The Egyptian Journal of Hospital Medicine (April 2019) Vol. 75 (4), Page 2585-2587

Loco-Regional Perforator Flaps for Reconstruction of Post Burn Contracted Elbow

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ABSTRACT

Context: the post-burn scar is inevitable problem even with the best treatment as it depends on the depth of the burn injury, so only superficial dermal burns, heal with no scarring, but the contracture is preventable problem especially with the best treatment. The post-burn elbow flexion contracture may be associated with heterotropic calcification of the elbow joint which needs orthopedic team consultation. The elbow reconstruction represents a demanding procedure for the plastic surgeon.

Objective: aim of this study was to evaluate the validity and application of local arm forearm and regional chest perforator flaps for coverage after release of post burn elbow contractures.

Patients and Methods: this prospective randomized study was done on 20 patients aged from 6 to 54 years old. All of them were asking for elective release of postburn flexion contracture of the elbow at outpatient clinics of Al Azhar University and Al-Ahrar Teaching Hospitals. It was done from March 2018 to March 2019.

Results: we have performed in our study the local and regional perforator flaps as lateral arm flap, medial arm flap, PBUF flap, PBRF flap, thoracoabdominal pedicle flap. Skin grafting is an easy procedure, however, success is limited with the technique because there is always the risk of incomplete graft take and prolonged splinting and physiotherapy is imperative in the postoperative period.

Conclusion: flaps are better for resurfacing the defects after post-burn contractures release. Flaps do not need vigorous post-operative physiotherapy or splint age and grow with age especially in children.

Keywords: Loco-Regional Perforator Flaps, PBCs

INTRODUCTION

Post-burn contractures (PBCs) are distressing problems in both the developed and developing worlds. They usually occur following inadequate primary burn injury management [(1)].

Children are the most affected by PBCs and elbow and shoulder joints are the most involved regions. Management of PBCs of elbow and shoulder joints is challenging, because they have a tendency to recur, and due to the wide range of motion of the joint [(2)].

In order to have a good coverage of the elbow, there are two requirements. The first is to use good tissue to protect the important structures, replacing "like with like". The second is a fast postoperative rehabilitation in order to prevent joint stiffness [(3)].

Over the last decades, surgeons were in search of an ideal flap that would be able to respond to these requirements. Away from the skin graft that has limited use in the elbow, random, axial and free myocutaneous and fasciocutaneous flaps were used. Each of these solutions has its own limitation: either a small converge surface, or prolonged immobilization, or bringing different quality tissue graft [(4)].

A step forward in flap design was the pedicled perforator flaps. They provide a simpler alternative to free flaps with less donor site morbidity. The pedicled perforator flaps for elbow reconstruction are a very reliable option for the plastic surgeon [(5)].

This is short operative time, a cost efficient option for both the patients and the medical team, they are recommended especially for patients with associated disease, in which a prolonged anesthesia should be avoided, and donor site can be usually closed by direct suture, providing a good cosmetic result, and only in few cases, where large flaps are harvested, skin grafting is mandatory [(6)].

The wide interest for this relative new technique in reconstructive surgery demonstrates its efficacy. The pedicled perforator flap in elbow coverage is an optimal alternative to the free flaps. It offers excellent cosmetic and functional results and shorter operative time [(2)].

AIM OF THE WORK

Aim of this study is to evaluate the validity and application of local arm forearm and regional chest perforator flaps for coverage after release of post burn elbow contractures.

PATIENTS AND METHODS

This prospective randomized study was done on 20 patients aged from 6 to 54 years old. All of them were asking for elective release of post-burn flexion contracture of the elbow at outpatient clinics of Al-Azhar University (El Hussein University Hospital) and Al-Ahrar Teaching Hospital in Zagazig city. It was done from March 2018 to March 2019.

Received:30/1/2019
Accepted:2/3/2019

All patients were subjected to the following:

1. **Full history taking** of the date of burn, initial management that was done whether conservative or surgical and clinical evaluation by the plastic surgery team.

The following features were assessed:

- **The magnitude of scarring and scar thickness** were assessed.
- **The site and the size of uninjured skin** were delineated.
- **The extent of joint contracture** was determined and the passive and active range of joint motion was assessed.
- **The axis of joint rotation** was located.

