Egypt, J. Plast. Reconstr. Surg., Vol. 35, No. 1, January: 71-78, 2011

Reconstruction of Soft Tissue Defects of the Foot Dorsum in Children by Free Latissimus Dorsi Muscle Flap: Four Year Experience

YEHIA ZAKARIA, M.D.* and HISHAM BUREZQ, B.Sc., M.D., F.R.C.S.C., F.A.A.P.**

The Departments of Burns & Plastic Surgery, Al-Babtain Center, Kuwait and Zagazig University, Egypt**.*

ABSTRACT

This study was conducted in Al-Babtain centre for burns & Plastic Surgery in Kuwait, during the period from March 2006 to February 2010. The aim of this study was to evaluate the use of free latissimus dorsi muscle flap with skin graft in reconstruction of extensive dorsal foot defects in children. It included 9 patients (7 boys and 2 girls) with post traumatic dorsal foot defects. Their ages ranged between 3.5 and 15 years (mean 7.1 years). The defect sizes ranged between 10 to 17 cm x 5 to 10 cm. All soft tissue defects were associated with extensor tendon injuries and 8 had associated bone or joint injuries. Patients were operated in 5 to 12 days after trauma (mean 6.6 days). Eight flaps survived completely and 1 had partial loss. One patient had partial skin graft loss. Two patients had seroma in the muscle flap donor site. The average follow-up period was 30 months. All patients had good functional and aesthetic outcome.

INTRODUCTION

Soft tissue reconstruction of the foot dorsum is a major problem and represents a challenge to plastic surgeons. The problem comes from the poor vascularity and limited mobility of skin in this region **[1]**. Extensive dorsal foot defects could be repaired using regional flaps like reverse sural flap or distant flaps like cross leg flap **[2,3]**. However, these techniques have been always criticized especially in paediatric patients, either for being staged operations with lengthy hospital stay, limited reach in cases of distal foot defects or the poor cosmetic appearance of the donor site **[4,5]**.

Microsurgical tissue transfer has been adopted by many centres worldwide as the preferred option for reconstruction of extensive soft tissue defects of the foot and ankle region in paediatric patients **[6]**. This is because free flap transfer is capable of providing enough tissue to reconstruct large size defects in a single stage **[7,8]**. Technical difficulties caused by small sized blood vessels in children can be overcome by current microsurgical capabilities **[4,9]**. A variety of free tissue transfers are available for reconstruction of the foot dorsum among them are muscle flaps with STSG (split thickness skin graft), musculocutaneous flaps and fasciocutaneous flaps **[8,9,10]**.

Many factors should be considered when using free flaps in the paediatric population among these are the effect of surgery on normal growth and development and the psychological impact of major surgery at a young age **[11]**.

The aim of this study was to report case series of free LDM (latissimus dorsi muscle) flap with skin graft used to cover extensive dorsal foot defects in 9 children during a 4 year period and to evaluate the functional and aesthetic outcome of the procedure during the follow-up period.

PATIENTS AND METHODS

During the period from March 2006 to February 2010, 9 patients (7 boys and 2 girls), with post traumatic soft tissue defects of the foot dorsum were treated by free LDM flap with STSG. Their ages at the time of surgery ranged between 3.5 and 15 years (mean 7.1 years). The cause of the defects was RTA (road traffic accident) in all cases. Size of the defects ranged from 10 to 17 cm x 5 to 10 cm. All patients had associated extensor tendon lacerations and 1 patient had avulsion of the tibialis anterior tendon. Patients were operated for flap coverage in 5 to 12 days after trauma (mean 6.6 days). Table (1) summarizes patients' data.

Preoperative evaluation and selection of the recipient vessels was done by clinical and Doppler examinations in 8 patients. Angiography was done in 1 patient in whom the severity of trauma did not allow for proper clinical evaluation of the vessels.

