Skin Adhesive Tapes are an effective wound closure method for Percutaneous Vertebral Body Stenting, A Retrospective Cohort Study

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Research Article

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Abstract

Background:

Percutaneous Vertebral Body Stenting (VBS) is performed via a balloon-expandable metallic stent introduced through a stab incision to reduce and maintain the reduction of vertebral body fractures and minimise bone cement extravasation. The delivery of the balloon and stent involves a larger skin incision, soft tissue trauma and pedicle bore tract compared to traditional vertebroplasty (PVP) systems (4.7mm vs 2.59mm diameter), thus increasing the risk of bleeding and wound complications. Skin Adhesive Tapes (SATs) are a common method of wound closure for PVP. This study aims to evaluate the use of SATs in closure of larger VBS wounds.

Methods:

A retrospective cohort of patients who underwent percutaneous VBS (DePuy Synthes, USA) was obtained from electronic medical records at a tertiary hospital from May 2019 to March 2021. Data was collected for wound closure method (conventional non-absorbable suture, SAT), number of operative levels, postoperative skin-related complications, wound dehiscence, wound infection, bleeding, symptomatic haematomas and return to operating theatre. At follow-up post-discharge, the wounds were reviewed for complete healing and unsightly scarring requiring wound revision. SAT closure was performed by applying 3 strips of SATs to loosely oppose the wound edges.

Results:

36 patients were identified with 45 levels of VBS performed. 3 (8.3%) patients received conventional suture closure, 33 (91.6%) received SAT closure. Conventional suture closure was performed due to ongoing bleeding at the wound site for 2 patients who had coagulopathy. The remaining patient received a planned suture closure in view of surgical expediency as part of a staged procedure.

Introduction

Vertebral compression fractures (VCF) arise due to various aetiologies including osteoporosis, osteolytic metastasis and multiple myeloma. These VCFs may be treated with infiltration of cancellous bone with polymethyl methacrylate (PMMA) bone cement to stabilise the fracture site and provide pain relief. The first generation of percutaneous vertebroplasty (PVP) was developed in 1987 [1], with the injection of bone cement into the vertebral body via a percutaneously inserted cannula under pressure. The pressure on the bone cement would cause interdigitation of porous channels between the cancellous trabeculae to provide pain relief and prevent further collapse. Limitations inherent to PVP are cement leaks caused by cement pressurisation [2, 3] and the presence of large open vascular channels [4]. PVP is also unable to
actively reduce vertebral body kyphosis, leading to an increased risk of adjacent segment fractures due to altered spinal biomechanics and alignment [5].

Balloon kyphoplasty (BKP) introduced 1998, addressed the deficiencies of PVP. This utilised a percutaneously placed inflatable balloon to both reduce the fracture site, restore spinal alignment, and create a low pressure void to allow for a more viscous bone cement mixture to flow under much lower pressure [6]. This succeeded in improving spinal alignment and reducing bone cement leakage [7].

Vertebral Body Stenting (Synthes, Oberdorf, Switzerland) (VBS), introduced in 2010 [8] refined BKP by adding a metallic stent to be expanded and deployed by an inflatable balloon within the fractured vertebral body. After the balloon was deflated and retrieved, the stent would effectively maintain fracture reduction and reduce the loss of vertebral body height after the momentary absence of support prior to cementation [9] (Fig. 1).

The evolution of vertebral body cementing techniques from PVP to VBS Stentoplasty is of improved fracture reduction, maintenance of vertebral height and reduced cement leakage rates at the tradeoff of requiring increased hardware being introduced to the fracture site. As a highly minimally invasive procedure with small incisions, PVP wounds can be closed with Skin Adhesive Tapes (SATs) alone. Compared to PVP cannulas, the VBS access kit requires a working sleeve of 4.7mm in diameter as opposed to 2.59mm. This 330% increase in surface area is necessary to accommodate both the metallic stent and inflatable balloon for deployment. In addition, the implantation of metal stents demands precise placement of the access kit compared to the larger and more forgiving target area for cement portal placement in PVP. VBS stentoplasty thus requires larger skin incisions, causes greater soft tissue trauma and generates a bigger pedicle bore tract with exposed cancellous bone. These factors increase the risk of bleeding and wound complications.

SATs are a common modality of wound closure, having the capacity to provide mechanical and strangulation-free support for wounds. It opposes the superficial wound edges with minimal tension, providing similar tensile strength as skin sutures while maintaining epidermal integrity [10]. They are typically used in conjunction with subdermal or subcuticular sutures in larger wounds but have shown reasonable reliability when used in isolation on lacerations or smaller surgical incisions. Compared to conventional suture closure, SATs have been found to deliver comparable [11] or better cosmetic results, and require less time for closure [12]. Complications associated with SATs are rare but include contact dermatitis, tension blisters, tape dislodgement, wound dehiscence and wound infection [13]. This study aims to evaluate the effectiveness, safety and cosmesis of skin adhesive tapes in the closure of VBS Stentoplasty wounds.