Preoperative investigations including:

- **Laboratory investigations** as: CBC, liver function tests, Kidney function tests, Coagulation profile.
- **Radiological investigations** as: chest x-ray, elbow x-ray for secondary elbow pathology (Heterotropic calcification), and doppler studies were done in all cases.
- **ECG.**

2. Inclusion Criteria:

- All patients had post-burn flexion contracture of the elbow of different degrees.
- Plateauing of the physiotherapy effect before shifting to surgery.
- Old contracture more than 6-12 months with mature scar.

3. Exclusion Criteria:

- Patients unfit for surgery or anesthesia.
- Recurrent flexion contracture of the elbow after previous trial of release.
- Recent contracture less than 6-12 months.
- Marjolin's ulcer.
- Stiff elbow.

4. Ethical Approvals:

An approval of the study was obtained from Al-Azhar University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of the operation.

5. Preoperative planning:

- Including examination of the remaining healthy tissues of arm and forearm and also regional lateral and posterior thoracic tissues.
- Design of a suitable flap that can cover the expected defect around a suitable perforator will be designed (using Doppler sonography to allocate a convenient perforator).

Perforators were marked preoperatively in all cases with an 8 MHz hand held Doppler device. Perforator vessels were identified by its unidirectional pulsatile flow at the higher volume and good battery charge of the Doppler which was identifying one or more of the perforators presented around the defect site.

Flap planning:

a) The ideal perforator as pivot point was chosen according to the larger and nearer to the defect.
b) The long axis of the flap had to be orientated in the long axis of the upper limb. The perforator situation should be at least 1-2 cm from the base of the flap.

6. Operative technique

All patients were operated under general anesthesia and in supine position. Tourniquet was applied to some cases and raised over the systolic pressure by 100 mmHg and in cases that extended beyond 2 hours we had to release the tourniquet for 15 minutes for reperfusion and then raised it again.

The incision was made up to or deep to the deep fascia, and was followed by either suprafascial and subfascial dissection under magnification by 4.5x magnification loop and all the identified perforators were preserved.

All through dissection, the perforators must be humidified with lidocaine 2% to prevent spasm [7]. If two adjacent perforators with same characteristics were found, it was better to keep both until the flap's dissection was completed and the tourniquet released.

After alternative clamping, it was possible to ligate one of them. Once the best perforator(s) was chosen, according with its location, size, and suitability to sustain the flap, number of venae comitantes, course and orientation, then the definitive design of the flap was accomplished.

Enlarging the perforator foramen using a longitudinal fascial incision was done, next to this, the chosen perforator was cleared retrograde of all muscular branches and fascial strands for at least 2 cm, but no longer than needed for optimal flap's rotation.

Now, the incision around the flap and the harvesting can be completed, but it was not yet rotated into the defect. If the perforator weren't pulsating after releasing the tourniquet, it was better to leave the flap in its original position for 10-15 minutes to allow its reperfusion and the perforator's spasm disappearance.

The flap could be rotated in a clockwise or counter-clockwise direction, and attention should be paid to choose the right rotational direction to avoid kinking of the vessels.

The donor site was not closed under tension, which would reduce the flap's blood supply by compressing the source vessel, and would induce swelling of the limb distally. If primary closure was not possible, the donor-site was partially directly sutured, and the remaining defect skin grafted.

7. Postoperative follow up

To avoid vascular embarrassment and related complications, it was important to avoid too-

tight bandaging as that combined with postoperative swelling may cause unnecessary complications. Dressing was provided with an open window to observe the flap, especially the flap-tip.

Postoperative follow up as regard: Evaluation of flap survival by clinical observation, where the flap was assessed for color, swelling, temperature, capillary refill, return to normal activity and photography.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (x^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
- Probability (P-value):
  - P-value <0.05 was considered significant.
  - P-value <0.001 was considered as highly significant.
  - P-value >0.05 was considered insignificant.

RESULTS

This prospective study included 20 patients; all of them were suffering from post-burn flexion contracture of the elbow joint and had been managed at Al-Azhar University and Al-Ahrar Teaching Hospitals by different surgical modalities, during the period from March 2018 to March 2019.

- The age of the patients ranged from 6 to 54 years.
- The commonest cause of burn in our study was scald burn.
- The commonest form of contracture was broadband.
- They were 9 female and 11 male in our study.