Surgical technique:

Surgery was performed in the lateral supine position allowing for two team approach. We always harvested the contralateral LDM. Dissection of the vascular pedicle continued in the axilla to achieve good length and calibre for anastomosis. The muscle tendon of insertion was dissected from the intertubercular groove of the humerus and harvested with the flap; it helped to cover the pedicle after its anastomosis in the leg especially when the leg is oedematous and the skin flaps could not be closed without tension after completion of the anastomosis.

At the same time, the second team was doing debridement, bone fixation, extensor tendons repair and preparation of the recipient vessels. Donor site was closed directly, after irrigation with saline, in two layers and suction drainage was inserted. Quilting of the skin flaps to the underlying bed was always done in all patients using vicryl® 3/0 stitches to reduce seroma formation.

Arterial anastomosis was done between the thoracodorsal artery of the flap and the anterior tibial artery in an end to end manner in 8 cases and in 1 case it was done with the posterior tibial artery in an end to side manner. Venous anastomosis was always done in an end to end manner with the vena-commitant of the recipient artery. The suture materials used for vascular repair were nylon 9/0 in 6 cases and 10/0 in 3 cases.

After insetting of the muscle flap, STSG meshed 1:1 was used to cover the muscle and fixed with skin staples.

Postoperatively, patients were kept in the ICU (intensive care unit) for 2 to 4 days (mean 2.5 days). Monitoring of flap viability was done clinically. Dangling of the foot was started at 11-14 days after surgery, by 3 minutes twice daily then increased gradually until it reached 30 minutes 3 times per day. Splinting was used for a period of 6-8 weeks postoperatively (related to associated bone and tendon injury) and was removed only during the dangling sessions. Compression garments were used for 3 months after removal of splint. The children and their parents were educated on dangling and exercise regimens to follow at home after discharge from the hospital.

RESULTS

The operative time ranged from 4 to 8 hours (mean 6.1 hours), while hospitalization time ranged from 14 to 21 days (mean 16.3 days).

All flaps survived completely except in 1 case (88.9%) there was partial flap loss due to venous congestion; Table (2) summarizes the overall complications. Two cases (22.2%) required reexploration of the vascular anastomosis on the same day of surgery due to flap congestion and thrombus was removed from the flap vein. One of these two flaps survived completely and the other had partial loss and was treated by skin grafting. One patient had infection at the recipient site with partial loss of the skin graft and was re-grafted when infection subsided. Donor site complications included seroma in 2 patients (22.2%) and resolved by conservative treatment.

The follow-up period ranged from 6 to 48 months (mean 30 months); Healing of bone fractures occurred in a period of 2-4 months (mean 2.6 months). Two patients (22.2%) had hypertrophy of scattered areas of the skin graft and were treated conservatively. One patient (11.1%) had dorsal flexion contracture of the big toe that required surgical correction by contracture release, extensor tendon lengthening and skin grafting by the 10th postoperative month. Good contour of the reconstructed foot was achieved in all cases.

Patients were walking independently in normal shoes 6 to 9 months postoperatively and none of them required modified shoes.

Case 1: A 5 year old boy sustained RTA with skin loss from whole of the dorsum of the left foot with exposed lacerated extensor tendons and fractures of D4 proximal Phalanx and D5 metatarsus. Patient was transferred to our centre 4 days after trauma and was operated in the 6th day post trauma. After wound debridement, bone fixation and extensor tendons repair, the defect was covered by free LDM flap anastomosed to the anterior tibial artery end to end. A meshed STSG was used to cover the muscle. Good functional and aesthetic outcome was achieved and maintained at 2 years follow-up (Figs. 1,2).

Case 2: A 7 year old boy with large skin defect on the dorsum of the right foot with exposed bones and tendons and avulsion of the tibialis anterior tendon. He was operated on the 7th day post RTA, tendons were repaired and the defect was covered by skin grafted free LDM anastomosed to the anterior tibial artery. He had good functional and aesthetic outcome. Skin graft shows scattered areas of hypertrophy at 1 year follow-up (Figs. 3,4).

