Topical negative pressure for the treatment of neonatal post-sternotomy wound dehiscence

J Hardwicke, H Richards, J Jagadeesan, T Jones, R Lester

Birmingham Children's Hospital, UK

ABSTRACT

The use of topical negative pressure (TNP) dressings for sternal wound dehiscence or mediastinitis in the neonatal population is rare. The majority of case reports have focused on wound healing as an endpoint and have not discussed the physiological advantage that TNP dressings may impart with regard to sternal stabilisation, improved respiratory function and early weaning from mechanical ventilation. We present a case of the use of TNP in neonatal post-sternotomy wound dehiscence and mediastinitis, from a UK perspective, with an emphasis on wound healing and physiological optimisation.

As well as an improvement in sternal wound healing due to the local effects of the TNP system, serial arterial blood gas analysis revealed a significant improvement in systemic physiological parameters, including a reduction in $p\text{CO}_2$ in the period (days 20–31) after application of TNP ($p < 0.0001$) compared to the period before where simple occlusive dressings were applied. Hydrogen ion concentration also significantly reduced in this period ($p = 0.0058$). The use of the TNP system in association with systemic antibiotics successfully treated the mediastinitis. A sealed, controlled wound environment also allowed ease of nursing and an expedited return to care by the parents. We would recommend the consideration of TNP dressings in similar cases of neonatal and paediatric sternal wound dehiscence. Not only do we observe the local effects of improved wound healing, the systemic effects of improved lung function are also valuable in the early management of such complex cases.

KEYWORDS

Topical negative pressure – Sternotomy – Wound – Dehiscence – Physiology

Accepted 10 June 2011; published online 20 December 2011

CORRESPONDENCE TO

Joseph Hardwicke, Department of Plastic Surgery, Birmingham Children's Hospital, Steelhouse Lane, Birmingham B4 6NH, UK
E: hardwickej@doctors.org.uk

Mediastinitis and subsequent wound dehiscence affects less than 1% of children undergoing median sternotomy.^{1,2} The use of topical negative pressure (TNP) dressings for the treatment of adult post-sternotomy wound dehiscence has been reported in the literature.³ It is considered a safe alternative to sterile draping in the cases of wound dehiscence or situations requiring delayed sternal closure (eg reperfusion myocardial oedema, haemodynamic instability, deep-seated infection, refractory bleeding and malignant arrhythmias). To date, limited information about the use of TNP for the treatment of post-sternotomy wound dehiscence in the paediatric population has been published from UK centres.⁴ We present a case of the use of TNP in neonatal post-sternotomy mediastinitis and wound dehiscence, from a UK perspective, with an emphasis on wound healing and physiological optimisation.

Case history

A 3.15kg female was diagnosed antenatally as having tricuspid and pulmonary valve atresia. After a normal vaginal delivery at 37+4 weeks, she underwent echocardiography that showed situs solitus, and tricuspid and pulmonary valve

atresia. Inferior and superior venae cavae drained into the right atrium and there was a right-to-left shunt across a secondary atrial septal defect. She also had mild mitral regurgitation and a large patent ductus arteriosus (PDA) that demonstrated left-to-right flow.

At four days old she underwent PDA ligation, a modified Blalock–Taussig shunt and atrial septectomy. The chest was left open. She subsequently required augmentation of the left pulmonary artery due to progressive narrowing by ductal tissue and mitral valve repair nine days later. The chest was then closed three days after the procedure. At 27 days she developed an isolated perforation of the transverse colon. The colon was repaired with an end-to-end anastomosis with access obtained via an upper abdominal transverse incision. At 46 days she underwent mitral valve repair due to recurrence of severe mitral regurgitation, requiring subsequent replacement at 65 days with delayed closure of the sternotomy wound that later dehiscid after 9 days. This was covered with an occlusive dressing prior to referral to the plastic surgeons (day 74). At this time there was evidence of mediastinitis and systemic sepsis.

Initially, the sternotomy wound was debrided, with removal of sternal wires and application of TNP (VAC®;

Figure 1 The surgically debrided sternotomy wound at time of referral (A), the wound with the topical negative pressure (TNP) dressing in situ (B), the wound after TNP administration (C) and the healed wound (D)

Kinetic Concepts Inc, San Antonio, TX, US), over a Mepitel® interface layer (Mölnlycke Health Care, Gothenburg, Sweden). The TNP (25 mmHg, continuous) was changed every 3–4 days, during which time the patient was weaned off the ventilator and could be handled by her parents and nurses. At day 116 the sternum was rewired and the wound partially closed, with TNP being reapplied. By day 126 the TNP dressings were removed and conventional dressings used until wound closure after 10 days (Fig 1). The wires were removed prior to full healing. A review of the medical case notes was performed and continuous data were analysed with Student’s paired t-test using Prism® version 4.00 (GraphPad Software Inc, La Jolla, CA, US). Statistical significance was considered at a probability of $p<0.05$.