**Methods**

**Surgical Technique for Transpedicular VBS Stentoplasty and subsequent closure**
Patients are sedated and positioned prone on a radiopaque surgical table. After surgical cleansing and draping, radiopaque markers are placed approximately 3–4 cm paramedian to the affected surgical level to localise the target pedicles by intraoperative radiography. Marcaine and adrenaline is infiltrated along the planned cannula tracts and to the periosteum surrounding the pedicle entry site. Stab incisions of approximately 1.5–2 cm are made. A guidewire is inserted through the skin incisions, across the pedicles and into the vertebral body guided by sequential radiographs. Adjustments to the final positions of the guidewires can be made by stretching the surrounding soft tissue envelope at the expense of tissue trauma.

A working sleeve is advanced over the guidewire and the guidewire removed. A drill is passed into the working sleeve to create an access channel which is tamped down with a blunt plunger. The VBS stent size is templated according to markings on the blunt plunger.

The bilateral VBS stents and inflation balloons are inserted into the vertebral body through the working sleeve. They are subsequently inflated with contrast-saline via a hand held pump with an integrated pressure gauge. Balloon inflation with stent expansion is performed in a bilateral and symmetrical fashion until there is adequate fracture reduction, or if a pressure of 30 atmospheres and/or the maximum height of the metal stent (Small: 15mm - Large: 17mm) is reached. Both balloons are then deflated and retrieved, leaving the expanded VBS stents to maintain the reduction. An injection needle is placed into the working sleeve and PMMA bone cement is subsequently injected to produce a stent-reinforced cement implant within the treated vertebral body (Fig. 2). The wound is irrigated with normal saline. If remnant bleeding is noted from the wound, manual pressure is applied for approximately 30 seconds before closure with SATs. If bleeding fails to stop after manual compression, the wound is closed with simple interrupted prolene sutures and dressed with non adherent waterproof dressings.

For suitable wounds, 3 SATs are applied to each incision in an overlapping fashion (Fig. 3). Non-adherent waterproof dressings are applied above the SATs (Fig. 4). The majority of the SATs are removed at the first dressing change, 3 days after surgery. Dry dressings are then continued until sufficient epithelization for the wound to be exposed. This typically occurs within 7 days. In the rare event that wounds continue to gape, SATs are reapplied until wound healing has progressed further.

**Data collection:**

A retrospective cohort of patients was obtained from electronic medical records. Collection of data was obtained under Institutional Review Board waiver. Data was anonymised and keyed into an electronic spreadsheet (Microsoft, Inc., USA). The inclusion criteria included all patients who underwent VBS Stentoplasty (DePuy Synthes, USA) at a tertiary hospital from May 2019 to March 2021. Only patients operated on by either of two surgeons who practised the surgical technique described were included.

Data was collected for patient biodata, number of operative levels, wound closure method, and postoperative skin-related wound complications: contact dermatitis, tape dislodgement, tension blisters, wound dehiscence, wound infection, postoperative bleeding, and return to operating theatre. Risk factors
for poor postoperative outcomes including wound site dehiscence and infection were recorded according to the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP®)

At clinic follow-up post-discharge, the wounds were also reviewed for complete healing and unsightly scarring requiring wound revision.

**Results**

36 patients were identified with a total of 45 levels of VBS stentoplasty performed. 3 (8.3%) patients received primary closure with non-absorbable sutures while 33 (91.6%) received SAT closure. Within the patients who received SAT closure, 27 (81.8%) had at least 1 risk factor for wound dehiscence including steroid use for chronic conditions (n = 4, 12.1%), disseminated cancer (n = 5, 15.1%), diabetes mellitus (n = 7, 21.1%), hypertension requiring medication (n = 18, 54.6%) and dialysis (n = 1, 3.03%)

Among patients whose wounds required conventional primary sutures, 2 of these patients had ongoing bleeding at the wound site at the end of the procedure. This was attributed to underlying coagulopathy, as one patient had perioperative aspirin use while the other had severe thrombocytopenia due to underlying bone marrow disease. The remaining 1 patient had VBS stentoplasty performed as part of a staged procedure. The primary suture closure was performed to accommodate an intra-theatre positional change from prone to supine on traction table for a femoral intramedullary nail insertion.