Different surgical modalities of perforator flap had been used in our study including: Lateral arm perforator flap, medial arm perforator flap, proximal radial artery perforator flap (PRAP-flap), proximal ulnar artery perforator flap (PUAP-flap), and Pedicled thoracoabdominal flap.

Table (1): Age and sex distribution among studied group (N=20)

Age / years	**Mean ±SD**	**31.4±10.4**	
	Median (Range)	**31.5 (6-54)**	
		N	**%**
Sex	**Male**	**11**	**55.0**
	Female	**9**	**45.0**
	Total	**20**	**100.0**

Age was distributed as **31.4±10.4** with minimum 6 and maximum 54 years, male were 55% and female 45%

Table (2): Cause distribution among studied group

		N	%
Causes	**Chemical**	**2**	**10.0**
	Flame	**8**	**40.0**
	Scald	**10**	**50.0**
	Total	**20**	**100.0**

Major cause was scald with 50% followed by flame 40% and finally 10%.

Table (3): Form of contracture distribution among studied group

		N	%
Contracture	**II a**	**4**	**20.0**
	II b	**8**	**40.0**
	III	**8**	**40.0**
	Total	**20**	**100.0**

IIb and III were distributed as 40% & 40% and IIa was 20%.

Table (4): Flap type distribution among studied group

		N	%
Flap	Lateral	8	40.0
	Medial	5	25.0
	PRAP	3	15.0
	PUAP	2	10.0
	Thoraco-abdominal	2	10.0
	Total	20	100.0

The majority were lateral with 40% followed by medial 25% then **PRAP** 10% finally PUAP and Thoraco-abdominal with 10%.

Table (5): Complication distribution among studied group

		N	%
Complication	Not complicated	10	50.0
	Congestion	2	10.0
	Congestion +partial loss of flap	4	20.0
	Delayed healing	1	5.0
	Delayed healing+ Bleeding	2	10.0
	Wound dehiscence	1	5.0
Overall complication	Not complicated	10	50.0
	Complicated	10	50.0
	Total	20	100.0

50% were complicated the major complication was Congestion +partial loss of flap.

Table (6): Relation with complication

			Not complicated	Complicated	t/X^2	P
			27.1±9.0	35.7±11.47	-1.452	0.152
Sex	Male		5	6	0.202	0.65
			50.0%	60.0%		
	Female		5	4		
			50.0%	40.0%		
cause	Chemical		1	1	0.0	1.0
			10.0%	10.0%		
	Flame		4	4		
			40.0%	40.0%		
	Scald		5	5		
			50.0%	50.0%		
Contracture	II a		2	2	1.0	0.607
			20.0%	20.0%		
	II b		3	5		
			30.0%	50.0%		
	III		5	3		
			50.0%	30.0%		
Flap	Lateral		5	3	5.03	0.28
			50.0%	30.0%		
	Medial		2	3		
			20.0%	30.0%		
	PRAP		1	2		
			10.0%	20.0%		
	PUAP		0	2		
			0.0%	20.0%		
	Thoraco-abdominal		2	0		
			20.0%	0.0%		
Total			10	10		
			100.0%	100.0%		

There was no significant difference or association.

CASE PRESENTATIONS

Case 1

Thirty two years old male presented with moderate degree post burn contracture of right elbow type IIa. He is exposed to burn tree years before presenting to our clinic. History, general and local examination and complete investigations were done. The patient was prepared for perforator flap based on perforator from the recurrent radial artery (lateral arm perforator flap). The perforator was detected and marked preoperatively. After general anesthesia, contracture release is done revealing a 5x9cm^2 defect. Incision was taken from the medial surface of the designed flap. Dissection was done and 3 perforators were detected. After complete dissection, the proper perforator - was chosen and the flap was rotated 90° to cover the defect. Adjustment of the recipient defect then the flap was sutured and the donor site was grafted. Posterior slap was applied and dressing allover with leaving a window to monitor the flap. Follow up and flap monitoring revealed minimal self-limited bleeding, good vascular supply with no ischemia or congestion. Patient discharged on 3rd postoperative day with all medical and surgical instructions. Appointment in outpatient clinic was done 7 days later. On 1st dressing there was delayed healing of the flap. Follow up after 2 months revealed complete take of the flap and graft patient was satisfied by contracture release.