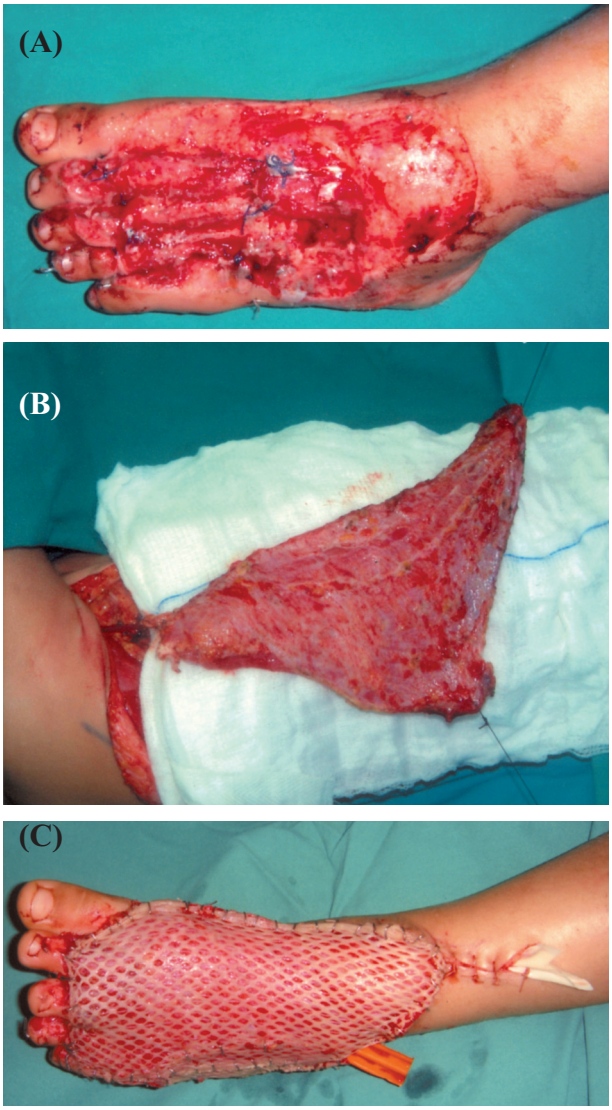
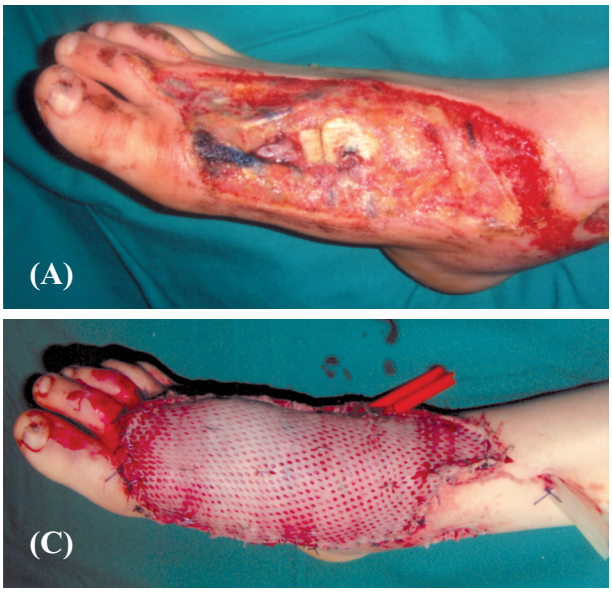


Fig. (1): A- Preoperative view of the foot. B- LDM flap prior to separation. C- Immediate postoperative view of the foot after insetting of the muscle flap and its coverage by meshed STSG.

Fig. (2): Reconstructed foot 2 years postoperatively; A- Lateral view. B- Anterior view.



