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The Conundrums of Defect Management in Deep Sternal Wound Infection: Review

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Abstract

Deep Sternal Wound Infection (DWSI) remains an important cause of morbidity and mortality following Cardiac surgery. Equally many methods of preventing it from occurring have been stated however when it does occur, the management by debridement and provision of cover for the defect can be challenging and thus different treatment options are instituted with various degrees of success. The use of Vacuum Assisted Closure therapy was stated as been mere effective in treatment of DSWI with mechanism not known but better used as an adjunct to flaps and with a potential for profuse bleeding. The major advantage in the use of Pectoralis Major Flap was in its bulky size that allows for the cover of defect following sternectomy. However, it had a serious draw back in neonates and infants as the compressive effect on the heart and the distortion of the mammary line and its preclusion in patients with previous radionecrosis and the divergent opinions for further resternontomy. The omental flap has the advantage of provision of cover as may be occasioned by deep defect; in extensive sepsis because of the immunogenic functions and does not lead to deformity but serious complications as the herniation of the transverse colon as an important drawback to its use.

This present review gives the omental flap a slight superior edge over the other two when considering the cover for defect; taking care of local sepsis and resternotomy. However, what is needed now is a multicenter randomised study to determine the option that best suit this condition.

Keywords: Deep sternal wound infection; Omental flap; Muscle flap; Vacuum assisted closure

Introduction

Deep Sternal Wound Infection (DSWI) is a rare but one of the challenging problems that can occur after open heart surgery ,especially with the management of defect; causing prolonged hospitalization, increased hospital costs, and increased morbidity and mortality [1-6]. There have been many novel surgical approaches that are geared toward the provision of adequate covers for the defects, as may occur in many cases; especially after extensive debridement [5-11]. The choice of flaps ranges from the use of muscles to the use of omentum as well as the use of Vacuum assisted wound closure (VAC) as a therapeutic strategy [2,12].

Method

We reviewed the relevant English literature relating to this topic via a MEDLINE and Google scholar search using the following terms: Omental flap and Deep Sternal Wound Infection; Vacuum Assisted Closure and DSWI; Pectoralis major flap and DSWI with no limitations to years of study. Expert opinions were sought in both conceptualizing and the write-up of this work.

The Epidemiology

The incidence of DSWI as reported in the literatures is between 0.2-3.6% [1,13,14] and this can be higher especially when the following risk factors like age, diabetes mellitus, obesity, Hypertension, postoperative mechanical ventilation, and early surgical re-exploration, and some surgical techniques such as double harvest of Internal thoracic artery(ITA) in pedicled fashion ;combined valve and coronary artery bypass graft are adopted [15]. In the preoperative period, parameters like diabetes mellitus, COPD and preoperative renal insufficiency were independent risk factors for postoperative sternal complications [16,17]. The prolonged hospital stay and attended escalated cost as notable morbidities. Mortality rates may vary between 0 to 20% [1,18]. The most causative microbiological agents of SWI are staphylococci species [19]. The incidence of infection caused by Gram-negative bacteria and Mycobacterial species are been seen [1] and fungi is less common [20].

Prevention

The rate of decreases with the adoption of d methicillin-resistant *Staphylococcus aureus* (MRSA) screening, bacterial decolonisation measures, good prophylactic use of antibiotic [1,14]. The other important step in preventing the DSWI is to identify the patients at risk in developing DSWI; Patients with co-morbid conditions like diabetes be properly optimized even before surgery. Diabetes mellitus has been an important risk factor from previous reports. Thus efforts at prevention of DSWI in such patients are of utmost importance. The work done by Furnary et al. [21] in patients with diabetes in which a continuous insulin infusion was used in such patients, the conclusion was that perioperative adoption of that method significantly reduced DSWI [20]. Also, the harvesting of ITA in diabetes, it was observed that the risk of DSWI was minimized in diabetic patients undergoing coronary artery bypass graft surgery by harvesting the ITA in a skeletonized fashion instead of pedicled harvest [21].

