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Original Research Paper

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ADD-ON EXTENDED DORSAL INTERCOSTAL ARTERY PERFORATOR PROPELLAR FLAP (AOE-DICAP) FOR THE RECONSTRUCTION OF LARGE POSTERIOR TRUNK DEFECTS

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ABSTRACT

Introduction: Reconstruction of large posterior trunk soft tissue defects poses a challenging problem. Until recently, these defects were reconstructed with multiple random pattern flaps, local pedicled muscle flaps and musculocutaneous flaps. The posterior intercostal arteries form the major angiosome of the trunk through multiple perforators to the skin. Some studies in the recent literature have highlighted the reliability of the classical DICAP flap in the posterior trunk reconstruction.

Aim: To determine the efficacy, reliability and clinical outcomes of the add-on extended dorsal intercostal artery perforator propeller flaps (AOE-DICAP) for the reconstruction of large posterior trunk defects.

Materials & Methods: Six patients (3 infants and 3 adults) with posterior trunk defects due to various aetiologies were reconstructed with AOE-DICAP flap.

Result: All flaps survived completely, except for superficial epidermolysis at the distal border of the flap in one patient that healed secondarily. Average follow up was 12 months.

Conclusion: Add-on extended DICAP (AOE-DICAP) flap provides an excellent stable cover and a viable option for large median and paramedian back defects reconstruction.

KEYWORDS : Dorsal intercostal artery perforator flap, Add-on extended dorsal intercostal artery perforator flap, meningomyelocele, large posterior trunk defects.

Introduction:

Reconstruction of large posterior trunk soft tissue defects poses a challenging problem. Until recently, these defects were reconstructed with multiple random pattern falps, local pedicled muscle flaps and musculocutaneous flaps. The posterior intercostal arteries form the major angiosome of the trunk through multiple perforators to the skin [1,2]. The dorsal intercostal artery perforator (DICAP) flap is a well-vascularised flap based on the dorsal perforators of the posterior intercostal artery. Some studies in the recent literature have highlighted the reliability of the classical DICAP flap in the posterior trunk reconstruction [1,2]. Classically, the safest zone of DICAP flap has been described extending up to the posterior axillary fold [2,3]. However in many instances, the DICAP propeller flaps may need to be harvested beyond this margin for a successful tension-free closure of large back defects. Extended DICAP propeller flaps (elongated beyond the posterior axillary fold) are not described adequately in literature. This paper illustrates our clinical experience with the use of add-on extended DICAP propeller flaps (AOE-DICAP - harvested beyond the anterior axillary line) for the reconstruction of large posterior trunk defects in paediatric and adult patients.

Aim:

The aim of this study was to determine the efficacy, reliability and clinical outcomes of the add-on extended dorsal intercostal artery perforator propeller flaps (AOE-DICAP) for the reconstruction of large posterior trunk defects due to various aetiologies.

Materials and Methods:

Study period: from July 2015 to July 2017.

Selection criteria:

A total of six patients including 3 infants and 3 adults with posterior trunk defects that could not be closed with the standard DICAP propeller flaps were included in the study

Exclusion criteria:

- Patients with rib fractures
- Defects that could be closed by the standard DICAP flap

Aetiologies were large congenital thoracolumbar meningomyelocele in infants and large soft tissue sarcoma of the back in adults.

Surgical technique:

After excision of the tumour by surgical oncologist or excision of meningomyelocele by neurosurgeon, the author's team assessed the defect. Using 10MHz hand held doppler, on-table confirmation of pre-operatively marked perforator was done. Based on the defect the pattern was cut and transposed from perforator pivotal donor area. In cases where the interpolation of perforator propellar flap was less than 180°, a trilobed flap design was done. If the rotation was 180° classical bilobed flap design was performed. The flaps were obliquely oriented towards the thoraco-abdominal junction where the loose tissues exist. This orientation facilitated large flap harvest beyond the anterior axillary line and the primary closure of the secondary defect. The flap in most patients was propelled through less than 90 degrees utilizing two modifications.

1. The flap was designed in a tri- lobed fashion in such a way that primary blade gets interpolated to the primary defect and the secondary blades overlies the donor defect of the primary blade which overlies the proximal end of the secondary defect relieving the pressure on pedicle during primary closure of the later. Tertiary blade is transposed to the donor defect of secondary blade.
2. Since the trilobed flap was propelled less than 90° in myelomeningocele cases, more than one perforator was included in the flap arising from the same or adjacent posterior intercostal spaces[8]. In the bilobed classical propeller DICAP flap, the classical bio geometry described by Teo was followed[9]. The

classical non delineating incision was carried out to locate the perforators and then the dissection was carried from lateral to medial direction. In the presence of more than one perforator, the single best perforator was chosen based on the following criteria:

a. Large dimension of the perforators
b. Prominent perforator pulsations seen 5 minutes post application of 2% topical lignocaine
c. Presence of one or two venae commitantes

The dissection was done elevating the flap sub-fascially from the epimysium of the back musculature. The perforators were identified and the peri-perforator intramuscular dissection was performed. The flaps were propelled into the defect after obtaining a minimum of 2 cms pedicle length that allowed a gracious turn of the flap without any twist or kinking of the pedicle.

