Extracorporeal Membrane Oxygenation in Severe Burns Debridement; Lessons Learnt

L Glanvill, J Wolrich, M Singh, J Leon-Villapalos
Burns Unit, Chelsea & Westminster Hospital, London

ABSTRACT

We present our experience of debridement and grafting of severe burns in a patient on ECMO support. Efficient thermoregulation on the operating table extended operative time and enabled extensive debridement, thereby reducing the number of trips to theatre and time to complete wound coverage.

BACKGROUND

In ventilated burn patients, prevalence of acute respiratory distress syndrome (ARDS) is 34%, with 41% mortality.¹ ECMO is used for ARDS with inadequate tissue oxygenation when conventional management strategies have failed. 58 adult burn patients have been treated with ECMO to date. Overall survival to hospital discharge in burn patients on ECMO is now 50% for 40-49% TBSA burn.² Of the 23 papers we found in the literature relating to ECMO in burns patients, only one mentioned debridement.³ As ECMO becomes more widely available it could support a significant proportion of our patient population. There are also current patents for heat exchangers which might make extracorporeal thermoregulation available as a standalone technology.

CASE

Previously fit and well 33 year old male involved in a domestic house fire. The patient sustained 38% TBSA full thickness burns to his back, bilateral hands, upper limbs, and lower limbs Fig¹ combined with a significant inhalational injury. He was managed with full protocol burns resuscitation, bronchial lavage and three consecutive days of burns debridement with allograft. On day 4 further operative intervention was delayed by acute renal failure and respiratory failure, on day 11 he was transferred to a national ECMO centre.

Seventeen days post burn he returned to theatre on ECMO for removal of allograft, debridement, MEEK to arms and legs bilaterally, debridement and 1:1 meshed autograft to both hands. ECMO allowed five operating surgeons to work simultaneously for 6 hours to debride and definitively cover 25% TBSA Fig². Graft take at 7 days was 100%. Graft take at 14 days was 80% (problem areas were hands).

Fig. 1

DISCUSSION

Major burns require multiple theatre sessions for debridement and coverage. Hypothermia not only limits exposure and length of procedure but also contributes to infection⁴, blood loss⁵, reduced drug clearance⁶, coagulopathy⁷ and acute lung injury.⁵

Thermoregulation

Previous studies have indicated that in severe burns debridement (>35%

TBSA) we can expect a loss of 1.5 degrees in 2 hours.⁵ In a single session burns debridement supported by ECMO, core temperature remained unchanged from baseline for 6 hours without the use of usual heat conserving strategies Fig³, allowing full exposure and simultaneous work of 5 operating surgeons including 3 consultants. 25% was debrided and autografted with time-intensive MEEK.

Category	Methods of rewarming	Rate (°C/hr)
Passive external	Blankets	0.5
Active external	Bair Hugger	1-2.5
Active internal	Warm humidified inhaled air	0.5-1.2
	Peritoneal dialysis	1-3
Extracorporeal	Haemodialysis/haemofiltration	2-3
	ECMO	7-10

Fig. 3, 8

Transfusion requirement

Studies have shown expected blood loss to be 125ml-170ml per 1% debrided - in this case 25% debridement equates to a transfusion requirement of 6-8 units. The initial debridement (not on ECMO) required 10u RBC, 8u FFP, 1u Plt, which is concordant with the literature given other influencing factors (eg DIC). On ECMO, for 25% debrided, our patient required 20u RBC, 10u FFP, 4u Plt. This is attributed to the concomitant anticoagulation required for the extracorporeal circuit. We encountered no immediate transfusion related morbidity.

Graft take

ECMO requires anticoagulation with unfractionated heparin, which via the action of anti-thrombin reduces production of fibrin. Since fibrin is responsible for initial graft adherence to the wound bed, there was concern regarding graft take. However we encountered successful graft take.

LEARNING POINTS

We propose that in our limited experience, despite a hefty transfusion requirement, debridement on ECMO is achievable and generated good graft take. When undertaking these types of procedures the multidisciplinary team can plan for extensive debridement thanks to excellent control of the physiological parameters which usually limit burn surgery. However, anticoagulation associated with ECMO resulted in transfusion of blood products equivalent to the patient's entire blood volume and may be the new limiting factor in future cases.

References:

1. Sine CR et al. Acute Respiratory Distress Syndrome in Burn Patients: A Comparison of the Berlin and American-European Definitions. J Burn Care Res. 2016.
2. Burke C et al. Extracorporeal Life Support Use in Adult Burn Patients. J Burn Care Res. 2017
3. Chou NK et al. Application of Extracorporeal Membrane Oxygenation in Adult Burn Patients. Artif Organs. 2001
4. Kurz A et al. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. N Engl J Med. 1996
5. Oda J et al. Hypothermia during burn surgery and postoperative acute lung injury in extensively burned patients. J Trauma. 2009
6. Zhou J, Poloyac SM. The effect of therapeutic hypothermia on drug metabolism and response: cellular mechanisms to organ function. Expert Opin Drug Metab Toxicol. 2011
7. Cosgriff N et al. Predicting life-threatening coagulopathy in the massively transfused trauma patient: hypothermia and acidosis revisited. J Trauma. 1997
8. Mulcahy A et al. Accidental Hypothermia: An Evidence-Based Approach (Trauma CME). EB Medicine. 2009