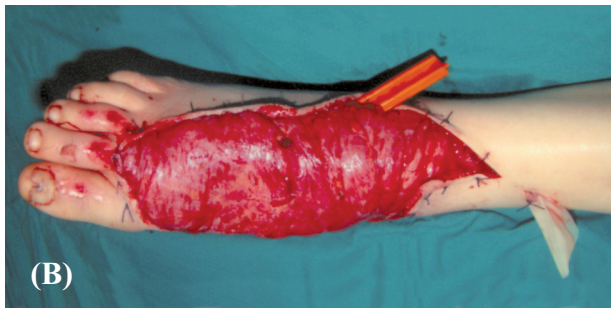


Fig. (3): A- Preoperative view of the foot. B- After completion of vascular anastomosis and insetting of the LDM flap. C- Immediate coverage of the muscle flap by meshed STSG.

(A) (B)

Fig. (4): One year postoperatively. A- Anterior view. B- Plantar flexion.

Table (1): Patients' data.

Patient	Age	Sex	Cause of defect	Bone damage	Defect size (cm)	Timing of surgery (Days)	Sutures used	ICU stay (Days)	Hospital stay (Days)	Follow-up (Months)
1	3.5	M	RTA	D1-3 metatarsus	10 X 5	5	10/0	2	15	48
2	4	F	RTA	D1-2 PP	11 X 7	6	10/0	3	14	6
3	7	F	RTA	None	10 X 8	7	9/0	4	21	36
4	9	M	RTA	D2-5 metatarsus	13 X 8	7	9/0	2	16	12
5	15	M	RTA	Open ankle Fx	17 X 10	5	9/0	2	15	24
6	5	M	RTA	D5 metatarsus D4 PP	12 X 7	6	9/0	2	14	36
7	4	M	RTA	D2-3 PP	10 X 8	12	10/0	3	21	24
8	8	M	RTA	D1-2 PP	16 X 9	5	9/0	2	16	48
9	8.5	M	RTA	D1-4 metatarsus	15 X 8	7	9/0	3	15	36

RTA: Road traffic accident. Fx: Fracture. PP: Proximal phalanx.

Table (2): Postoperative complications.

Complication	No. of patients (%)
Vascular reexploration	2 (22.2%)
Total flap loss	0
Partial flap loss	1 (11.1%)
Partial skin graft loss	1 (11.1%)
Seroma	2 (22.2%)
Osteomyelitis	0
Hypertrophy of the skin graft	2 (22.2%)
Ulceration of the flap	0
Secondary deformity	1 (11.1%)

DISCUSSION

Reconstruction of dorsal foot defects has always been a Challenging problem for plastic surgeons because of the limitations of the local tissues and the need to maintain the contour of the foot for successful functional and aesthetic outcome **[1,12]**.

Foot injuries constitute a spectrum of problems that were classified by Hidalgo and Shaw **[13]** into 3 types according to extension and complexity as follows: Type I with soft tissue loss less than $3cm^2$; Type II with soft tissue loss greater than $3cm^2$ with no bony involvement; Type III with large soft tissue loss greater than $3cm^2$ with associated bony damage.

Trauma was reported as the most common indication for free flap surgery in the pediatric age group **[4,9,14]**. In our study all patients were children with large, complex post traumatic dorsal foot defects, classified as Type III according to Hidalgo and Shaw **[13]**. When such defects occur in children, they should be treated as in adults and reconstructed by well vascularized tissues **[14,15]**. Local flaps cannot provide enough tissues for such defects and are mostly not available **[4,10,16]**. Cross leg flap, which has been widely used and has proven reliability and efficacy **[3]**, still has disadvantages like the need for prolonged immobilization in a discomfortable position for a period from 2 to 3 weeks and also the need for at least 2-stage surgical procedure. Again the transferred tissue is never as

well vascularized as the free tissue transfer **[10,17]**. The reverse sural flap offers a versatile option for reconstruction of medium and large foot and ankle defects **[5]**. This flap has many advantages like; it does not sacrifice a major artery in the limb and it is easily dissected in a short operative time **[2,5]**. However, it is always criticized for its questionable vascular reliability, limited reach in cases of distal foot defects, unsightly scar over the donor area and the numbness that develops along the lateral aspect of the foot following its harvest, due to sacrifice of the sural nerve **[1,5]**.

