

## Original Research Article

# Combined free flap and ilizarov bone reconstruction in complex lower limb trauma: our experience

Ravi Mahajan<sup>1</sup>, Inderdeep Singh<sup>2\*</sup>, Avtar Singh<sup>2</sup>, Mahipal Singh<sup>1</sup>, Sandeep Kansal<sup>1</sup>

<sup>1</sup>Department of Plastic Surgery, <sup>2</sup>Department of Orthopaedic, Amandeep Hospital, Amritsar, Punjab, India

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**\*Correspondence:**

Dr. Inderdeep Singh,

E-mail: orthoinder@gmail.com

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### ABSTRACT

**Background:** Reconstruction of complex lower limb trauma is a major concern for both plastic and Orthopedic surgeons. The use of free flap with Ilizarov method for soft tissue coverage and bone reconstruction not only gives the patient near normal shape and function but also allows early mobilization of the patient, even during the process of distraction with Ilizarov method.

**Methods:** In this study patients with bone and soft tissue defects of the lower leg were included in the study. Our protocol was immediate wound debridement along with application of external fixator and early free flap coverage within 48-72 hours. After 3-4 weeks of the free flap transfer definitive bone reconstruction is done with Ilizarov method.

**Results:** 122 flaps survived fully and distal flap necrosis occurred in 4 patients. Necrosis of flap occurred before the start of bone reconstruction with Ilizarov and was managed conservatively or with skin graft. Pin tract infection occurred in 45 (35.71%) patients and was treated by pin care and antibiotics. Other complications in treated patients included pain due to distraction (33.33%), delayed union at docking site (11.90%), discrepancy of limb size (9.52%) and union with deformity (6.35%). The functional outcome was satisfactory in majority of the cases.

**Conclusions:** Combined use of free flap and Ilizarov provides a more reliable soft tissue coverage and bone reconstruction with almost near normal shape and function. It has advantages like regenerating same quality bone and allowing the early mobilization of the patient with acceptable rate of complications.

**Keywords:** Complex lower limb trauma, Ilizarov, Free flap, Complications, Outcome

### INTRODUCTION

Reconstruction of a complex lower limb trauma is a major concern for both plastic and orthopedic surgeons. There are many options available for soft tissue and bone reconstruction. Major concern is to give the patient near normal shape and function of the limb. Ilizarov method for bone reconstruction, described first by Prof G A Ilizarov for external bone fixation for managing bone injuries and orthopedic diseases, and free flap for soft tissue reconstruction is a promising answer for treating complex defects of lower extremities.<sup>1</sup> The bone

transport technique defined by Ilizarov has been used in the treatment of bone defects produced by various causes.<sup>2</sup> The advantages of Ilizarov technique is that it is biological with low complication rate than any other technique, it can be applied to defect of any size, and it does not require long term immobilization and intensive autogenous bone grafts.<sup>3</sup> Moreover, it can be used whenever there is a bone defect of more than 4 cm. These defects may be secondary to bone tumor resection, osteomyelitis or due to complex fractures with bone loss secondary to complex limb trauma.<sup>4</sup> The other more complex use of this technique is in managing rare

orthopedic conditions such as congenital pseudoarthrosis of tibia, tibial or fibular hemimelia and for joint arthrodesis where it can be used for correction of deformities. The disadvantages of Ilizarov technique include adequate training of orthopedic surgeons for proper application of this technique. The common complications associated with this procedure include wire tract infection and prolonged period required with the apparatus.<sup>5</sup> The important aspects which must be monitored properly include radiographic evaluation of bone fragment position, proper adjustment of frame and maintenance of joint motion. To overcome some of the drawbacks of this method the researchers have come up with various hybrid assemblies and various randomized controlled trials have concluded that hybrid assemblies has many distinct advantages over conventional assembly particularly in terms of complications such as delayed consolidation of regenerate, refracture, deformity and aneurysm which were seen less in hybrid assemblies.<sup>6</sup>