Results

Serial arterial blood gas analysis revealed a significant reduction in $p\text{CO}_2$ in the period (days 20–30) after application of TNP compared to the period before where simple occlusive dressings were applied ($p<0.0001$). Although the reduction was not apparent until 10 days after the application of the TNP, Figure 2 shows a gradual reduction, likely to have been due to the sternal stabilisation offered by the TNP dressing. Hydrogen ion (H^+) concentration also significantly reduced in this period ($p=0.0058$) (Fig 3). pO_2 in this timeframe did not significantly change in response to TNP, nor did the fraction of inspired oxygen (FiO_2) needed to maintain pO_2 . Although base excess was highly variable during the study period (Fig 5), analysis showed that it was significantly increased in response to TNP ($p=0.0012$), which was evident in the period directly after TNP application (days 10–30). There was no significant change in the amount of analgesia or inotropes required in the periods before or after the use of TNP dressings.

Figure 2 The reduction in arterial pCO_2 during the period after topical negative pressure (TNP) application at day 10 (dotted line). There is a significant ($p<0.0001$) reduction in the period during days 20–31 (grey) when compared to the period prior to TNP application. pO_2 remains stable with no improvement in oxygenation.

Figure 3 Arterial hydrogen ion (H^+) concentration significantly reduced after topical negative pressure (TNP) application (dotted line) in the period from days 20–30 (grey) ($p=0.0058$). Base excess was highly variable during the study period; it was significantly increased in response to TNP ($p=0.0012$).

Discussion

The use of TNP for sternal wound dehiscence or mediastinitis in the neonatal population is rare. In this case report, the repeated sternotomies ultimately led to wound breakdown with disruption of the sternum and mediastinitis. Although this is a single case report, the serial analysis of arterial blood gases as a measure of lung function as well as other physiological parameters indicated that TNP can improve ventilation in cases of sternal wound dehiscence where the continuity of the rib cage has been disrupted. Although oxygenation was not improved in this case of congenital heart disease because of intracardiac mixing secondary to the anatomical defect, the reduction in pCO_2 and H^+ in conjunction with an increased base excess was an indicator

of improved pulmonary physiology in response to the TNP dressing versus occlusive dressing alone. The reduction in H^+ concentration may also reflect improvement secondary to the treatment of sepsis.

Conclusions

With the provision of a closed, controlled wound environment, nursing was easier to perform. The formation of maternal and paternal bonds was enhanced by wound stabilisation and the ability of the parents to pick up their child without the worry of causing discomfort. In our case, the TNP did not cause any significant increase in analgesia requirement during TNP administration as has been reported.⁵ With healing occurring by secondary intention, the resultant wound was flat and of small area with good cosmesis.

We would recommend a non-adherent interface dressing and the use of TNP at low negative pressure (25mmHg) with regular monitoring of the TNP canister as a review of the literature has shown evidence of cardiac dysfunction and risk of right ventricular rupture.^{6,7} Although we did not

see any detrimental effect on cardiac function secondary to TNP, we must remain aware of the possible adverse local effects of negative pressure dressings in this situation.

References

1. Ohye RG, Maniker RB, Graves HL *et al*. Primary closure for postoperative mediastinitis in children. *J Thorac Cardiovasc Surg* 2004; **128**: 480–486.
2. Barker GM, O'Brien SM, Welke KF *et al*. Major infection after pediatric cardiac surgery: a risk estimation model. *Ann Thorac Surg* 2010; **89**: 843–850.
3. Agarwal JP, Ogilvie M, Wu LC *et al*. Vacuum-assisted closure for sternal wounds: a first-line therapeutic management approach. *Plast Reconstr Surg* 2005; **116**: 1,035–1,040.
4. Ramnarine IR, McLean A, Pollock JC. Vacuum-assisted closure in the paediatric patient with post-cardiotomy mediastinitis. *Eur J Cardiothorac Surg* 2002; **22**: 1,029–1,031.
5. Ahearn C. Intermittant NPWT and lower negative pressures – exploring the disparity between science and current practice: a review. *Ostomy Wound Manage* 2009; **55**: 22–28.
6. Malmsjö M, Ingemansson R, Sjögren J. Mechanisms governing the effects of vacuum-assisted closure in cardiac surgery. *Plast Reconstr Surg* 2007; **120**: 1,266–1,275.
7. Conquest AM, Garofalo JH, Maziarz DM *et al*. Hemodynamic effects of the vacuum-assisted closure device on open mediastinal wounds. *J Surg Res* 2003; **115**: 209–213.