The use of free tissue transfer allowed large defects of the lower extremity to be covered in a single stage giving a chance for early mobilization and rehabilitation of the injured limb **[4]**. Free tissue transfer has proven to be safe and reliable in children, small sized blood vessels is not a problem with the current advance in microsurgical instruments and capabilities **[4,18]**. Based on the high success rates found in this study (88.9%), we agree with Organek et al. **[11]** and Shenaq and Dinh **[19]** that many of the potential risk factors for free flap failure like smoking and peripheral vascular disease are commonly not present in children and this may improve the free flap survival in the pediatric age group.

Many free flaps are available for reconstruction of the dorsum of the foot including fasciocutaneous, fascial, musculocutaneous or skin-grafted muscle flaps **[4,10,20]**. The flap used for coverage of the foot dorsum should provide well vascularized tissue for exposed tendons and bones and should be thin to maintain the contour of the foot which is essential for the future wear of normal shoes and achieving good functional and aesthetic outcome. Rainer et al., **[16]** added that the ideal flap for this region should allow tendon gliding and have the potential to be innervated. Some fasciocutaneous flaps, like the radial forearm free flap, and skin-grafted fascial free flaps, like the temperoparietal fascia flap or the fascial forearm flap, can provide these criteria **[10,20]**. However, for extensive and severe injuries with lacerated tendons and open fractures, it is preferable to use muscle flaps as they have the capabilities of filling three dimensional defects, obliterating dead spaces and improving the vascularity and oxygen delivery to the wound **[9,21]**. These in turn, help to deliver antibiotics and improve leucocytes function in the contaminated wound reducing the rate of infection **[22]**.

Many authors pointed out the advantages of LDM flap including its reliable and constant blood supply, long, large-caliber vascular pedicle that allows easy vascular anastomosis to be done away from the trauma zone **[16]**. The flap also provides big amount of tissue to be used for large three dimensional defects with open joints and exposed bones **[9,11]**. Furthermore serratus anterior muscle can be included with the flap if larger amount of tissue is needed, as they share the same vascular pedicle **[10]**. Another advantage of using the LDM flap is that it allows for two team approach harvesting the flap and preparing the recipient vessels thus reducing the operative time **[10]**. The operative time in this series ranged between 4 and 8 hours (mean 6.1 hours).

Appropriate selection of the recipient artery is essential for the success of free tissue transfer to the lower limb. General consensus on which vessel to be used has not been reached. Using the anterior tibial artery as the recipient vessel has proved to be safe, reliable with less arterial complication rate when properly evaluated before anastomosis **[10,23]**. In this study, the anterior tibial artery was used as the recipient vessel in the distal leg, away from the zone of injury except in 1 case where it was found extensively injured with inadequate flow and the posterior tibial artery was used instead. Serletti **[9]** suggested that younger children, ages from 2 to 10 years, have smaller vessels and the morphology of their vessel walls is different than adults and recommended that operating microscope and 10/0 and 11/0 microsutures should be available for the vascular anastomoses. He suggested that as these children grow older, they develop features and characteristics of the adult soft tissue and vessels and they do not require any special technical considerations than the adult population. In our group of patients the mean age was 7.1 years (3.5 to 15 years). We used 9/0 microsutures in 6 patients and in 3 cases 10/0 microsutures were used without technical difficulty (Table 1).

Many authors share the high success rate in free flap surgery in the pediatric age **[4,11,19,24]**. Despite this high success rate, still some cases require reexploration of the vascular anastomosis due to flap compromise **[4,24,25]**. Khouri et al. **[25]** reviewed the literature and found that the incidence of reexploration of the vascular anastomosis ranged between 3.7% and 25%. Duteille et al. **[24]** in their study on 22 pediatric patients with free flap surgery reported an incidence of vascular reexploration of (13.6%) due to venous insuffiency with successful outcome. Rinker, et al. **[26]** in their review of 28 free flaps done for pediatric patients reported an incidence of (10.71%) of vascular reexploration also due to venous congestion noticed in the first 72 hours postoperatively and flap failure occurred despite attempts for its salvage. In this study,

vascular reexploration was done in 2 patients (22.2%) due to venous congestion noticed on the same day of surgery with complete salvage of one flap and partial loss of the other.