Ilizarov technique and free flap for soft tissue reconstruction has distinct advantages when used properly in patients with complex limb trauma caused by high energy injury to the lower limbs.<sup>7</sup> These injuries are usually accompanied by significant soft tissue involvement and risk of secondary infections, non-union and malunion.<sup>8</sup> Ilizarov fixators with tensioned small wire-fixations have reported to bear satisfactory results in all these cases. It is important not to miss other injuries which may be present in these patients which may include musculoskeletal or spinal injuries.<sup>9</sup> In many instances of high velocity trauma to lower limb open reduction and internal fixation is all that may be needed while in other cases it is impossible to achieve open reduction and internal fixation owing to extensive loss of bone or when fractures are severely comminuted and in all such cases Ilizarov technique and free flap for soft tissue reconstruction can bear excellent outcomes.<sup>10</sup>

This study reports our results of using the combined method (free flap and Ilizarov) for soft tissue coverage and bone reconstruction, which not only gave the patients near normal shape and function of the limb but also allowed early mobilization of the patients, even during the process of distraction with Ilizarov method.

## METHODS

The study was conducted in the departments of orthopedics and plastic surgery in Amandeep hospital, Amritsar which is a tertiary care institute. This was a retrospective review of patients who have undergone Ilizarov technique and free flap for soft tissue reconstruction following complex lower limb trauma from January 2001 to December 2015. The cases were included in the study on the basis of predefined inclusion criteria. Cases having any of the exclusion criteria were excluded from the study. Total number of 126 patients was operated during the period of Dec 2001 to Dec 2015.

The protocol of treatment followed in our institution comprised of 3 major stages.

1. First stage - Immediate debridement of the wound and external fixator for skeletal stabilization.
2. Second stage - Early free flap coverage with in 48 -72 hours of debridement.
3. Third stage - Ilizarov application for bone reconstruction after 3-4 weeks of free flap coverage.

Patient was allowed weight bearing during the distraction period.



**Figure 1: (A): Extensive degloving injury involving lower limb; (B): Ilizarov technique; (C): x-ray showing fracture of tibia fibula with Ilizarov fixator; (D): limb after healing.**

All the patients were followed up for a period of 1 year after discharge from our institute. The data was collected from the case papers of the patients who have undergone combined. Statistical analysis was done with Minitab version 17 running on windows 10. Microsoft word was used for manuscript preparation while excel was used for creation of figures and graphs.

## Inclusion criteria

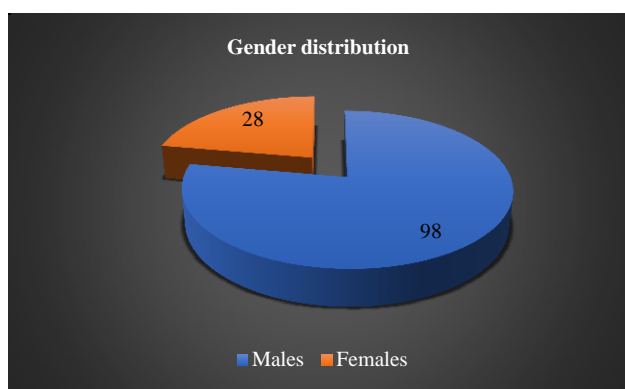
Inclusion criteria were all patients who have undergone Ilizarov technique and free flap for soft tissue reconstruction following complex lower limb trauma at our institute over a period of 15 years; the cases papers of all the patients included in this study had complete record of treatment as well as of follow up visits for at least 1 year after the discharge of patients from our institute.

**Exclusion criteria**

Exclusion criteria were patients who have undergone failed attempts at open reduction and internal fixation prior to being referred to our institute; patients in whom treatment record was not complete or missing; follow up record for at least 1 year was not present.

**RESULTS**

This was a retrospective study in which the patients who had undergone Ilizarov procedure and free flap for soft tissue reconstruction following complex lower limb trauma. The clinical details, operative management and outcome was reviewed from the case papers. A total of 126 patients who fulfilled the inclusion criteria were included in this study. Out of these 126 patients there were 98 (77.77%) males and 28 (33.33%) females with a M:F ratio of 1:0.28.



**Figure 1: Gender distribution of the studied cases.**

The analysis of the age groups of the patient showed that the most common age group to be affected was between the age group of 25-35 years comprising of 52.38% of all the cases followed by 15-25 (28.57%) years and 35-45 years (9.52%). There were no cases below 5 years of age.

The analysis of mechanism of injury showed that the most common mode of injury was road traffic accidents (64.29%) followed by fall of heavy object (19.05%), direct blow like assault (14.29%) and others like firearm injuries (2.38%).

