A novel use of cement as a salvage procedure in patients with complex spinal injuries with proximal junctional failure

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ABSTRACT

Long-construct fixations can be complicated by proximal junctional kyphosis. In elderly, high-risk patients with numerous comorbidities, lengthy surgical times and increased blood loss associated with revision osteotomies and extension of fusions are not often tolerated and pose serious life-threatening risks. We present a salvage technique used in a patient with proximal junctional failure and demonstrate its role in improving symptoms and functionality in those not deemed fit for major surgery. Pre- and postoperative pain scores in accordance with the visual analogue scale, walking distances and radiographs were reviewed in a patient who underwent the salvage technique to ascertain the subjective and objective difference in pain and functionality. The patient showed marked improvement in pain scores and walking distances postoperatively. Additionally, the degree of proximal junctional kyphosis was lower on postoperative radiographs. While holding risks of its own, our described technique can be performed in select cases and is a good salvage procedure in high-risk patients. It prevents their exposure to the risks that accompany large revision operations and fusion models with further potential to fail. We recommend that our technique is performed only at specialist centres.

KEYWORDS

Proximal junctional kyphosis – Salvage procedure – Kyphoplasty – Vertebroplasty – Cement

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Introduction

Polymethylmethacrylate, also known as bone cement, was first employed in orthopaedic surgery almost 70 years ago.^{1,2} Its enduring material and unique properties has enabled it to play a central role in arthroplasty surgery. More recently, it has revolutionised percutaneous spinal procedures and is readily used during kyphoplasty and vertebroplasty.³ Cement has often been used in the vertebral body at the most proximal instrumented level in a bid to prevent proximal junctional failure and fractures at the bone–screw interface. It has also been used in the vertebral body above a long-construct fixation to stop this level failing secondary to the increased mechanical stiffness generated below.^{4,5} A case of prophylactic stabilisation of vertebral body metastasis at risk of imminent fracture using balloon kyphoplasty has also been described;⁶ however, the application of cement to an upper instrumented vertebral body, its superior intervertebral disc and vertebral body above as a salvage procedure has never been reported.

In reporting this case of a patient with a complex spine injury, we aim to highlight a novel technique that can be used as a salvage procedure to prevent patients from being exposed to further large and high-risk revision operations.

Case history

A 63-year-old woman with rheumatoid arthritis had multiple instrumented procedures to her lumbar spine, starting with an initial L4–S1 instrumented fusion for spondylolisthesis with a subsequent L2 pedicle subtraction osteotomy and T11–L5 instrumented fusion. Following this treatment, she presented to us with a significant degree of thoracolumbar pain, which she described as ‘intolerable’, localised to the site of her proximal junctional kyphosis (Table 1). Her walking distance was limited to 150 metres and her standing time to less than five minutes, all of which detrimentally impacted her quality of life.

Investigation with serial radiographs demonstrated deterioration in proximal junctional failure (Fig 1). Subsequent investigations with magnetic resonance imaging, dual energy x-ray absorptiometry and Single-photon emission computed tomography (Fig 2) demonstrated increased activity at the T11 level. The top end screw was seen penetrating the disc space and abutting the inferior endplate of the level above the instrumentation.

The risks and benefits of potential revision deformity corrections were discussed with the patient. Revision surgery would have involved a revision osteotomy, being particularly

Table 1 Patient pain scores.

Questionnaire	Preoperative	Postoperative			Comments
		6 weeks	6 months	12 months	
EQ-5D (%)	23	69	74	74	
EQ-5D VAS (%)	29	70	65	44	Mainly due to lower back pain and large inguinal hernia
ODI	62	24	20	12	
SRS22	2.4	4.1	4.0	3.6	
VAS back	10/10	1/10	1/10	1/10	
VAS leg	0/10	1/10	5/10	6/10	Not related to the thoracic spine

ODI, Oswestry Disability Index; SRS, Scoliosis Research Society; VAS, Visual Analogue Scale.

Figure 1 Progressive proximal junctional failure one year apart

difficult with the canal having been encroached once previously. Additionally, with the patient's comorbidities and increased risk for further failure, plus significant functional restrictions and limitations associated with T2 to pelvis instrumentation, it was decided major surgery of this nature was not a favourable option. Conservative measures in the way of lifelong bracing were also explored and excluded due to issues with poor skin.

