Hand reconstruction using thigh, groin and lateral thorax flaps.

A systematic review, have we found the ideal flap for hand reconstruction?

Abstract

Background:

Reconstruction of the hand is a challenging topic. Bearing in mind the unique structure of the hand, simple wound reconstruction was never satisfactory for both patients and surgeons.

Objectives:

In this systematic review, we focus on appraising the current practice in order to answer our proposed question, Have we find an ideal reconstruction technique for the hand?

Methods:

A literature review was carried out using OVID, Cochrane and google scholar.

Results and Conclusion:

37 relevant articles were included for discussion.

Many reconstruction approaches were described, some were proven reliable. However standardisation of the approach and management was not elicited. Management differed hugely according to surgeon's preference and experience along with available facilities and logistics.

Introduction:

The complex and unique hand anatomy and function created an outstanding challenge to achieve a satisfactory reconstruction outcome.[1, 2]

Not only the defect reconstruction was aspired, but also the function, the appearance and sensation were targeted.[3, 4] The introduction of the functional free tissue transfer (FFTT) took the hand reconstruction ahead in achieving satisfactory function restoration.[5, 6] When bony framework was insulted, the bone graft and vascularized bone transfer reconstruction achieved a robust skeleton to achieve a desirable outcome. Using sensate flaps for hand reconstruction fulfilled the sensation dilemma in a reconstructed hand and achieved the protective sensation necessary for the hand function.[7] With the new advances and introducing the perforator flaps, thin skin and adipofascial flaps were used for reconstruction of the hand with very pleasant appearance. Hence, addressing the concern of the bulkiness issue in the reconstructed hand. [8, 9] Furthermore , using LASER for hair ablation in the flaps provided a reasonable solution for the problematic appearance of a flap with a hair bearing skin in a non-hair bearing areas.[10]

Taking hand reconstruction further, more recent reports reported

successful complex hand reconstruction in a single stage. Putting the classic concept of staged reconstruction into question.[3,9]

So, clearly, reviewing the current literature shows that this is where we stand now in hand reconstruction.

However, our question still stands; do we have the ideal hand reconstruction technique? Do we have the gold standard flap for each indication?

That is what the following lines will try to highlight through extensive current literature review and analysis.

Limitations:

The current documented practice in hand reconstruction literature shows well-described operative techniques, but, unfortunately, lacks unified guidelines or systematic approach the hand reconstruction. It, instead, shows variable protocols that were proved reliable, but mostly based on individual experience and preference [1]. The documentation was not always available with regards to the facilities and logistics availability and its impact on the decision making in the reconstruction pathway. Moreover, patient related factors such as: existing co-morbidities, age, occupation, hobbies, handedness and preference was not widely documented as well.[7] Preoperative work up e.g., CTA, Duplex scans… etc. And how their results affected the reconstruction options is another thing that was not clearly mentioned in some of the papers.[9]
All these limitations contributed to limit the ability to extract a gold standard approach for hand reconstruction.

METHODS:

Using OVID interface, google scholar and Cochrane, literature search carried out.

Key words: Hand resurfacing, Hand reconstruction, Mutilated Hand Mangled Hand, in both abstracts and titles.

Lay out was adherent to PRISMA 2009 guidelines and BEST BETS principles.

RESULTS

37 articles were included.

Inclusion criteria:

Literature in English language.

Lateral thorax, groin and thigh flaps only were included.

Mangled and mutilated hand along with post burn and post oncho-surgery reconstruction were included.

Outcome criteria included, function outcome, patient satisfaction, need for secondary surgery, need for salvage procedure, cosmetic appearance and protective sensation restoration.

Exclusion Criteria:

Non-flap based hand reconstruction (Skin graft).
Non- lateral thorax, thigh and groin flap reconstruction.
Primary Amputation.
37 Relevant articles were included and discussed with analytic critique to conclude a systematic approach to ideal hand reconstruction.

DISCUSSION

The various proved reliable flap techniques used in hand reconstruction will be discussed and analysed in the following lines.Wei and Mardini text book was used as a reference to demonstrate the common flaps discussed. After discussing the commonly used flaps, analytical in-depth review will be outlined aiming at establishing a satisfactory pathway for hand reconstruction.

Groin flap: [11]

Main Arterial supply: SCIA

Main Venous Drainage: SCIV and SCIA concomitant veins.

Main innervation:

Main Sensory: Lateral cutaneous branch of T12
Main Motor: motor branch to Sartorius, if Sartorius to be included.
Modifications:
Combination of iliac bone, fascia lata, Sartorius muscle (upper part), adipose tissue, cutaneous branch of T12.
Free flap (SCIP).

Advantages:
Minimal morbidity to donor site.
Constant blood supply
Harvesting thin flap is possible(especially lateral portion)
Large Skin paddle 20*15 cm

Disadvantages:
Bulkiness
Pedicle is short.
Vessels are small.
Variable anatomy of the vessels
The pubis is a hair bearing area.

