Original Article

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Role of Latissimus Dorsi Island Flap in Coverage of Mutilating Upper Limb Injuries in Pediatric Age Group

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***Background/Purpose**: Latissimus dorsi muscle (LDM) is one of the most versatile muscles that is commonly used in different reconstructive procedures. Severe mutilating injuries of the upper limb in children represent a great challenge to reconstructive surgeons especially when important structures become exposed.*

***Materials & Methods**: we utilized LDM as an island flap to cover extensive soft tissue defects in the upper limb of pediatric patients. This work included 17 children (13 males and 4 females). All of them had extensive soft tissue loss of the upper limb with exposure of important structures. The cause of injury was road traffic accident in all patients. We analyzed the operative time, need for multi-stage surgery and the recorded complications. Finally, we recorded the ultimate functional and aesthetic outcome after a period of two years of follow up.*

***Results**: From the harvested seventeen flaps, none of them was lost. Split thickness skin graft was done one week after flap harvesting and insetting to cover the muscle flap. There were four cases with partial loss of the skin graft secondary to infection. Those four cases needed re-grafting after eradication of infection that needed almost two weeks of local wound care and dressing. Re-grafting was successful in the four cases.*

***Conclusion**: For complex upper extremity wounds in the pediatric age group, we advice aggressive debridement and early reconstruction with LDM pedicle flap with a split-thickness skin graft cover over it. The technique is reliable, with minimal donor site morbidity and very accepted functional and cosmetic outcome.*

***Index Word**: Latissimus dorsi muscle flap, complex trauma, pediatric age group.*

INTRODUCTION

The latissimus dorsi muscle (LDM) is the largest muscle in the body and it has been widely used in reconstruction of large soft tissue defects in different parts of the body. Despite its large size, no practical functional motor deficit results from its transposition. The muscle originates on the iliac crest inferiorly and the thoraco-lumbar fascia near the midline posteriorly. It inserts into the humerus, where it acts as a humeral adductor and internal rotator [1, 2].

The nerve supply of LDM is via the thoracodorsal nerve, a branch of the posterior cord of the brachial plexus. Blood reaches the muscle via the subscapular artery, a branch of the axillary artery. The subscapular sends off a circumflex scapular branch posteriorly, and then distributes a serratus branch before it enters

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the substance of the muscle on its undersurface as the thoracodorsal artery. A 5–10 cm pedicle can be obtained off the subscapular system. A single venae comitant typically accompanies the artery [2, 3].

Being one of the most versatile flaps in the human body, LDM flap has been used for a long time for coverage of extensive soft tissue defects at different body areas. It could be used as a pedicled flap on its main vascular pedicle to reconstruct the breast following radical or modified radical mastectomy. Also, it is used to cover defects of anterior chest wall, shoulder and upper arm and head and neck defects up to the temporo-parietal area [2, 4-10].

Using it as a free flap gives it a wider range of applications to be used for coverage of almost all body areas i.e. head and neck, upper and lower limbs and torso. It could be used as myo-cutaneous, osseo-myo-cutaneous or isolated muscle flap. Sometimes it may be used as a schemeric flap combined with serratus anterior muscle or as a split muscle flap [2, 11-16].

Extensive soft-tissue defects in the upper limb of a child are rare, and emergency surgical repair represents a challenge to the clinician and requires high proficiency in operating skills. The use of common regular flaps usually fails to completely cover the defect occurred after trauma [17].

In this study we aimed at studying the effectiveness of using this large muscle flap (LDM flap), either in the pedicled or island fashion, in reconstruction of extensive soft tissue defects of the upper limb in the pediatric age group.

PATIENTS AND METHODS

This study was conducted in Zagazig university hospitals during the period from May 2007 to May 2010. . It included 17 pediatric patients admitted to the causality department as victims of road traffic accident (RTA). All of them had extensive soft tissue loss of the upper limb with exposure of important structures. Types of trauma, associated injuries and demographic data of all patients are listed in Table (1).

The nature of upper limb injury and associated local injuries are presented in Table (2). There were 11 suffered total loss of the skin and subcutaneous tissue of the arm and elbow with exposure of the neurovascular bundle at the antero-medial aspect of the arm. Six patients had incomplete loss of the arm skin but with exposure of important vital structures that necessitated flap coverage (3 had exposed vessels and 3 had exposed bone). Various types of humeral fractures were found in 9 cases. They were dealt with by the orthopedic surgeons in the standard ways in the same setting at which coverage was done. This was varied between wiring (4 cases), plate fixation (4 cases) and external fixator application in one case. Exposure with opening of the elbow joint was found in three cases. Also exposure of the shoulder joint was found in one patient only. Vascular injury was present in 8 cases and it was dealt with immediately by the vascular surgeon (in 6 patients the brachial artery was grafted using a long saphenous graft and primary repair was done in two cases).