Godina [27] reported that early microsurgical reconstruction of the lower extremity reduces rate of complications like infection, flap failure and also reduces bone union time and hospital stay. Rinker, et al. [26] reported that the complication rate in their series was 50% less for free flaps done within 7 days of injury, than for those performed after 7 days. On the other hand many authors [4,10,21] reported that free flap surgery for the severely injured extremity, that requires several sessions of debridement, can be performed successfully in the sub acute period (between 1 and 6 weeks) and delayed (more than 6 weeks after injury) with high success rate. This is comparable with our success rate (88.9%) in this study where free flap surgery was done in 5 to 12 days (mean 6.6 days) after injury. We had 1 case (11.1%) with partial skin graft loss due to infection; this case was operated 12 days after trauma and delay was due to other associated injuries. We did not report any cases of osteomyelitis, delayed bone union or infection during the follow-up period.

The mean follow-up period in this study was 19.3 months (from 6 to 48 months), during that period of time all of our patients were able to walk independently wearing normal shoes. Depending on our observations in this study we agree that denervated muscles that are fashioned properly to the defect will shrink with time and take the contour of the foot giving good cosmetic appearance [10,28,29].

There is always debate about the importance of cutaneous sensibility of flaps used in foot reconstruction. Ulucay et al. [10] reported that none of the 13 patients included in their study developed ulceration of the skin-grafted free LDM flap used for reconstruction of non-weight bearing foot dorsum during a mean follow-up period of 23 months, none of these patients developed cutaneous sensation in the flaps but they all developed protective sensation, this is comparable with our results. Rainer et al. [16] reported lower ulceration rate in muscle flaps covered with split thickness skin grafts than in fasciocutaneous flaps in reconstruction of weight bearing areas of the foot (27% Vs. 60%). Lin et al. [4] on the other hand, reported higher incidence of ulceration in the skin-grafted muscle flap than in the skin/musculocutaneous flap group (78.6% Vs. 75%) in reconstruction of weight bearing areas of the foot.

Meanwhile Potparić and Rajacić [30] found no significant difference in the incidence of ulceration of skin-grafted muscle flaps or fasciocutaneous flaps, whether innervated or not, in reconstruction of weight bearing areas of the foot. Good selection of patients with normal foot innervations and deep pressure sensation and absence of peripheral neuropathy, intensive education about foot care and regular follow-up visits are essential to maintain healthy flap with no break down or ulceration [10,29,30].

Serletti et al. [6] stated that growth disturbance of the extremity occurs when the physis of the underlying growing bone is affected. They reported a series of 17 patients; 2 of them (11.7%) developed secondary deformities in the form of progressive equinus deformity and discrepancy that increased with time. Lin et al. [4] suggested some factors that might contribute to the occurrence of secondary deformities like; scars formed around the foot and ankle region causing growth restriction and subsequent deformity, direct bone and joint injury, fibrosis of the damaged muscles and tendons especially the tibialis anterior muscle and Achilles tendon which can lead to varus, valgus or equines ankle deformities. Serletti [9] stressed on the importance of the appropriate postoperative physiotherapy regimen and return to the full function possible in prevention of significant growth disturbances, all our patients started on physiotherapy regimen before discharge from the hospital and parents were instructed to follow these exercises at home after discharge from the hospital. In our study flap growth was noticed to be in accordance with the patient's growth during the follow-up period. We had one case (11.1%) with extension deformity of the big toe which did not respond to physical therapy, scar massaging and splinting and was corrected surgically.

The most common donor site complication after harvesting LDM flap is seroma formation. Its incidence is reported to vary from 3% to 80 of cases [31].

The exact cause for its occurrence is not yet defined and it is thought to be multifactorial involving surgically created dead space, excessive use of electric diathermy, cutting of the lymphatic channels, inflammatory response to surgical trauma and finally shearing effect of the skin flaps against the underlying bed [23,33].