**Table 1: Age groups of the affected patients.**

Age group (years)	No. of patients	Percentage (%)
0-5	nil	-
5-15	7	5.56
15-25	36	28.57
25-35	66	52.38
35-45	12	9.52
>45	5	3.97
<b>Total</b>	<b>126</b>	<b>100</b>

**Table 2: Mode of injury.**

Mode of injury	No of patients	Percentage (%)
<b>R.T.A</b>	81	64.29
<b>Fall of heavy objects</b>	24	19.05
<b>Direct impact</b>	18	14.29
<b>Others (fire arm injury)</b>	3	2.38
<b>Total</b>	<b>126</b>	<b>100</b>

In majority of the patients, latissimus dorsi (96.83%) flap was used. Only in 4 (3.17%) patients anterolateral flap for soft tissue reconstruction was used.

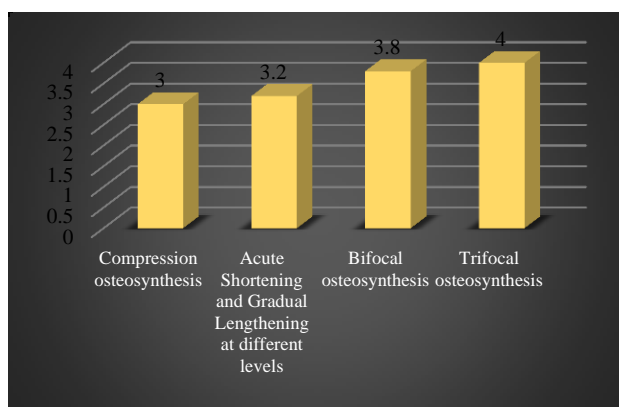
**Table 3: Distribution of flap.**

Type of flap	No. of patients	Percentage (%)
<b>Latissimus dorsi muscle flap</b>	122	98.5
<b>Anterolateral flap</b>	4	3.17
<b>Total</b>	<b>126</b>	<b>100</b>

The analysis of the patients' records showed that out of 126 reviewed cases 42 patients (33.33%) were treated by trifocal osteosynthesis, while 40 patients were treated by bifocal osteosynthesis (31.75%). Compression osteosynthesis and acute shortening and gradual lengthening at different levels were done in 32 (25.40%) and 12 (9.52%) cases respectively. Bone grafting was done in 21 patients (16.67%).

**Table 4: Bone defect size, method of Ilizarov osteosynthesis and average time of bone union.**

Bone defect size(in cm)	Patients		Method	Bone Grafting done in patients
	N	%		
< 2	32	25.40	Compression osteosynthesis	-
2-5	12	9.52	Acute shortening and gradual lengthening at different level	2
5-10	40	31.75	Bifocal osteosynthesis	7
>10	42	33.33	Trifocal osteosynthesis	12
<b>Total</b>	<b>126</b>	<b>100</b>	--	<b>21</b>



**Figure 2: Average time of union after docking (months).**

Average time of union after docking was found to be maximum after trifocal osteosynthesis (4 months) and minimum after compression osteosynthesis (3 months). 3.8 months and 3.2 months was found to be average time of union after docking after bifocal osteosynthesis and Acute shortening and gradual lengthening at different level.

**Table 5: Complications in the studied cases.**

Complications	No. of patients	Percentage (%)
<b>Distal flap necrosis</b>	3	2.38
<b>Pain due to distraction</b>	30	23.81
<b>Pin tract infection</b>	34	26.98
<b>Union with deformity</b>	6	4.76
<b>Delayed union at docking site (bone grafting done)</b>	12	9.52
<b>Discrepancy of limbs &lt;2 cms</b>	4	3.17
<b>Discrepancy of limbs &gt;2 cms &amp; &lt;5 cms</b>	3	2.38
<b>Total</b>	92	73.02

From the review of case papers, it was found that the most common complication in the studied cases was pin tract infection which was seen in 34 (26.98%) patients followed by pain due to distraction (23.81%). Other less common complications included delayed union at docking site (9.52%), discrepancy of limb size (5.55%), union with deformity (4.76 %) and distal flap necrosis (2.38%).