Cases associated with peripheral nerve injury were excluded from this work. This was to reduce the period of follow up and also to avoid the debate about functional deficit following sacrificing the Latissimus dorsi muscle as an internal rotator of the shoulder joint.

Management of our patients, in some instances, required more than one stage. Debridement (Fig. 1) was needed in 6 patients as preparatory step before flap harvesting. Then after 7-10 days, flap harvesting as an isolated muscle flap and insetting was done in the classical way (Fig. 2). The tendinous insertion was left intact to guard against excessive traction on the pedicle as the flap was used for soft-tissue coverage only. Coverage of the flap with split thickness skin graft (STSG) was done in another stage after being sure that the flap was soundly healed and the general health of the patient can support graft take (Fig. 3). Some secondary procedures and complementary steps were needed in 7 cases and were done later on (Table 3).

Formal consent was obtained from the guardians of the children after discussing full details of surgery with them. They were informed about the nature of the procedure and the possibility of needing more than one stage to complete the work.

Table 1: Types of trauma, associated injuries and demographic data

Item	Age (in years)			Sex		Types of Injury			Associated Injuries		
	< 5	6-10	11-15	♂	♀	MCA	B	ROA	H & N	C & A	O
NO	4	6	7	13	4	10	3	4	6	3	3
%	23.5	35.3	41.2	76.49	23.53	58.8	17.7	23.5	35.3	17.7	17.7
Total		**17**			**17**			**17**			**12/17**

MCA = Motor Car Accident. H & N = Head and Neck. B = Bicycle. C & A = Chest & Abdomen. ROA = Run-Over Accident. O = Others.

Table 2: The nature of upper limb injury and associated local injuries

Item	Skin Loss		Bone Injury		Vascular Injury
	Complete	Incomplete	Fractures	Exposed Joint	
No	11	6	9	4	8
%	64.7	35.3	52.9	23.5	47.1
Total	**17**		**13**		**8**

Table (3): Secondary procedures and complementary steps

Item	Z-Plasty	Release & STSG	Wire Removal
No. of Patients	3	2	2
Timing from main surgery	12-14 Weeks	12-14 Weeks	4 Weeks
Total No.	7		

Fig 1: (A) Before debridement and (B) After Debridement.

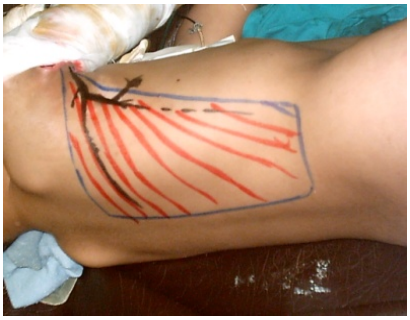

Fig. 2- A: LDM Flap design

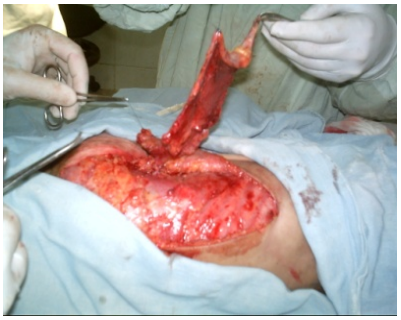

Fig. 2- B: Flap harvest

Fig. 2- C: Flap inset

Fig 3-A: 1 week after trauma: before STSG

Fig. 3-B: One week after STSG

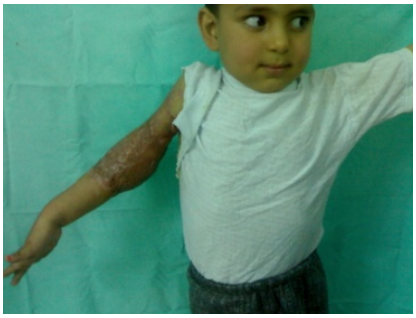

Fig. 3-C: One month thereafter

Fig. 4-A: Posterior axillary web

Fig. 4-B: Multiple Z-Plasty

Fig. 4-C: Final outcome

RESULTS

From the seventeen flaps we had harvested, none of them was lost. They were all successful. STSG was done one week after flap harvesting and insetting to cover the muscle flap. There were four cases with partial loss of the skin graft secondary to infection. Those four cases needed re-grafting after eradication of infection that needed almost two weeks of local wound care and dressing. Re-grafting was successful in the four cases. Table (4) reveals the total number of surgeries done in this study and the number of operative sessions needed for our patients.

No mortalities were reported in this series. Table (5) summarizes the morbidities in patients included in this series. We needed partial skin re-grafting in only 4 patients. Donor-site morbidity was in the form of seroma collection (3 cases), superficial wound infection (2 cases) and partial wound dehiscence (only one patient). None of these donor-site complications needed surgical intervention. They were all managed conservatively. Delayed complications that needed secondary procedures were present in 5 cases in the form of contracted axilla and needed either Z-plasty (3 cases) or release and STSG (two cases).