Another important mark is the technique of closure of the sternum after sternotomy. This is desirable in other to ensure optimal sternal stability. A retrospective-prospective descriptive and comparative study

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of two sternal closure techniques, divided into: group A, steel band closure and group B, conventional technique closure , a statistically significant difference was found in the frequency of sternal dehiscence between both groups (p=0.022) in favor of group A [22].

In another method of achieving sternal stability, 53 fresh adult human cadaveric sternal plates with adjacent ribs were fixed with specially designed spiked stainless steel clamps and attached to a texture analyzer. Single peristernal and transsternal, alternating single peristernal and transsternal, figure-eight peristernal, figure-eight pericostal, and Robicsek closures using no. 5 stainless steel wires were tested. The bone density, stiffness, and displacement using perpendicular, repetitive variable force loads of 800 the single peristernal and alternating peristernal and transsternal closures proved superior in strength and stability ($p<0.001$). The figure-eight peristernal, then the single transsternal, then the Robicsek were next stablest groups in decreasing order. The figure-eight pericostal closure had the highest failure rate ($p<0.001$) [23]. Equally in another study, it was demonstrated that the number of wires had no influence on sternal complications in entire patient cohort [24]. Generally, in orthopaedic surgeries, rigid bone fixation is the standard of care for all bone reconstructions except that of sternotomy, thus sternal reconstruction after median sternotomy using rigid fixation with plates when compared with sternal wiring with respect to bone healing and reduction in pain and concluded that Sternal reconstruction using rigid fixation with plates improved bone healing and reduced early postoperative pain compared with sternal wiring [25].

Modalities of Managing DSWI

The provision of cover for the defect after debridement in DSWI has been a subject of debate and opinions defer as to what appropriate tissue to use or what treatment modalities to be adopted [4-12,26-31]. This review heightened the ensuing difficulty with the management of this defect.

The use of Vacuum Assisted device Closure (VAC)

The use of the VAC therapy as a definitive closure strategy in the management of DSWI and its defect has been recently reported. However, the approach seemed to be mostly beneficial in reducing dependence on regional flaps such as the muscle or musculocutaneous flaps, or at best, may be used as adjunct for definitive wound closure with flap [4,32]. It was stated as been effective in taking care of DSWI but the mechanism on how it could be achieved was not well elucidated [33]. The therapy was employed to aid wound healing in different areas of the body and equally in sternotomy wounds. The treatment of the sternum in postoperative DSWI enhances sternal preservation and increases the rate of possible rewiring. In using this modality, two separate layers of polyurethane foam are placed to fit between the sternal edges and subcutaneous area with a continuous negative pressure of about 125 mm Hg applied [34]. Prolonged use of the VAC system as a replacement for surgical closure of sternal defect wound appeared to be, viciously, associated with recurrent problems of the sternal wound infection and thus strategic use of it for a short duration followed by early surgical closure is advocated. Furthermore, VAC therapy required specialist supervision by Clinicians with experience and requisite training on the use of the technique [4,27-30].

In a recent report, 34 patients who had VAC therapy for sternal wound infection following cardiac surgery showed that the overall length of hospitalization was 34.6 days (range 9 to 62) which was prolonged and the therapy was solely used as a bridge to definite wound closure [35]. A group of Experts developed clinical guidelines on the practical application of VAC therapy in DSWI; the consensus reached at was that VAC therapy should be instituted early with specialist surgical supervision by clinicians with adequate experience and training in the use of the technique [29]. Beyond the preclusions on the use of VAC, there are fearful complications of profuse bleeding which may occur [31]. Equally, a meta-analysis conducted showed that VAC therapy resulted in a decrease of 7.18 days in hospital length of stay (confidence interval (CI) 95%: 10.82, 3.54), with no significant impact on mortality with the conclusion that there was a robust evidence of the effectiveness of VAC therapy in the management of DSWI [32]. From the aforementioned, the use of VAC therapy was stated as been mere effective in treatment of DSWI with mechanism not known but better used as an adjunct to flaps and with a potential for profuse bleeding.

