Composite Tissue Allotransplantation for Burn and Blast Injuries

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Introduction

Burn injuries can be reconstructed using Vascularised Composite Allografts (VCAs) in Composite Tissue Allotransplantations (CTAs). Recent advances in immunology and plastic surgery have improved the survival and quality of CTAs, which are complex alternatives to prosthetics.

Facial and hand transplants were the first breakthroughs in CTA. These injuries.

Epidemiology and Aetiology

Burn injuries

Burns are a form of mutilating injury to tissue caused by thermal energy. Blast injuries and electrical burns can lead to extensive tissue destruction requiring amputation. Severe burns can cause systemic derangement that leads to high risk of mortality. Patients with severe burns however are not contraindicated for CTAs. (One third of facial transplants were performed on patients with burn injuries).

Blast-related Burn injuries

The incidence of blast injuries has increased, especially due to improvised Explosive Devices (IEDs). Due to the configuration of present day armour, complex injuries are especially seen in the exposed limbs. Fireworks and electrical arc flashes also cause these injuries.

Methods

A PubMed search was conducted to access the Medline database using the terms “burns”, “vascularized composite allotransplantation” and “composite tissue allotransplantation”.

Aims

To review recent advances in plastic and transplant surgery in CTAs used in burns reconstruction.

Graft Preservation

Modern perfusion has increased warm ischaemic time of solid organs. Extracorporeal devices are proposed for CTAs and glycerol preservation is preferred to cryopreservation.

Desensitisation

Plasma exchange, immunoadsorption, IVIG, mTOR inhibitors (raptamycin), pulsed steroids, calcineurin inhibitors (tacrolimus), anti-thymocyte globulin and monoclonal antibodies (rituximab)

Monitoring

Skin is highly allogenic (Robbins, Wordsworth et al. 2019). However, imaging modalities like Laser Doppler Imaging and blood markers may allow better monitoring of rejection than the traditional Banff classification.

Banff Classification for VCAs with Skin

Prevention

Mechanical or pharmacological ischaemic preconditioning (Achkar, Sutherland et al. 2014) can delay CTA rejection by priming the transplant.

Improvements in Allotransplantation

Facial Transplantation

View CT scan of Upper Limb Allografts

Facial and hand transplants were the first breakthroughs in CTA.

Allimmune Responses in CTAs

MHC Class II-expressing Langheins cells of skin-containing CTAs are immunogenic and are more abundant compared to solid organ transplants.

Sensitisation is increased by blood transfusion, dermal allografts and unknown factors resulting in a rise of HLA sensitisation in polytransfused patients (Klein, M., 2011).

CTA are associated with increased mortality

CT scan of Upper Limb Allografts

Composite Tissue Allografts in Upper Limbs (Salminger et al., 2016)

Alloimmune responses in CTAs

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Immunosuppression toxicity remains a problem

Triple therapy:

- Mycophenolate mofetil, tacrolimus, methylprednisolone commonly used in CTA has a high rate of acute rejection from cellular immunity rather than antibody mediated rejection seen in organ transplants. (Klein, Schaner et al. 2016)

Type

Mechanism

Examples

Quaternary

Radiant

Fireball – Fatal

Flash burns

Quinary

Confabulation


Reconstructive Options

The current gold standard to complex limb reconstruction is an initial orthopaedic approach. This will help in managing extensive limb damage with early debridement, reconstruction, and soft tissue cover (Wordsworth, Maclver et al. 2014)(Lerman, Kovach et al. 2011)

Graft Monitoring

Free fasciocutaneous forearm flaps can be used as indicators of graft failure along with other biomarkers (exosomes)

Emergency VCA

Blood transfusions and cadaveric dermal allografts increase CTA rejection in burn patients (Press, Lee et al. 2017).

Descentisation

Flash burns, Fireball, Radiant

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Banff Classification for VCAs with Skin

Grade of Rejection

Perivasculaar Inflammation

Epidermal Involvement

0 (none)

None

None

I (mild)

None

Mild

II (moderate)

Moderate

Mild (Oedema or lymphocytic exocytosis)

III (severe)

Dense

Apoptosis, dyskeratosis, keratinolysis

IV (acute necrosis)

Frank epidermal or adenial necrosis

Conclusion

Composite tissue allotransplantation remains a viable approach to devastating injuries caused by burns. Transplant advances can help plastic surgeons optimise long-term CTA outcomes in burn patients.

References


ROBBINS, N. L., WORDSWORTH, M. J., PARIDA, B. K., KAPLAN, B., GORANTLA, V. S., WEITZEL, E. K., & ROBBINS, N. L. 2019. Is Skin the Most Allogenic Tissue in Vascularized Composite Allografts in Upper Limbs (Salminger et al., 2016)?

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