## DISCUSSION

With increasing motorization and industrialization there is an exponential increase in incidence as well as severity of road traffic accidents. Both plastic and orthopedic surgeons are encountering more and more complex injuries involving soft tissue and bone defects. Managing a skeletal defect is one of the most demanding and difficult tasks for an orthopedic and plastic surgeon.

There are many options available for managing these defects in the form of cancellous bone graft and flap, free vascularized bone graft and flap and Ilizarov with flap.

Reconstruction with free osteocutaneous flap is possible only in small soft tissue defect. Large defects may need surgery in stages and require additional recipient vessels for anastomosis. Moreover, most commonly free vascularized bone graft in fibula as compared with tibia is very thin and requires good amount of time period for hypertrophy of graft comparable with that of tibia. Impairment in muscle strength and minimal to moderate joint motion changes have been seen after free fibula transfer. It also requires a longer period of healing to achieve full weight bearing ability.<sup>11</sup>

The Ilizarov method has been used to overcome segmental bone loss and to treat the late consequences of trauma such as limb malunion & nonunion originally developed by Gavriel Ilizarov in 1950. His techniques of distraction osteogenesis have documented success for management of length discrepancy and large segmental defects.<sup>12</sup> Ilizarov has also been found to be effective in treatment of complex malunions. Marsh et al demonstrated an 87% rate of bony healing using Ilizarov technique.<sup>13</sup> Magadam et al was able to achieve a mean lengthening of 10 cm and a mean time of bony union was found to be 6 months.<sup>14</sup> Recent studies indicate that the combination of free flap coverage for soft tissue reconstruction and Ilizarov technique for bone reconstruction has provided the best results for the salvage of extremities. The rationale for using a free flap with the Ilizarov technique is that distracted bone should lie in a well-nourished safe bed and should be covered with well vascularized tissue.

Lowenberg et al published their experience of 31 patients treated with Ilizarov fixation and free flap cover.<sup>15</sup> In their study, they included wide range of patients with various injuries, both flap success and bone unions were high. In 1994, Feibel and Buncke demonstrated the feasibility and utility of combining the Ilizarov and free flap in their description of 5 patients with lower extremity injuries.<sup>16</sup> In this study, the composite bone and soft tissue transport was used to fill the bony gap produced by traumatic bone loss. All the defects were successfully treated by this technique.

The concern of injury to the flap or pedicle during frame placement or subsequent distraction was not borne out in our study. In 2000, however Park and Lee described the importance of strategic consideration of the configuration of free flaps and their vascular pedicles placement. To minimize the undue forces to the vascular pedicles and reduce the possibility of vascular compromise, the transferred free flap should have the configuration that its vascular pedicle lies in the territory of the mobile compartment.<sup>17</sup> This helps to deal with problem of distraction against fixed vascular pedicle. A close working relationship between orthopedic surgeon



and reconstructive surgeon is mandatory for the successful outcome.

The risk of pin –site infection has been shown to be increased when there is local thermal injury and hematoma formation, whereas preventive measures such as proper use of antiseptics and occlusive pressure dressings may reduce infections.<sup>18</sup> Many problems have been reported with combined use of free flap and Ilizarov, which include downward depression of the transferred muscle flap between the bone gap.<sup>19</sup> Bone exposure, non- union at the bone junction and ischemia of the transferred flap. Kim et al reported a case of flap ischemia during the distraction process that eventually required vascularized bone transfer.<sup>20</sup>

In our study we have used the combined free flap and Ilizarov method for soft tissue and bone reconstruction. We have used this technique in patients with massive soft tissue and bone defect.

In our study distal flap necrosis occurred in 3 patients but before the application of Ilizarov. In our study free Latissimus Dorsi flap is done in majority of cases because of the severity of the trauma leading to massive soft tissue defect which needs bulky tissue to cover the defect as in free Latissimus Dorsi flap. Almost all our patients complained of pain during distraction which varies from patient to patient and treated by analgesics. Many patients had the pin tract infection which was treated by educating the staff, patients and their relatives about pin care. Pin site infection settled with the use of antibiotics. We found no correlation between complications and method of Ilizarov.

## CONCLUSION

Our study, being one of the studies having large group of patients, has showed that the combined use of free flap and Ilizarov provides a more reliable soft tissue coverage and bone reconstruction with almost near normal shape and function. Moreover, it has advantages like improved quality of bone regeneration, early mobilization of the patient and deformity correction even during postoperative period.

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