In this series, seroma was reported in 2 cases (22.2%) and resolved with conservative treatment. We refer this relatively low incidence of seroma to avoidance of excessive burning of tissues by

diathermy, saline irrigation of the wound to remove any blood clots or debris before closure and finally to quilting of the skin flaps to the underlying bed to avoid shearing **[34]**.

In conclusion, free LDM flap with skin graft in pediatric patients provides a safe and reliable option for reconstruction of extensive dorsal foot defects. We believe it should be adopted as the first option for reconstruction of such defects as it provides large amount of well vacularized tissue for coverage of exposed tendons and bones, can be harvested in a relatively short time with two team approach and it has an acceptable functional and aesthetic outcome.

REFERENCES

1- Buluc L., Tosum B., Sen C. and Sarlak A.Y.: A modified technique for transposition of the reverse sural flap. Plast. Reconstr. Surg., 117: 2488, 2006.

2- Kneser U., Bach A.D., Polykandriotis E., Kopp J. and Horch R.E.: Delayed reverse sural flap for staged reconstruction of the foot and lower leg. Plast. Reconstr. Surg., 116: 1910, 2005.

3- Mooney J.F.III, DeFranzo A. and Marks M.W.: The use of cross-extremity flaps stabilized with external fixation in severe pediatric foot and ankle trauma. An alternative to free tissue transfer. J. Pediatr. Ortho., 18: 6, 1998.

4- Lin C.H., Mardini S., Wei F.C., Lin Y.T. and Chen C.T.: Free flap reconstruction of foot and ankle defects in pediatric patients: Long-term outcome in 91 cases. Plast. Reconstr. Surg., 117: 2478, 2006.

5- Afifi A.M., Mahboub T.A., Losee J.E., Smith D.M. and Khalil H.H.: The reverse sural flap: Modifications to improve efficacy in foot and ankle reconstruction. Ann. Plast. Surg., 61: 430, 2008.

6- Serletti J.M., Schingo V.A.Jr., Deuber M.A., Carras A.J., Herrera H.R. and Reale V.F.: Free tissue transfer in pediatric patients. Ann. Plast. Surg., 36: 561, 1996.

7- Heller L. and Levin L.S.: Lower extremity microsurgical reconstruction. Plast. Reconstr. Surg., 108: 1029, 2001.

8- Hallock G.G.: Utility of both muscle and fascia flaps in severe lower extremity trauma. J. Trauma, 48: 913, 2000.

9- Serleti J.M.: Current trends in pediatric microsurgery. Clin. Plast. Surg., 32: 45, 2005.

10- Ulucay G.E., Yildirim S., Aydoğdu E. and Akoz T.: Reconstruction of crush injuries of the foot dorsum: Is the latissimus dorsi muscle flap a reliable choice? J. Reconstr. Microsurg., 22: 157, 2006.

11- Organek A.J., Klebuc M.J. and Zuker R.M.: Indications and outcomes of free tissue transfer to the lower extremity in children: Review. J. Reconstr. Microsurg., 2: 173, 2006.

12- Serletti J.M. and Moran S.L.: Soft tissue coverage options for dorsal foot wounds. Foot Ankle Clin., 6: 839, 2001.

13- Hidalgo D.A. and Shaw W.W.: Reconstruction of foot injuries. Clin. Plast. Surg., 13: 663, 1986.

14- Hallock G.G.: Efficacy of free flaps for pediatric trauma patients in an adult trauma center. J. Reconstr. Microsurg., 11: 169, 1995.

15- Hahn S.B., Lee J.W. and Jeong J.H.: Tendon transfer with a microvascular free flap for injured feet in children. J. Bone Joint Surg. Br., 80: 86, 1998.

16- Rainer C., Schwabegger A.H., Bauer T., Ninković M., Klestil T., Harpf C. and Ninković M.M.: Free flap reconstruction of the foot. Ann. Plast. Surg., 42: 595, 1999.

