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Advances in Limb Reconstruction Surgery

Ajit Chalak[1], Schine Kale[2], Ashok Ghodke[3]

Abstract

Limb reconstruction surgery has witnessed remarkable advancements in recent years. The hexapods have revolutionized limb reconstruction surgery, offering patients reduced postoperative discomfort, accelerated recovery times, and a quicker return to functional independence. This article aims to delve into the current aspects of limb reconstruction surgery, exploring the strategies employed in addressing these complex issues.

Keywords: Limb reconstruction, Stimulan, Hexapod, ALFA Fixator

Introduction

As the pace of industrialization quickens, incidents involving traffic and engineering mishaps have surged, leading to a rise in high-impact injuries and limb fractures. Individuals facing open fractures and osteomyelitis are at a heightened risk of severe wound infections, skin necrosis, and prolonged open wounds. This elevates their vulnerability to bone defect infections and bone nonunion. Managing both these conditions proves challenging due to extended treatment durations, potential complications, and frequent severe bone infections post-trauma [1].

These occurrences not only significantly affect the quality of life for patients but also place a substantial burden on families and society as a whole. Consequently, health-care professionals urgently require more effective methods to address bone defects and bone nonunion in various scenarios [2].

The primary objective of treatment is to achieve bone union, eliminate infection, correct alignment issues, equalize limb length discrepancies, and preserve joint function. This article aims to delve into the current aspects of limb reconstruction surgery, exploring the strategies employed in addressing these complex issues.

Hexapod Devices

Over time, the evolution of external fixation has led to the genesis of the hexapod which has also been shown to be very effective in the setting of bone defect management [3]. Functional outcomes after stacked hexapod application for bone transport can give good functional outcomes [4]. When compared with Ilizarov frames, hexapods have been shown to be more powerful in the correction of translational and angular deformity, but many surgeons believe that hexapods are not stable enough to produce optimal regenerate when compared with classic Ilizarov rigid ring connections [5]. For this reason, Sheridan et al., in 2023 compared patients with bone defects treated with conventional Ilizarov fixator and hexapod.

This study found that hexapods may confer a significant advantage over Ilizarov frames in the management of bone defects treated with either bone transport or acute shortening and lengthening. It was found that time to consolidation, bone healing index (BHI), and external fixator index (EFI) were all superior in the hexapod group compared with the Ilizarov group. Final limb alignment parameters were also significantly better in the hexapod group. The only significant predictor of improved BHI was the use of hexapod. There were two significant predictors for lower EFI including the use of a hexapod and the use of bone transport over shortening and lengthening. This information is in direct contrast to previous studies and is of great interest to surgeons managing these complex reconstructive procedures. Although the results attained with the classic Ilizarov ring connections in expert hands were very good, this study supports the conclusion that the addition of hexapod technology will provide even better

[1]Department of Orthopaedic Surgery, Dr D Y Patil Hospital, Nerul, Navi Mumbai, Maharashtra, India,
[2]Department Of Orthopaedics, Dr DY Patil Hospital, Navi Mumbai, India,
[3]Dept of Orthopaedics, MGM Medical College, Navi Mumbai, India.

Address of Correspondence
Dr. Ajit Chalak,
Department of Orthopaedic Surgery, Fellowship in Limb Reconstruction and Ilizarov Surgery, Mumbai, Maharashtra, India.
E-mail: ajitchalak@gmail.com

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results in the treatment of bone defects [6].

Stimulan

Osteomyelitis has always been a challenging condition to treat and to achieve a cure. Although there are various newer treatment methods available in the last two decades, we still have many hurdles to get on top of this difficult problem [7].

The local delivery of antimicrobial agents at the infection site in orthopedics is based on the need for high concentrations of these drugs to kill planktonic and biofilm-based bacteria [1]. Most of the debridements are intralesional and leave the resected surfaces exposed to the contaminating bacteria. The debris that remains in the wound includes small biofilm fragments and a few organisms that are usually unresponsive to antimicrobial agents in the given concentrations. Pharmacokinetic factors, including alterations in local tissue perfusion, make the local antibiotic delivery system as the best method of achieving an extremely high antimicrobial level [8].

Stimulan is an absorbable calcium sulfate that can be directly applied at the site of infection, for control of infection and dead space management in infected non-unions, osteomyelitis, and PJIs. Stimulan has the advantage of complete absorption within 6–8 weeks, and second surgery for removal is not needed [9].

Articulated Lengthening Fixator Apparatus (ALFA) Fixator

Distal femur non-union is difficult to deal with because of limited or no bone stock left for holding pins. Also, knee range of motion is a major concern in case of distal femur non-union to deal with. ALFA is a new modality of definitive external fixator with limited literatures. This paper aims to present the series of cases of gap non-union of the distal femur managed with an ALFA fixator and their outcome as an initial experience on a new device.

ALFA fixator for gap non-union as an alternative to Ilizarov, and LRS provides adequate distraction osteogenesis, less neurovascular complication due to pins, better patient tolerability, and user-friendly distraction of the distal femur with preserved knee range of motion [10].

Motorized Intramedullary Lengthening Device

The goal of limb lengthening is to restore length to bone, safely stretch soft tissues and improve quality of life with minimal complications. Conventionally, this was achieved with the use of external fixators, associated with complications related to pin site tethering and infections, joint stiffness and regenerate deformity and fracture following frame removal. The duration of treatment also impacts on patient mental health and well-being. To reduce external fixator time, intramedullary nails have been introduced as an adjunct, either at the initial surgery or after completion of lengthening. Complications related to the external fixator still remained and innovation has led to the popularization of the intramedullary lengthening nail.

The popularity of using an intramedullary implant during limb lengthening has grown over the past 5 years. The literature supports the use of lengthening over nails as a surgical technique, both for excellent clinical outcomes and it is a cost effectiveness. In the past decade, the motorized intramedullary lengthening nails appear to have become the gold standard method of femoral lengthening. However, surgeons must remain cautious with recognition and reports of implant, regenerate and soft-tissue complications. Certain conditions remain susceptible to complications, such as joint subluxation during lengthening in congenital femoral deficiency regardless of the technique used, and in these cases, more care and attention is essential for a successful outcome [11].

Conclusion

As technology continues to advance, the scope of limb reconstruction surgery is poised to expand further, promising ongoing improvements in patient outcomes, reduced recovery times, and enhanced overall quality of life. This dynamic field stands at the forefront of medical innovation, continuously pushing boundaries to provide individuals with comprehensive solutions that enable them to lead fulfilling and active lives. The future of limb reconstruction surgery holds great promise, offering new horizons for those in need of limb restoration and rehabilitation.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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