The use of pectoralis major muscle flap

The review on the use of pectoralis muscle flap (PMF) showed that it was an easy technique, promoted wound healing and covered all of the sternal wound defects without tension and without requiring additional flaps; it produced minimal growth and developmental problems, and may not preclude resternotomy [36,37]. Although the use of muscle flaps was not free of complications, it was an effective and reliable method for the management of patients with complicated cardiothoracic problems [38,39]. That was similarly experiencen in the use of PMF in the treatment of neonates with sternal wound infection, and stated that though the wounds healed successfully but there was the fear on the potential for the disturbance of future breast development especially in female patients. Furthermore the delay in the use of PMF because of myocardiac compression consequent upon postoperative myocardial oedema and small chest cavity in the neonate were all stated as notably drawbacks [6,35]. And in small infants the pectoralis muscle can be thin and inadequate for the cover of large sternal defects [32]. There have also been flap dehiscence, persistent infection and even mortality with the use of PMF, and the unalloyed fear of reoperation for repeated cardiac surgeries in the patients [30] in contrary to an previously stated as non preclusion for resternotomy [36]. However its use with subsequent quality of life assessments of those patients showed no significant limitations but a disturbed sleep pattern with mild restriction of executing hobbies and social activities [31]. In another review, the experience with the treated 54 patients with complicated cardiothoracic problems by reconstruction with pedicled myocutaneous or muscle flaps showed that chest wall with multiple scars from previous procedures, limited the use of the pectoralis muscle; the use of PMF does not require skin grafting and the combination of immunocompetent bulky muscle tissue used to obliterate the sternal cavity [40].

The major advantage in the use of PMF is in its bulky size that allows for the cover of defect following sternectomy. However, it also had serious draw back in neonates and infants as the compressive effect on the heart and the distortion of the mammary line and its preclusion in patients with previous radionecrosis and the divergent opinions for further resternontomy.

The use of omental flap

In a heterotopic location, the omentum still could continue its peritoneal role and thus will be useful in the treatment of cavitationally infected as well as broken-down irradiated wounds [7]. The various uses of omental flap were for suppurative and radionecrotic wound; to complement muscle flap, or to cover chest wall prosthesis, and when used to treat post-sternotomy mediastinitis after cardiac surgery as, in this situation, the omental flap improves control of infection and prognosis of the patient [7,8,35].

The use of the omental flap was noted as having a superior impact in situations that requires tackling local sepsis especially in diabetes who are prone to such. One study noted a higher failure rate especially in diabetes when muscle flap was use, which subsequently necessitated the use of omental flap in such patients and another; reported a high mortality rate of 14% in patients in whom pectoralis major muscle flap was used in treatment and also stated that raising of pectoralis muscle flap in radionecrosis can be difficult if not impossible [7]. In a 3-year review of 25 patients who underwent transposition of the greater omentum, either alone or in combination with muscle flaps, for treatment of recalcitrant DSWI with most of the patients undergoing radical sternectomy for extensive sternal wounds; the outcome was good when omental flap was used [7]. The advantage of using omentum comes to fore again even when the need for reoperation in a patient who had previous DSWI and had omental flap done. Even in complex cardiac surgery e.g. cardiac retransplantation, absence of significant thick scar and calcification within the retrosternal space may be a good indicator that the procedure can be safely performed without injury to underlying structure [32]. Also, in a different account, it was observed that omental flap can be used in the management of sternal wound infection even after heart transplant and there was no fear of it contraindicating subsequent reoperations in these patients [41,42]. There was the fear of infection spreading to the abdomen with resulting peritonitis with the use of omental flap in sternal wound infection, but this is quite rare [43,44]. There may also be gastric ileus after surgery but it resolves with time also the complication of epigastric hernia [32] is not a too much of a threat than the possibility of tube in VAC eroding into the heart or the necrosis of the medial portion pectoralis major flap or the overlying skin failure [33,45]. A systemic review using 333 citations which focused on publications from single institutions with experience with both types of flap in the treatment of DSWI covering 1046 patients, the conclusion was that the weight of the evidence was insufficient to prove the superiority of reconstruction with Muscle flap to a laparotomy-harvested, over omental flap in the treatment of DSWI and also suggested that use of the omentum may be associated with lower mortality and fewer complications [46]. The limitation to the use of omental flap in patients severe low cardiac output or malnutrition as it may compressing the heart and have attenuated immunogenic properties [46]. The use of omental flap was precluded in patients who may be having peritoneal dialysis and the use of pectoralis major was a difficult technique in neonates and the haemodynamic conditions were poor in the cases they reviewed [30]. An important but rare complication is the transverse colon herniation into the anterior mediastinum that required emergency exploration and colon resection as reported by Halldorsson et al. [45] in a 59-year-old man who developed a DSWI after an emergency cardiac surgery. Omental flap transposition was used to cover the sternal defect and several days later, the patient developed a transverse colon herniation into the anterior mediastinum that required emergency exploration and colon resection. In recent reviews; findings in the treatment of High risk patients such as diabetic or Hypertensive; Stump et al. [9] observed that diabetic patients who were treated with omental flap were 5.4 times less likely to require reoperation for sternal wound management than were patients in whom PMF were used for treatment [8]. The authors more recent findings furthermore showed that the omental flap offered good surgical outcome when used in a diabetic and hypertensive patient with suppurating wound and thereby concluded that the use of omental flap was an effective surgical option in dealing with this condition.