17- Yildirim S., Akan M., Gideroğlu K. and Akoz T.: Use of distally based saphenous neurofasciocutaneous and musculofasciocutaneous cross-leg flaps in limb salvage. Ann. Plast. Surg., 47: 568, 2001.

18- Chiang Y.C.,. Jeng S.F., Yeh M.C., Liu Y.T., Chen H.T. and Wei F.C.: Free tissue transfer for leg reconstruction in children. B. J. Plast. Surg., 50: 335-342, 1997.

19- Shenaq S.M. and Dinh T.A.: Pediatric microsurgery: Replantation, revascularization and obstetric plexus palsy. Clin. Plast. Surg., 17: 77, 1990.

20- Ismail T.I.: The free fascial forearm flap. Microsurgery, 10: 155, 1989.

21- Yazar S., Lin C.H., Lin Y.T., Ulusal A.E. and Wei F.C.: Outcome comparison between free muscle and free fasciocutaneous flaps for reconstruction of distal third and ankle traumatic open tibial fractures. Plast. Reconstr. Surg., 117: 2468, 2006.

22- De Fontaine S., Gaede F. and Berthe J.V.: The reverse turnover latissimus dorsi flap for closure of midline lumbar defects. J. Plast. Reconstr. Aesthet. Surg., 61: 917, 2008.

23- Di Spilimbergo S.S., Coskunfirat K.O., Mardini S., Tsao C.K., Rampazzo A. and Chen H.C.: Multiple spurting test in microsurgical reconstruction of the lower extremities. J. Maxillofac. Oral Surg., 8: 312, 2010.

24- Duteille F., Lim A. and Dautel G.: Free flap coverage of upper and lower limb tissue defects in children: A series of 22 patients. Ann. Plast. Surg., 50: 344, 2003.

25- Khouri R.K., Cooley B.C., Kunselman A.R., Landis J.R., Yeramian P., Ingram D., Natarajan N., Benes C.O. and Wllemark C.: A prospective study of microvascular free-flap surgery and outcome. Plast. Reconstr. Surg., 102: 711, 1998.

26- Rinker B., Valerio I.L., Stewart D.H., Pu L.L.Q. and Vasconez H.C.: Microvascular free flap reconstruction in pediatric lower extremity trauma: A 10-year review. Plast. Reconstr. Surg., 115: 1618, 2005.

27- Godina M.: Early microsurgical reconstruction of complex trauma of the extremities. Plast. Reconstr. Surg., 78: 285, 1986.

28- Marek C.A. and Pu L.L.: Refinements of free tissue transfer for optimal outcome in lower extremity reconstruction. Ann. Plast. Surg., 52: 270, 2004.

29- Isik S., Celikz B., Demiroullari M., Slengezer M. and Selmanpakoglu N.: Repair of high-energy-induced tissue defects of the dorsal foot by free muscle transfer and skin graft. Ann. Plast. Surg., 43: 21, 1999.

30- Potparić Z. and Rajacić N.: Long-term results of weight bearing foot reconstruction with non-innervated and re-innervated free flaps. Br. J. Plast. Surg., 50: 176, 1997.

31- mcArthur G.J., Rowan C. and Greig A.V.: Delayed pseudocyst formation following free latissimus dorsi transfer. Euro. J. Plast. Surg., 32: 261, 2009.

32- Schwabegger A., Ninkovic M., Brenner E. and Anderl H.: Seroma as common donor site morbidity after harvesting the latissimus dorsi flap: Observations on cause and prevention. Ann. Plast. Surg., 38: 594, 1997.

33- Daltrey I., Thomson H., Hussien M., Krishna K., Rayter Z. and Winters Z.E.: Randomized clinical trial of the effect of quilting latissimus dorsi flap donor site on seroma formation. Br. J. Surg., 93: 825, 2006.

34- Ali S.N., Gill P., Oikonomou D. and Sterne G.D.: The combination of fibrin glue and quilting reduces drainage in the extended latissimus dorsi flap donor site. Plast. Reconstr. Surg., 125: 1615, 2010.