refine and subtly alter established techniques for flaps in an attempt to quantify their appropriate and precise usage.

DISCUSSION

The thirst for knowledge, notoriety and acclaim is notable amongst the medical profession. Though not directly involved with trauma surgery, the first part of the article discusses a parallel topic, which has implications on trauma surgery. John Hunter was the first clinician to really question established practice and conjecture regarding not only medical treatments, but also anatomy and physiology of humans and animals. More specifically to the article, his attention to detail in anatomy dissection allowed mapping and understanding of the lympho-vascular system. The knock on effect was to fervently increase activity of physicians to not only question existing findings, but also search for more answers. If extrapolated this led to Manchot's work in the 19th century who in turn stimulated Salmon and Taylor et al. who looked further into vascular territories once clinical applications became apparent.

The tissue flap for reconstruction is a prime example of constant questioning, development and refining of surgery. As outlined earlier the concept of flap surgery is not novel, what is remarkable, however, is the rapid development in the 20th century of its use in trauma surgery. Once the importance of sepsis was identified and controlled, reconstructive surgery could be developed. In a landmark paper Ponten described the fasciocutaneous flap. As well as acceptance of a radical development in plastic surgery, this also stimulated further questions to be answered not only in pure anatomy, but also regarding flaps themselves. This is highlighted by the progression of works from Barclay, Cormack and Lamberty and Fu-Chan Wei through to a recent paper still attempting to answer the question of the best reconstructive option for different defects (11).

The most recent paper on this subject is from India, and demonstrates a new scoring system for classifying open lower limb injuries. This is called the Ganga Hospital Score (17). In the paper they suggest a new scoring system, which has less of the subjectivity bias of Gustillo and more specificity with regards to the modality of fixation and reconstruction of the injured limb. The results of their application of this system in a surgical context are to be published soon, and could be the foundations of an alteration in practice.

CONCLUSION

The various treatments of severe lower limb injuries have in fact at one time or another been present in history. Pierre-Joseph Desault (1744-95) coined debridement, and recognised its importance in trauma surgery. Ollier (1825-1900) introduced stabilisation of fractures by plaster casts, however it was not till the work of Godina et al. (PRS; 78; 285, 1986) that recognised that wound closure within 72 hrs gave the best results, in addition to the afore mentioned treatments.

During the course of the article a timeline has been illustrated to show that despite groundbreaking research and landmark publications, work in this field has never been viewed as complete and is ongoing.

What this proves is that the medical profession has a

relentless drive in personal and specialty development. Every question answered leads to a further question asked, which in turn needs to be answered.

In conclusion landmark papers in reconstructive lower limb trauma surgery do raise more questions than they have answered.

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