Figure (1): Show postburn elbow contraction

Figure (2): Show contraction release

Figure (3): Intraoperation flap elevation and insertion

Figure (4): Postoperation first dressing

Figure (5): Result after 3 months

Case 2

Six years old male presented with moderate degree post burn contracture of left elbow type III. He is exposed to burn two years before presenting to our clinic. History, general and local examination and complete investigations were done. The patient was prepared for thoracoabdominal pedicle flap. The flap was detected and marked on lateral side of abdominal wall preoperatively. The patient is placed in the lateral decubitus or semi lateral decubitus position, depending on the size of the defect and the amount of coverage needed. Landmarks outlining the typical flap dimensions are the nipple line superiorly, the anterior border of the latissimus laterally, the lateral border of the rectus abdominis medially, and the umbilicus inferiorly. The pedicle can be an anteriorly based thoracoepigastric flap or a posteriorly based random pedicle flap, depending on the area needing coverage and the amount and size of excursion demanded by the wound. In the case of the after general anesthesia, contracture release is done revealing a 4x6 cm^2 defect. Incision was taken from the inferior surface of the designed flap. Dissection was done and. Once the flap is raised, the donor site can be closed primarily if the flap is small enough, or the corners can be sutured to decrease the size of the donor site and a split thickness skin graft is applied. It is critical to do this prior to suturing the flap in place cover the defect by the flap suturing flap to arm after first dressing they limited bleeding, good vascular supply with no ischaemia or congestion, separation of flap is done after 21 day of first operation. Patient discharged after separation of flap postoperative day with all medical and surgical instructions. Appointment in outpatient clinic was done 7 days later. On 1st dressing there was delayed healing of the flap. Follow up after 2 months revealed complete take of the flap and graft patient was satisfied by contracture release.

Figure (6): Show postburn elbow contraction

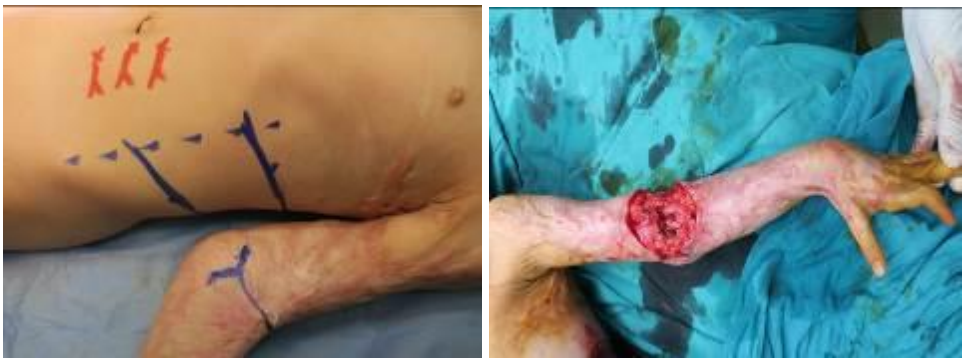

Figure (7): Contraction release and flap design

Figure (8): End result after 3 months

DISCUSSION

Post-burn scar contractures are the most common post-burn problem that requires management by the burn reconstructive surgeon. They are characterized by tight, shortened scar tissue. They can form over joints, creating a limitation of movement, or can create a deformity as the result of their effect on a mobile anatomic structure. They are more common on the flexor surfaces because these muscles are generally stronger and the flexed position is often the position of comfort [8].

In our study we only include post-burn scar flexion contracture of the elbow joint.

Post-burn scar contractures are classified into cutaneous and or subcutaneous contracture. If tendon, ligament, and muscle contracture were diagnosed, these replacement and reconstruction methods should be considered in addition to releasing scar contractures [9]. Elbow burn contractures are more likely to be complicated by heterotopic bone formation[9]. The surgeon must be aware of this possibility, diagnose this before any skin contracture release, and plan operative strategy accordingly. Some surgeons perform both the skin release and heterotopic bone release in one sitting[9]. **Richard**[10] recommends two staged procedures.

In this study we have operated only on cutaneous/subcutaneous contracture after exclusion of the heterotropic calcification of the elbow joint by X-ray on the elbow joint preoperatively.