Donor sites of all the flaps were closed primarily. Post operatively, prone or lateral decubitus position on the non-operated side was advised for 2 weeks with frequent change of posture. Myelomeningocoele cases were nursed on water bed.

CASE 1:

A 4 months old male child presented with congenital thoracolumbar meningomyelocele (fig 1.). MRI of lumbosacral spine revealed central syrinx from D4 downwards and tethered cord at L2 level. Open Spina Bifida defect was noted at L2- L5 level with herniation of meninges along with nerve root (fig 2.). CT brain showed dilated 3rd and Lateral ventricles causing non-communicating hydrocephalus (fig 3.).

fig 1. 4 months old baby with meningomyelocele.

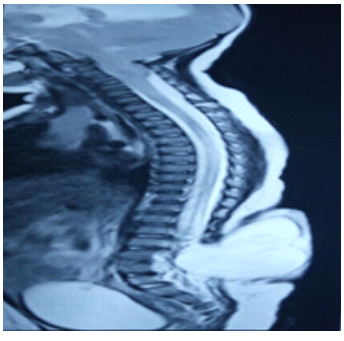

fig 2. MRI Lumbosacral spine

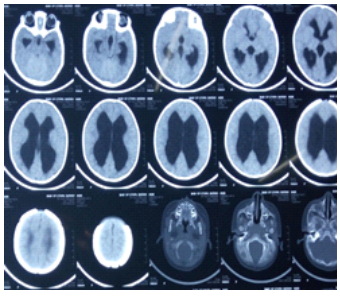

fig 3. CT brain

Excision of meningomyelocele was performed by the neurosurgeons under general anaesthesia (A ventriculo peritoneal shunt was inserted for hydrocephalus before this surgery). After excision, dural dissection and defect reconstruction was done over the released and repositioned cauda equina. Dissection was done in the prone position under 4 X magnification. Post excisional defect measured 11x9 cms.

Fig 4. Preoperative Doppler localisation of the perforator.

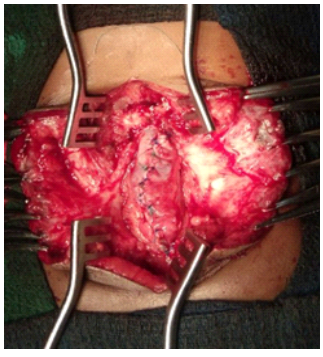

Fig 5. Excision of the meningomyelocele, dural repair and repositioning.

Technique of flap harvest (fig 6.) -Marking of a trilobed add-on extended DICAP propellar flap was done based on the perforator identified using Doppler [7]. The flap was 12.5 x 10 cms at its greatest dimension.

Fig 6a post excisional defect.

Fig 6b. Flap marking

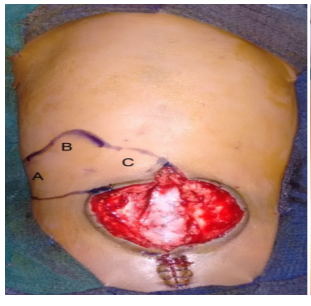

Fig 6c. trilobed flap showing primary, secondary and tertiary blades.

Fig 6d. Flap elevation based on two perforators.

Flap was initially elevated from the antero-lateral abdominal wall by a non delineating incision, until the perforators were encountered. In this case we found two large perforators from DICA at 7th and 8th intercostal spaces.

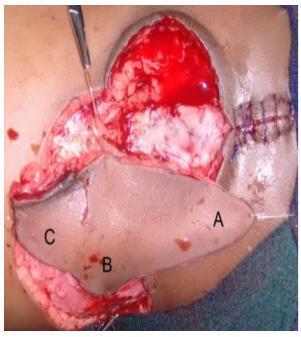

fig 7- flap interpolation

fig 8- flap inset.

As this flap envisaged interpolation through less than 90 degrees, both the perforators were maintained. Peri-perforator dissection was carried out through the fascial defects in the posterior layer of thoraco lumbar fascia until obtaining 1.5cms length of each perforator. Flap was interpolated through the shortest route and final inset was given. Secondary defects were closed primarily. Child was followed up for 1 year with no complaints.