McGregor and Jackson described it first in 1972 as a pedicle flap. [12] Used widely for reliable hand and forearm reconstruction especially in the acute trauma settings. [13] Many Modifications have been used following that such as the bilobed groin flap to reconstruct both volar and dorsal hand defects as in Trevor M Brooks et al[14] series in 2007 and combing the groin flap with the TFL flap to the dorsum and palm of the hand.[15]

Superficial circumflex iliac artery perforator(SCIP) flaps are carry the same advantages as the classic groin flap, but it has a challenging technical part due to the short pedicle and the small calibre vessels which might need super microsurgery skills. In the experienced hand, it can be a brilliant thin flap with large skin paddle to resurface the hand and fingers as Koshima et al described.[16]

Iliac flap: [17]

Main Arterial supply: DCIA

Main Venous Drainage: DCIV and SCIV

Main innervation:

Main Sensory innervation: Lateral cutaneous branch of T12.

Modifications:

Combining iliac bone as the whole bicortical part of the iliac crest subunit , fascia, internal oblique muscle, cutaneous branch of T12.

Advantages:
Donor site can be well-concealed
Constant blood supply
Long pedicle
Generous bone component (16cm)
Large skin paddle (20*16 cm)

Disadvantages:
Challenging dissection
Technically difficult in obese population.
Bulkiness
Complications at the donor site: altered sensation, herniation, hematoma, abnormalities in the gait.[18]

DCIA flaps were reliably used in cases of large bony defects in hands injury as in multiple metacarpals loss. Moreover it was used for a single stage complex hand reconstruction providing sensate skin, bone and muscle components to reconstruct, resurface and obliterate the dead spaces in injured hand.[8,19]

ALT: [20]

Main Arterial supply: LCFA Descending branch

Main Venous Drainage: LCFA venae comitantes

Main innervation:

Main Sensory innervation: lateral cutaneous femoral nerve

Main motor innervation: motor branch to vastus lateralis

Modifications:
May combine muscle (RF, TFL, VL) fascia, Lateral cutaneous femoral nerve, adipose tissue chimeric options based on the LCFA/MCFA systems

Free flap or pedicle options

Advantages:

Reliable anatomy

Pedicle is long

Straight forward harvest

Minimal morbidity to the donor site.

Thin skin, fascia or adipo-fascial flaps harvest is feasible.

Large skin paddle 35*25cm

Disadvantages:

Challenging in obese population

Mismatch of the colour

Hair bearing skin

Described by Song in 1984. Since then it became one the most popular workhorse free flaps used in almost all regions of the body providing.[21] In line with this, ALT has been used extensively as a thin reliable sensate flap with long pedicle that can provide out of trauma zone anastomosis. Especially in large and complex defects requiring multifunctional ALT reconstruction with satisfactory outcome as described by Giderolu K1 et al in 2009.[22]

TFL: [23]

Main Arterial supply: LCFA transverse branch

Main Venous Drainage: LCFA venae comitantes

Main innervation:

Main Sensory innervation: lateral cutaneous femoral nerve and T12 lateral cutaneous branch.

Main motor innervation: superior gluteal nerve motor branch to TFL.

Modifications:

Combination of adipose tissue, fascia, Lateral cutaneous femoral nerve, tendons, cutaneous branch of femoral nerve, muscle (TFL), iliac crest. Free flap or pedicle versions

Advantages:

Reliable anatomy

Pedicle is long.

Harvest is technically straight forward.

Minimal morbidity to donor site. Large

skin paddle 30*20cm

Disadvantages:

Mismatch of the colour

Skin is hair bearing.

Technically difficult in overweight population.

Donor sight scars are not satisfactory and not easy to conceal.

Bulkiness, unless a perforator flap is harvested as Smith AA et al described in 1999.[24]

Lateral knee instability.[25]

Described for soft tissue reconstruction of hand total degloving injury in combination with groin flap with the ability to reconstruct the first web space in the same setting as a single stage procedure as described by **Narushima M et al in 2016** .[15]

Gracilis: [26]

Main Arterial supply: MCFA terminal branch

Main Venous Drainage: Gracilis branch from MCFA venae comitantes

Main innervation:

Main Sensory innervation: the Medial Cutaneous nerve of the thigh

Main Motor innervation: the obturator nerve anterior division.

Modifications:

May include adipose tissue, fascia, Medial Cutaneous nerve of the thigh and Adductor longus& Gracilis muscles.

Advantages:

Reliable constant anatomy

Pedicle is long.

Minimal morbidity to the donor site.

Considered a Gold Standard in free functional muscle transfer FFT with thin non bulky muscle strip

Reliable excursion.

Large skin paddle 25*25cm

Disadvantages:

Limited skin paddle for larger defects

Unreliable distal skin paddle.
Short Gracilis strip FFT was described by Baker et al to reconstruct the thenar muscles with great success in opposition restoration and cosmetically appealing contour as well in 2007. [27,28]

Thoracodorsal Perforator flap:[29]

Main Arterial supply: septocutaneous perforators of the Thoracodorsal artery.