The omental flap has the advantage of provision of cover as may be occasioned by deep defect; in extensive sepsis because of the immunogenic functions and does not lead to deformity but serious complications as the herniation of the transverse colon will severe as an important drawback to its use.

Conclusion

This present review gives the omental flap a slight superior edge over the other two when considering the cover for defect; taking care of local sepsis and resternotomy. However, what is needed now is a multicenter randomized study to determine the option that best suit this condition.

References

1. Okonta K E, Anbarasu M, Agarwal V, Jamesraj J, kurian VM, et al. (2011) Sternal wound infection: appraisal of incidence, risk factors, changing bacteriologic pattern and treatment outcome. Indian J Thorac Cardiovasc Surg 27: 28-32.
2. Okonta KE, Rajan S (2011) Re-exploration after open Heart Surgery at Madras Medical Mission, Chennai. India J West Afr Coll Surg 2: 1-17.
3. Okonta KE (2012) eComment. The cheaper and efficient methods of prevention of deep sternal wound infection. Interact Cardiovasc Thorac Surg 15: 222-223.
4. Simek M, Nemec P, Zalesak B, Kalab M, Hajek R, et al. (2007) Vacuum-assisted closure in the treatment of sternal wound infection after cardiac surgery. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub 151: 295-299.
5. Erez E, Katz M, Sharoni E, Katz Y, Leviav A, et al. (2000) Pectoralis major muscle flap for deep sternal wound infection in neonates. Ann Thorac Surg 69: 572-577.
6. Jurkiewicz MJ, Nahai F (1982) The omentum: its use as a free vascularized graft for reconstruction of the head and neck. Ann Surg 195: 756-765.
7. Weinzweig N, Yetman R (1995) Transposition of the greater omentum for recalcitrant median sternotomy wound infections. Ann Plast Surg 34:471-477.
8. Stump A, Bedri M, Goldberg NH, Slezak S, Silverman RP (2010) Omental transposition flap for sternal wound reconstruction in diabetic patients. Ann Plast Surg 65: 206-210.
9. Arnold PG, Pairolero PC (1979) Use of pectoralis major muscle flaps to repair defects of anterior chest wall. Plast Reconstr Surg 63: 205-213.
10. Nahai F, Morales L Jr, Bone DK, Bostwick J 3rd (1982) Pectoralis major muscle turnover flaps for closure of the infected sternotomy wound with preservation of form and function. Plast Reconstr Surg 70: 471-474.
11. Salehi Omran A, Karimi A, Ahmadi SH, Davoodi S, Marzban M, et al. (2007) Superficial and deep sternal wound infection after more than 9000 coronary artery bypass graft (CABG): incidence, risk factors and mortality. BMC Infect Dis 7: 112.
12. Argenta LC, Morykwas MJ, Marks MW, DeFranzo AJ, Molnar JA, et al. (2006) Vacuum-assisted closure: state of clinic art. Plast Reconstr Surg 117: 127S-142S.
13. Lucet JC; Parisian Mediastinitis Study Group (2006) Surgical site infection after cardiac surgery: a simplified surveillance method. Infect Control Hosp Epidemiol 27: 1393-1396.
14. Graf K, Sohr D, Haverich A, Kühn C, Gastmeier P, et al. (2009) Decrease of deep sternal surgical site infection rates after cardiac surgery by a comprehensive infection control program. Interact Cardiovasc Thorac Surg 9: 282-286.
15. Filsoufi F, Castillo JG, Rahmanian PB, Broumand SR, Silvay G, et al. (2009) Epidemiology of deep sternal wound infection in cardiac surgery. J Cardiothorac Vasc Anesth 23: 488-494.
16. Coskun D, Aytac J, Aydinli A, Bayer A (2005) Mortality rate, length of stay and extra cost of sternal surgical site infections following coronary artery bypass grafting in a private medical centre in Turkey. J Hosp Infect 60: 176-179.
17. Koziol M, Koziol-Montewka M, Stazka J, Tanrgonka S (2012) Sternal wound infection after cardiac Surgery.SEPSIS 5:105-111
18. Furnary AP, Zerr KJ, Grunkemeier GL, Starr A (1999) Continuous intravenous insulin infusion reduces the incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedures. Ann Thorac Surg 67: 352-360.
19. Deo SV, Shah IK, Dunlay SM, Erwin PJ, Locker C, et al. (2013) Bilateral internal thoracic artery harvest and deep sternal wound infection in diabetic patients. Ann Thorac Surg 95: 862-869.