Fig 9a, 9b- six months post-op follow up picture showing distal extent of the scar beyond the anterior axillary line.

CASE 2:

A 24 years old lady presented with complaints of a large swelling over the left scapular region of 7 months duration. She was diagnosed to have soft tissue sarcoma of the back based on clinical, radiological and histopathological examination.

Fig 10a- preoperative picture of the patient with soft tissue sarcoma of the back.

Fig 10b- post excisional defect.

Patient underwent surgical excision of the swelling by oncosurgical team. Post excisional defect measured 29x20 cms.

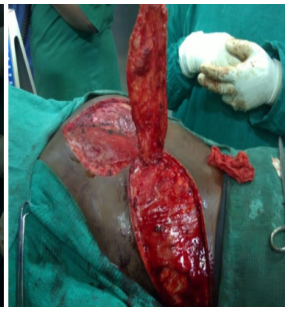

Fig 10c and 10d- flap harvest and flap elevation on the single best perforator from DICA.

An add-on extended bilobed DICAP flap was planned on the ipsilateral side. Flap was harvested based on the single best perforator from 7th intercostal space to cover the defect. Flap measured 28x18cms. On post op day 5 superficial epidermolysis at the distal end of the flap was noted that healed secondarily without any intervention. Patient was followed up for 18 months with no locoregional recurrence. Patient had post- operative radiotherapy and chemotherapy that were tolerated well.

Fig 10e- flap inset.

Fig 10f- superficial epidermolysis at the distal edge of the flap.

Case 3:

A 40 days old male infant presented with thoracolumbar meningomyelocele. MRI of lumboscaral spine revealed central syrinx from D4 downwards and tethered cord at L1 - L2 level. Open Spina Bifida defect noted at L2- L5 level with herniation of meninges along the nerve root. CT brain showed a non-communicating hydrocephalus (fig 11a-f).

Fig 11a- pre-op picture.

Fig 11b- MRI

Fig 11c- defect post excision

Fig 11d- flap planning

Excision of meningomyelocele was performed by the neurosurgeons under general anaesthesia (A ventriculo peritoneal shunt was inserted for hydrocephalus prior to this surgery). Post excisional defect measured 10x7.5cms.

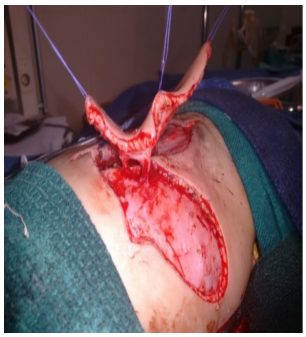

Fig 11e- flap elevation on two perforators **fig 11f- flap inset**

Fig 11g,h- nine months post-op follow up.

A trilobed AOE-DICAP flap was harvested based on the perforators from 7th and 8th intercostal spaces. The flap was 11.5x8.5 cms at its greatest dimension. Flap settled well and child had stable cover in 12 months follow up.

Results:

- The age of the patients ranged between 40 days to 55 years (mean = 19.5 years).
- All the defects were located in the thoracic or thoracolumbar regions.
- The maximum flap dimension was 28 x 18 Cms.
- The minimum flap dimension was 11.5 x 8.5 Cms.
- The average size of the AOE-DICAP flap used in the meningomyelocele defect was 123.75 cm^2
- The average size of the AOE-DICAP flap used in the soft tissue sarcoma defect was 315.08 cm^2
- The horizontal lengths of all the flaps were extended beyond the anterior axillary line, at an average distance of 1.5cms in meningomyelocele group and 2.5cms in post tumor excision group.
- All flaps survived completely, except for a superficial epidermolysis at the distal border of the flap in one patient that healed secondarily.
- No wound infection at the donor site or recipient site was observed.
- No hematoma or seroma formation was observed during the postoperative follow-up period.
- No functional loss attributable to flap harvest was noted.
- One patient (patient 1), had cerebrospinal fluid leakage through the drain site which stopped spontaneously in 1 week.
- None of the flap donor sites were reconstructed using skin graft and all were closed primarily.
- Average follow up was 13 months.