Functional outcome is recorded in Table (6). Both shoulder and elbow movements were tested. Apart from those 5 cases in which shoulder movement was hindered by the axillary contracture, the functional outcome was quite good and accepted. Also, after doing correction for those with axillary contracture, they resumed good function of the shoulder joint Figure (4). The functional outcome was considered good when the patient can obtain a score of 4 or more on the Medical Research Council (MRC) muscle grading system [17]. All muscle flaps with the overlying grafts had contoured well, producing satisfactory cosmoses.

Table 4: Reveals the total number of surgeries done and the number of operative sessions needed

Item	Debridement	Flap Harvesting	STSG	Re-grafting	Secondary Procedure
No. Of Patients	6	17	17	4	7
Those Needed Two-stage Surgery			4		
Those Needed Three-stage Surgery			6		
Those Needed Four-stage Surgery			7		

Table 5: Overall Morbidity and Mortality in the Study

Item	Mortality	Early Flap Morbidity		Donor-Site Morbidity			Axillary Contracture
		Flap Necrosis	Re-grafting	Seroma	Superficial Wound Infection	Partial Wound Dehiscence	
No	0	0	4	3	2	1	5
%	0	0	23.5	17.6	11.8	5.9	29.4

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Table 6: Functional outcome

Item	Shoulder					Elbow	
	Flexion	Extension	Abduction	Adduction	Ext. Rotation	Flexion	Extension
Good	12	17	12	17	17	17	17
Poor	5	0	5	0	0	0	0

DISCUSSION

The latissimus dorsi is often used as a functional muscle transfer to restore elbow and shoulder motion. Although less common, its use as a pedicled muscle flap with STSG provides excellent soft-tissue coverage of large upper extremity wounds. The tendinous insertion is left intact to guard against excessive traction on the pedicle when the flap is used for soft-tissue coverage only [18].

In a case report given by Lin et al., 2003 [19], they reported using the scapula latissimus dorsi musculo-cutaneous flap as a free tissue transfer to cover an extensive skin and soft tissue loss in the left upper limb of a child aged 12 years. They reported a total hospital stay of two weeks after which the patient was discharged from the hospital fully recovered. This is of course an under reporting for the case, as they didn't mention any data about the operative time, postoperative donor site morbidity or functional deficit with such extensive trauma. Another report given by Duteille et al., 2003 [20], also used LDM as a free flap to cover defects in children in both upper and lower limbs. They operated upon 22 patients, six of them were having injury of the upper limb and four of them were managed by free LDM transfer. Although they mentioned several advantages of using free flap coverage as being a one-step procedure, decreased incidence of infection, promotion of bone consolidation, shorter hospitalization and cost reduction, they reported that when possible, less aggressive solutions for reconstructing lost tissues should be tried first.

In this study we had harvested seventeen LDM flaps. None of them was partially or totally necrosed. This was comparable to the work presented by Rogachefsky et al., 2002 [18]. They reported only seven cases where they used LDM and STSG for coverage of open wounds of the shoulder, arm, or elbow with exposed vital structures (mean wound size: 15x10 cm). All of their flaps and STSG were successful. Of course their group of patients was smaller than ours (only seven cases). Also, their work included a wide age range (6-71 years) while in this study we made it exclusively confined to pediatric age group (age ranged between 5-15 years). This didn't affect the flap outcome in our series as we were committed to the use of magnification during flap harvesting (using 4x magnifying loupe). But we had encountered four cases of partial STSG loss secondary to infection.

Balakrishnan et al., 2007 [2] stated that it is a very helpful muscle in upper arm reconstruction with minimal donor site morbidity. We found this true in the pediatric age group also as we didn't face any major complication and low incidence of postoperative morbidity.

Another study published in 2008 by Ma et al [21], adopted the use of pedicled LDM flap for reconstruction of upper extremity large soft-tissue defects. The ages of their patients was ranging between 17-67 years. Of course, this is a much older group of patients, but they reported that transfer of the pedicled latissimus dorsi muscle flap is a very useful procedure in the reconstruction of the upper extremity and considered safe, simple and reliable. Their 20 flaps survived without loss. Only minor complications of flap edge necrosis and wound breakdown were found in three patients, and varying degrees of minor split-thickness skin graft loss were present in five patients. No deep infections were found in their series. Those are more or less comparable to our results mentioned in Tables (5,6).

CONCLUSION

In the pediatric age group, using LDM flap for covering of mutilating upper limb injuries is a reliable method with minimal donor site morbidity and very accepted functional and cosmetic outcome. Vascular integrity of the flap pedicle in children is, certainly one of the essential reasons for the high success rate of this flap in the pediatric series, although vessel diameter in the child is smaller than in the adult. The primary blood supply is usually far away from the zone of trauma and is not affected by high-energy trauma. So, for complex upper extremity wounds in the pediatric age group, we recommend aggressive debridement and early reconstruction with LDM pedicle flap with STSG cover over it.

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