Before attempting release, the patient should be advised to wait preferably a year from the time of the burn, which can be frustrating to the patient. However during this time massage, splinting and regular visits to the physiotherapist will pay dividends in the end [11].

But, in our study we operated on the postburn scar after 6-12 months, after plateuing of the effect of the physiotherapy. Release of an elbow burn contracture usually produces a secondary defect that needs to be reconstructed with proper measures [12].

The release should be carried down through all scar tissue to obtain optimal release Excise as much scar as reasonable to obtain maximum release of the joint. The release will generally need to go down to the midpoint of the joint to obtain complete release. One must be aware of important structures (nerves and vessels) in danger of being traumatized during the release e.g. the brachial artery and the median nerve in our study. Another risk is over-zealous correction leading to vessel spasm and possible limb loss [11]. Numerous methods that have been suggested for antecubital burn contracture release include; skin graft, Z-plasty, Y-V flaps, five z-plasty flap, local or distant fasciocutaneous flaps, muscle or myocutaneous flaps, free flaps, tissue expanders and non-surgical orthotics [12].

We have performed in our study the local and regonal perforator flaps as lateral arm flap, medial arm flap, PBUF flap, PBRF flap, thoracoabdominal pedicle flap. Skin grafting is an easy procedure, however, success is limited with the technique because there is always the risk of incomplete graft take and prolonged splinting and physiotherapy is imperative in the postoperative period. Despite the latter, grafting usually has a high possibility of recontracture [12]. All grafting techniques rely on revascularization from the wound bed, and shearing forces, infection, the presence of seromas or hematomas, or poor contact can all prevent revascularization and lead to graft failure, as partial loss of the graft had occurred in one of our cases. When using a skin graft technique, it is recommended to make a template of the release site to determine graft size and shape and, when multiple grafts are used, to orient the contact borders perpendicular to the line of tension [8].

The Z-plasty can be successfully used in combination with skin grafting to reduce the amount of skin graft used. Care must be taken in this instance as flap necrosis and infection can then lead to graft loss If only one side is scarred one can do a half Z- plasty where on one side the angle can be about 90 degrees. Z-plasties can be single or multiple [11].

Serial Z-plasties are successive small Z-plasties, oriented in the same direction along the line of contracture. This technique has the advantage of using multiple, smaller flaps, which have a more favorable blood supply than a single large flap. It also distributes the release more evenly along the line of contracture and requires less recruitment from the side [8].

Local fasciocutaneous flaps have the advantages of using regional tissue in a single stage and can be categorized as proximally or distally based around the elbow joint. The basis of these flaps is a direct application of the vascular anatomy of the upper arm and collateral circulation around the elbow joint [13].

In our study we used perforator flap in reconstructions of burned elbow contracture and in comparisons with other techniques:

- It allows for early mobilization of the involved elbow joint for rehabilitation.
- It offers a single stage reconstruction with an acceptable skin color match.
- Flaps are better for resurfacing the defects after post-burn contractures release. Flaps do not need vigorous post-operativ physiotherapy or

splintage and grow with age especially in children.

- The use of fasciocutaneous perforator flaps is preferred, but requires the presence of local adjacent healthy unscarred tissues and healthy untraumatised donor sites in case of local fasciocutaneous flaps that may .endanger the vascular pedicle of the flap.
- The local fasciocutaneous flaps as the reversed lateral arm flap and the proximally based lateral forearm flaps is preferred in case of broadband contracture as long as the donor sites are healthy, unscarred and not previously traumatized. These flaps are aethetically superior to the grafts and sacrifice no major vessel or nerve.
- In case of broadband contracture with no local healthy unscarred tissue, we can use thoracoabdominal pedicle flap

CONCLUSION

1. It offers a single stage reconstruction with an acceptable skin color match.
2. Flaps are better for resurfacing the defects after post-burn contractures release. Flaps do not need vigorous post-operative physiotherapy or splint age and grow with age especially in children.
3. These flaps are aethetically superior to the grafts and sacrifice no major vessel or nerve.
4. In case of broadband contracture with no local healthy unscarred tissues, then we can use of the thoracoabdominal pedicled flap will be necessary as blood supply from regonal area and flap good in resurfacing and coverage.

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