20. Franco S, Herrera AM, Atehortúa M, Vélez L, Botero J, et al. (2009) Use of steel bands in sternotomy closure: implications in high-risk cardiac surgical population. Interact Cardiovasc Thorac Surg 8: 200-205.

21. Losanoff JE, Collier AD, Wagner-Mann CC, Richman BW, Huff H, et al. (2004) Biomechanical comparison of median sternotomy closures. Ann Thorac Surg 77: 203-209.

22. Kamiya H, Al-maisary SS, Akhyari P, Ruhparwar A, Kallenbach K, et al. (2012) The number of wires for sternal closure has a significant influence on sternal complications in high-risk patients. Interact Cardiovasc Thorac Surg 15: 665-670.

23. Raman J, Lehmann S, Zehr K, De Guzman BJ, Aklog L, et al. (2012) Sternal closure with rigid plate fixation versus wire closure: a randomized controlled multicenter trial. Ann Thorac Surg 94: 1854-1861.

24. Scholl L, Chang E, Reitz B, Chang J (2004) Sternal osteomyelitis: use of vacuum-assisted closure device as an adjunct to definitive closure with sternectomy and muscle flap reconstruction. J Card Surg 19: 453-461.

25. Bapat V, El-Muttardi N, Young C, Venn G, Roxburgh J (2008) Experience with Vacuum-assisted closure of sternal wound infections following cardiac surgery and evaluation of chronic complications associated with its use. J Card Surg 23: 227-233.

26. Fleck T, Gustafsson R, Harding K, Ingemansson R, Lirtzman MD, Meites HL, et al. (2006) The management of deep sternal wound infections using vacuum assisted closure (V.A.C.) therapy. Int Wound J 3:273-80.

27. Salazard B, Niddam J, Ghez O, Metras D, Magalon G (2008) Vacuum-assisted closure in the treatment of poststernotomy mediastinitis in the paediatric patient. J Plast Reconstr Aesthet Surg 61: 302-305.

28. van Wingerden JJ, Segers P, Jekel L (2011) Major bleeding during negative pressure wound/V.A.C.®--therapy for postsurgical deep sternal wound infection--a critical appraisal. J Cardiothorac Surg 6: 121.

29. Damiani G, Pinnarelli L, Sommella L, Tocco MP, Marvulli M, et al. (2011) Vacuum-assisted closure therapy for patients with infected sternal wounds: a meta-analysis of current evidence. J Plast Reconstr Aesthet Surg 64: 1119-1123.