Main Venous Drainage: TDA, Lateral thoracic and suprascapular arteries venae comitantes, Lateral thoracic vein

Main innervation:

Sensory innervation: lateral cutaneous branches of intercostal nerves

Motor innervation: when LD/SA muscles are included.

Modifications:
May comprise LD& SA muscles, fascia, Lateral cutaneous branches of intercostal nerves, adipose tissue, rib +/-scapula
Free flap or pedicle options

Advantages:
Pedicle is long
Minimal morbidity to donor sites.
Large skin paddle 25*25cm
Disadvantages:
Challenging dissection and harvest
Technically difficult in obese population
Breast deviation when large skin paddle is harvested with direct closure in slim females

Latissimus dorsi perforator flap: [30]

Main Arterial supply: musculocutaneous perforators of the Thoracodorsal artery

Main Venous Drainage: TDA venae comitantes, Suprascapular or Lateral thoracic arteries, Lateral thoracic vein

Main Innervation:
Sensory innervation: lateral cutaneous branches of the intercostal nerves
Motor innervation : when LD/SA muscles are included

Modifications:
May comprise SA/LD muscles, adipose tissue(extended)fascia, scapula+/- rib, Lateral cutaneous intercostal nerves.
Free flap/pedicle choice

Advantages:
Pedicle is long
Minimal morbidity to the donor site
Large skin paddle 25*25cm

Disadvantages:
Challenging harvest
Challenging in overweight individuals
Breast deviation if large skin paddle is required and direct closure is performed in slim patients.

Lateral Thoracic Perforator flap: [31]

Main Arterial supply: skin perforators of the Lateral Thoracic artery.

Main Venous Drainage: TDA, Suprascapular & Lateral thoracic arteries venae comitantes, Lateral thoracic vein

Main Innervation:

Sensory innervation: lateral cutaneous branches of the intercostal nerves

Motor innervation: when LD/ SA muscles are included

Modifications:
May comprise SA/LD muscles, adipose tissue, fascia, scapula/rib, Lateral cutaneous branches of the intercostal nerves.
Free flap&pedicle choice

Advantages:
Pedicle is long.
Minimal Morbidity to the donor site.
Large skin paddle 25*25cm

Disadvantages:
Challenging dissection and harvest
Technically difficult in overweight individuals
Breast deviation when large skin paddle is needed and donor site id closed directly in slim females.[32]

The new workhorse flap the TDAP is gaining increased popularity recently. It was described in resurfacing the soft tissue defects in the hand with promising outcome by Shao-Liang Chen et al in 2006. Whereas SE Logan and GA Brody used free SA transfer in hand reconstruction in their series published in 1990 with success.

KC Hui pushed the limits further ahead when he included a rib with free SA tissue transfer as a chimeric flap to reconstruct both soft tissue and bone defects in the hand in 1999.[29,32,33]

Tips:

Bone graft vs Vascularized bone transfer:

Evidence from the current literature favours vascularized bone graft as it has higher healing rate and lower infection, mal-union rates. Especially in unfriendly tissue e.g. burns, post radiation, crushes trauma, infection risk and high contamination as **Alexandros E. Beris et al reported in 2011.**[34]

One stage vs staged reconstruction of complex hand defects:

Both techniques were reported successfully with no evidence of one being superior to the other. Many series described successful single stage complex reconstruction provided that debridement is completed as Sundine M et al in 1996 and Goseph Bakkash et al in 2013 reported with great success.[35]

Outcome and CONCLUSION:

Many hand reconstruction techniques have been used efficiently. Many factors can determine which technique should be more suitable for each indication. These factors can be related to patients, surgeons and facility logistics. We summarized the outcome of this systematic review in tables 1, 2. Universal guidelines are needed to compare different techniques and validate the gold standard reconstruction methods.

Criteria of choosing the flap of choice for hand reconstruction:

- Pedicle length
- vessel size match (to perform anastomosis outside the zone of trauma)
- sensation
- Thin skin
- Bulkiness & appearance
- Patient satisfaction.
- Tendon reconstruction.
- bony component
- Donor site morbidities.

See table (1), (2)

Table(1)Outcome of literature review of groin, thigh and lateral thorax donor sites flaps for Hand reconstruction.

-	Skin	Sensate	Tendon	Bone	Pedicle	Donor insult	Aesthetic	Patient satisfaction
Groin	Bulky	+	-	-	Pedicle	Acceptable	Poor	the hand is attached to the groin for average 3 weeks
SCIP	Thin	+	-	-	Short super microsurgery	Acceptable	Poor	fair
DCIA	Thin	+	-	+	Reliable	Moderate	Fair	Fair
ALT	Thin	+	-	+	Excellent	Acceptable	Good	Fair
Gracilis	Thin	+	+	-	Reliable	Acceptable	Fair	Opposition Restoration
TFL	Bulky	+	+	+	Reliable	Acceptable	Poor	Fair
TDAP	Thin	+	-	+	Excellent	Minimal	Good	Fair

Table(2)Literature review-based Suggested Indications of Groin, Thigh and Lateral Thorax flaps in hand reconstruction

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