32 (97.0%) patients received SAT closure without any early complications of contact dermatitis, tension blisters, tape dislodgement, wound dehiscence, wound infection and return to theatre. 1 (3.0%) patient developed blood soaked dressings that required early removal and reapplication of the SATs at the ward a day later with uneventful recovery thereafter. (Fig. 5) All patients with SAT closure had complete wound healing at outpatient follow up with adequate cosmetic outcome, without the need for wound revision. (Fig. 6)
Table 1
Demographics and biodata of patients

<table>
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<tr>
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<tr>
<td>Indian</td>
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<td>3</td>
</tr>
<tr>
<td>Others</td>
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<td>3</td>
</tr>
<tr>
<td>BMI</td>
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<td></td>
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<td>&lt; 18.5</td>
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<td>18.5 to 24.9</td>
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Table 2
Risk factors for wound dehiscence

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<th>Whole sample</th>
<th>SAT</th>
<th>Primary closure</th>
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<tr>
<td></td>
<td>n = 36</td>
<td>n = 33</td>
<td>n = 3</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
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<td>Steroid use for chronic conditions</td>
<td>4</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Systemic sepsis &lt; 48 hours prior to surgery</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Ventilator dependent</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Disseminated cancer</td>
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<td>16.67</td>
<td>5</td>
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<tr>
<td>Diabetes</td>
<td>7</td>
<td>19.44</td>
<td>7</td>
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<tr>
<td>Hypertension requiring medication</td>
<td>18</td>
<td>50.00</td>
<td>18</td>
</tr>
<tr>
<td>CHF &lt; 30 days prior to surgery</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Dyspnoea</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Current smoker &lt; 1 year prior to surgery</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>History of severe COPD</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Dialysis</td>
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<td>2.78</td>
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<tr>
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Discussion

Compared to skin sutures and staples, SATS are an easy to apply and non-invasive method of skin closure. SATs eliminate the risk of introducing skin infections via the suture needle or suture material, avoids scarring associated with suture/staple entry and exit sites and wound strangulation. SATS are faster to apply than conventional skin sutures and can save 1.5 to 3.5 minutes of operating time per patient compared to skin sutures [14]. Due to its ease of application, it may also be applied in the ward setting, as shown in the one patient in this study with a soaked dressing. It also does not require a removal of stitches or staples, which reduces outpatient time and cost [15].

Limitations to SAT closure include long, deep or gaping wounds as well as wounds located at areas of high movement, such as those overlying joints. This is due to the relatively lower amounts of tissue and skin support provided by SATs. In addition, bleeding or oozy wounds introduce moisture at the site of tape adhesion which can lead to easy dislodgement. For wounds which exhibit mild bleeding, sutures still provide an additional hemostatic advantage for the avoidance of haematoma formation.
VBS wounds are short but deep, and located over the thoracolumbar spine that is an area under tension and subject to friction. They have a potential to continue bleeding from exposed cancellous bone surfaces and traumatised muscle. Compared to PVP, the VBS skin incision has an increase in length of 50–100% (1.5–2 cm vs 1 cm). Nonetheless, a low rate of conversion to primary sutures was observed 5.7% (n = 2). In this study, these patients had risk factors for coagulopathy which could account for the lack of wound site hemostasis after gentle pressure. One patient had blood soaked wounds on postoperative day 1, and while initially concerning, the removal of soaked SATs and re-application of new SATs in the ward under mild manual pressure appeared sufficient in controlling the bleeding and providing wound closure. A return to the operating theatre or conversion to primary sutures for wound closure and haemostasis was avoided. This study demonstrates that SATs are effective, safe and produce acceptable cosmetic results in the primary wound closure for VBS wounds. This has been demonstrated in a cohort where the majority of patients (81.2%) had at least 1 risk factor for wound dehiscence.

Despite the overall positive results, the authors advise caution on the use of SATs in patients with bleeding diathesis, such as a background of malignancy, anticoagulant use or liver disease. The superficial means of skin apposition may not be suitable to provide adequate pressure for haemostasis, especially at deeper layers.

**Conclusion**

SATs are a simple, safe and effective means of wound closure for the majority of percutaneous VBS procedures. Conversion to primary suture closure due to continued wound site bleeding is rarely required.

**Declarations**

The authors declare that this is an independent original study.

Funding – Not applicable. There are no financial disclosures.

The authors declare that they have no conflicts of interest.

Ethical waiver was granted concordance with regulations established by our institution's Centralised Institutional Review Board (CIRB).

Consent for publication of images were obtained from relevant patients prior to publication.

OYYH and SCCR conceived the idea and edited the manuscript. YC took the lead in writing the manuscript. QT collected the data. All authors read and approved the final manuscript.

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Figures
Figure 1

a) Pre-operative and b) Post-operative VBS correction of kyphosis
Figure 2

a) Anterior-Posterior View, b) Lateral View of Intraoperative VBS Insertion prior to cement implantation

Figure 3

SAT closure of VBS wounds in stellate pattern

Figure 4
Non-adherent dressing applied over SATs

Patients undergoing stentoplasty

Planned for closure with Skin Adhesive Tapes (SATs)

Planned for primary suture closure*

Converted to primary suture closure^  

Closed with Skin Adhesive Tapes

Primary suture closure

No further wound related complications  

Post-operative day 1 dressing change

*As part of multi-staged surgery  
^Due to poor wound site hemostasis

Figure 5

Flowchart of interventions
Figure 6

Typical appearance of post-VBS wound closed by SAT at 6 weeks