In myelomeningocele group recovery from paraperesis/paraplegia were not taken as the part of assessment of the study

S. NO	AGE/SEX	ETIOLOGY OF DEFECT AND LOCATION	DEFECT SIZE	PERFORATOR LOCATION	HORIZONTAL EXTENT OF FLAP	FLAP SIZE & NO. OF PERFOARTORS	FOLLOWUP PERIOD (MONTHS)
1	40 DAYS/ MALE	THORACO-LUMBAR MENINGOMYELOCELE	10 X 7.5	7^{TH} AND 8^{TH}	BEYOND AAL	11.5 X 8.5(2)	6/ stable cover
2	4 MONTHS/ MALE	THORACO-LUMBAR MENINGOMYELOCELE	11 X 9	7^{TH} AND 8^{TH}	BEYOND AAL	12.5 X 10(2)	14/ stable cover
3	6 MONTHS/ MALE	THORACO-LUMBAR MENINGOMYELOCELE	12 X 10	7^{TH} AND 8^{TH}	BEYOND AAL	13.5 X 11(2)	6/ stable cover
4	37 YEARS/ MALE	THORACO-LUMBAR SOFT TISSUE SARCOMA	20 X 9	8^{TH}	BEYOND AAL	20.5 X 10(1)	12/ No locoregional recurrence
5	55YEARS/ MALE	THORACIC SOFT TISSUE SARCOMA	21 X 9.5	7^{TH}	BEYOND AAL	22.5 X 10.5(1)	24/ No locoregional recurrence
6	24 YEARS/ FEMALE	THORACIC SOFT TISSUE SARCOMA	29 X 20	7^{TH}	BEYOND AAL	28 X 18(1)	16/ No locoregional recurrence

AAL – Anterior Axillary Line

DISCUSSION:

Several anatomical studies[1,2] have illustrated the angiograms of the back describing the posterior intercostal angiosome as the largest angiosome of the body.

Daniel et al.[4,5] described the anatomy of the intercostal arteries and potentiality of intercostal artery flaps. Studies reported that the perforators of dorsal intercostal arteries measuring approximately 1.5 mm branched off in the vertebral segment.

The dorsal cutaneous perforators diverge into medial and lateral branches. The medial dorsal intercostal artery perforators are located within 5 cms from the dorsal midline. There exist choke anastomoses between the intercostal perforators and the adjacent arteries leading to recruitment of potential vascular territories as demonstrated by perforator mapping in cadaveric studies [1,2,4]

There are several options for the reconstruction of back defects ranging from primary closure for small defects, rotation-transposition fasciocutaneous flaps, bilobed flaps, Z-plasties, musculocutaneous flaps to DICAP propeller flaps [2,4,5,6]. Classical DICAP flaps harvested upto the posterior axillary line provide good coverage of the posterior trunk defects as described well in literature.[1,2]

Few studies have demonstrated the reliability of extended DICAP flaps (harvested beyond the posterior axillary line) for large posterior trunk defects[2]. To our knowledge extension of the DICAP flaps beyond anterior axillary line has not been described in literature. So ours is the first clinical series on this category of flaps (AOE-DICAP flaps).

Based on the findings of several anatomical studies well documented in literature, the author has harevested Add on Extended DICAP (AOE- DICAP – harvested beyond the Anterior Axillary Line) flaps for large posterior trunk defect in this clinical series.

DICAP flaps based on the single best perforator have high mobilisation capacity with preservation of muscle functions and lower donor site morbidity. The vessel passes through the dorsal musculature and provides around 1.5 to 2 cms pedicle length permitting the gracious twist of the perforator facilitating propeller movement of the flap. The robust vascularity of this flap is due to the perforators directly arising from the posterior intercostal arteries which in turn are direct branches from aorta. Large double venae comittantes are always found in relation to these perforators.The average size of these perforators is 1.5 mms [1,2]. All these aspects and probably the high mean arterial pressure contribute to the safety of these AOE - DICAP flaps. These flaps can be used for the repair of larger median and paramedian back defects[3]. The tri-lobed flap design resulted in the tensionless closure of the secondary defect and eschewed the pressure over the pedicle. Interpolation was less than 90 degrees in many patients. The AOE- DICAP flap offers several advantages. It is a technically less demanding procedure because it is microvascular surgery without microvascular anastamosis. Large defects can be resurfaced easily. The donor site morbidity is very minimal. In our clinical series all our secondary defects were primarily closed[2] utilising the loose tissues at the loin region. Aesthesis is restored at the reconstructed site without any standing cone or deformities with intact sensation (useful in myelomeningocele cases, also contributing to the stable cover). As the flap has got robust blood supply wound healing is well facilitated. AOE-DICAP flap provides an excellent cover for large median and paramedian back defects and in cases where prosthetic reconstructions are required[2]. The strength of this clinical study is the clinical demonstration of safe rising of add-on extended DICAP flap. The limitation of this study is its small size.

CONCLUSION:

Based on our clinical experience, DICAP flaps are more reliable when compared with random pattern flaps, because they do not cause functional loss of any muscle, which is important for future ambulation of paraparetic patients. It enables us to reconstruct the defect without overlapping of dura and skin suture lines. AOE-DICAP flap can be safely harvested beyond the classically described DICAP or extended DICAP flap. These flaps can be a reliable option in the reconstructive armamentarium for large posterior trunk defects.

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