30. Sjögren J, Malmsjö M, Gustafsson R, Ingemansson R (2006) Poststernotomy mediastinitis: a review of conventional surgical treatments, vacuum-assisted closure therapy and presentation of the Lund University Hospital mediastinitis algorithm. Eur J Cardiothorac Surg 30: 898-905.

31. Gustafsson RI, Sjögren J, Ingemansson R (2003) Deep sternal wound infection: a sternal-sparing technique with vacuum-assisted closure therapy. Ann Thorac Surg 76: 2048-2053.

32. Ortak T, Uraloglu M, Uysal AC, Orbay H, Tekin F, et al. (2008) Reconstruction of sternal defects with pectoralis major muscle flap. Eur. J Plast. Surg 5:223-228

33. Sung K, Jun TG, Park PW, Park KH, Lee YT, et al. (2004) Management of deep sternal infection in infants and children with advanced pectoralis major muscle flaps. Ann Thorac Surg 77: 1371-1375.

34. Klesius AA, Dzemali O, Simon A, Kleine P, Abdel-Rahman U, et al. (2004) Successful treatment of deep sternal infections following open heart surgery by bilateral pectoralis major flaps. Eur J Cardiothorac Surg 25: 218-223.

35. Dosios T, Papadopoulos O, Mantas D, Georgiou P, Asimacopoulos P (2003) Pedicled myocutaneous and muscle flaps in the management of complicated cardiothoracic problems. Scand J Plast Reconstr Surg Hand Surg 37: 220-224.

36. Grant RT, Breitbart AS, Parnell V (1997) Muscle flap reconstruction of pediatric poststernotomy wound infections. Ann Plast Surg 38: 365-370.

37. Quiroga Martínez J, Gualis Cardona J, Gregorio Crespo B, Cabanyes Candela S, Cilleruelo Ramos A, et al. (2008) [Utility of omentoplasty for poststernotomy mediastinitis secondary to myocardial revascularization surgery]. Arch Bronconeumol 44: 113-115.

38. Simunovic F, Koulaxouzidis G, Stark GB, Torio-Padron N (2013) Infraareolar pectoralis major myocutaneous island flap as treatment of first choice for deep sternal wound infection. J Plast Reconstr Aesthet Surg 66: 187-192.

39. Castedo E, Cañas A, Varela A, Ugarte J (2001) Does omentoplasty preclude cardiac retransplantation? Chest 120: 1425-1426.

40. Frimpong-Boateng K, Warnecke H, Schüler S, Haverich A, Borst HG (1986) Transposition of the greater omentum for management of mediastinal infection following orthotopic heart transplantation: a case report. J Heart Transplant 5: 330-331.

41. Wornom IL 3rd, Maragh H, Pozez A, Guerraty AJ (1995) Use of the omentum in the management of sternal wound infection after cardiac transplantation. Plast Reconstr Surg 95: 697-702.

42. Yasuura K, Okamoto H, Morita S, Ogawa Y, Sawazaki M, et al. (1998) Results of omental flap transposition for deep sternal wound infection after cardiovascular surgery. Ann Surg 227: 455-459.

43. van Wingerden JJ, Lapid O, Boonstra PW, de Mol BA (2011) Muscle flaps or omental flap in the management of deep sternal wound infection. Interact Cardiovasc Thorac Surg 13: 179-187.

44. Chittithavorn V, Rergkliang C, Chetpaophan A, Simapattanapong T (2011) Single-stage omental flap transposition: modality of an effective treatment for deep sternal wound infection. Interact Cardiovasc Thorac Surg 12: 982-986.

45. Halldorsson A, Meyerrose G, Griswold J (2007) Anterior mediastinal herniation of the transverse colon after an omental flap transposition. Am Surg 73: 367-370.

46. Okonta KE, Anbarasu M (2012) Omentoplasty as an effective surgical modality for managing a high risk patient with deep sternal wound infection. Niger J Clin Pract 15: 481-483.