In view of her tremendous pain but extremely limited surgical options, the patient underwent a kyphoplasty at T10 and T11 including cement injection into the T10/11 disc space, which we considered to be a salvage procedure. The key to this technique is to get a continuum of cement flowing through the upper instrumented vertebral level up proximally into the disc and into the vertebral body above. Three cannulae are therefore required: one into the disc, one into the vertebral body above the instrumentation and one into the upper instrumented level (Fig 3). The aim is to pierce the endplates with the trochars to ensure that the cement flows across the motion segment providing a continuum of

Figure 2 Single photon emission computed tomography/computed tomography of patient's thoracolumbar spine with intense uptake in T11 and anterior wedging

cement as opposed to all cement injections acting independently. An O-arm was deployed to aid the passage of cement past the screws and to accurately ensure its adequate placement in the upper instrumented level.

In the prone position, lordosis is maximised, thus creating space for cement to be injected. With cement being an ideal material in withstanding compression, it is able to tolerate the patient's body weight on standing and, as a result, the deformity was lessened. Again, instrumenting this patient over a much longer distance would have been technically difficult given her poor bone quality secondary to age. Creating a fusion mass in very poor bone is fraught with potential complications and failure. Additionally, cement has shown to be a very good accommodator of osteoporotic bone and has been a treatment for many years of osteoporotic fractures and also fractures related to tumours.

Figure 4 illustrates not only an arrested development of proximal junctional kyphosis but also an improvement in the patient, taken at the twelfth postoperative month. As illustrated by Table 1, her clinical function significantly improved, as did her back-pain score. She was able to return to recreational walking and her pain initially recorded on the visual analogue scale as nine was down to less than one. Unfortunately, she did go on to deteriorate at the one-year mark, but this was secondary to a large symptomatic inguinal hernia and radiculopathy associated with her lumbar spine. Her visual analogue scale back score at the one-year mark maintained a score of 1/10.

Discussion

Many patients with similar scenarios to those highlighted in this paper are either elderly with multiple comorbidities

or with a diagnosis of myeloma. They are typically osteoporotic and tend to have bad sagittal malalignment since previous instrumentation has already failed. They therefore require salvage procedures to accommodate metalwork already put into their spine. Normally they would require a pedicle subtraction osteotomy to correct their overall balance and a fixation extended to a much higher level. This in turn would create a further fusion model with the potential to fail.

Our technique essentially allows the patient's current position to be accommodated and not to act as a fusion model. Cement is very good in axial compression.⁷ If it can be placed in the most proximal instrumented level, one is able to strengthen the remaining vertebral body and accommodate the failure that has occurred. By placing cement into the disc above and also into the vertebral body above the upper instrumented level via our described technique, the cement can act as a conduit between this motion segment, which is also at risk of failure as demonstrated by our patient, where the top end screw is seen penetrating the disc space and abutting the inferior end plate of the level above the instrumentation.

Revision surgery for patients similar to the one we describe is an extremely high risk procedure. They have already experienced mechanical failure once and with the risk of metalwork failure following adult deformity surgery reported at 37–40%, further failure is very likely.^{8,9} Additionally, the perioperative risk of motor abnormality following complex adult spinal deformity surgery is reported to

Figure 3 Intraoperative technique with three trochars, one penetrating the intervertebral disc and inferior endplate of the vertebral body proximal to instrumentation to create a continuum of cement

Figure 4 Twelve-month postoperative radiograph illustrating improvement and arrest of further proximal junctional failure

be as high at 26% and considering that our patients would be having a revision of their complex adult spinal deformity surgery, their risk is likely to be significantly higher.¹⁰

While we describe our proposed technique as a simple salvage procedure, it is not free of risk. Normally, cement can be contained very easily within the disc itself; however, there is a risk of cement leakage. For this reason, it is advocated that cement is put in just prior to it starting to set; it should be of high viscosity. Also, while we appreciate our technique does not improve the overall spinopelvic alignment, the advantage is that one avoids loading across a bearing surface. Since the top end instrumented level

has already fractured, the disc above has failed and the vertebral body proximal to this has migrated distally, one avoids creating any longer fusion than one had previously. The cement simply arrests micro-movement, providing stability at the failing motion segment.

Conclusion

While the technique described can only be performed in select cases and holds risks of its own, it is an excellent salvage procedure that can form part of the armamentarium of a complex spinal surgeon managing proximal junctional kyphosis, which is clearly the remit of a complex deformity surgeon. In high-risk patients with multiple comorbidities and very difficult deformities, this may indeed be the only salvage technique available if the patient is unfit for a significant revision operation. It can prevent their exposure to the risks that accompany large revision operations and fusion models with further potential to fail. We recommend that our technique is performed only at specialist centres.

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