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Original Article

Outcome of a posterior spinal fusion technique using spinous process wire and vertical strut

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Abstract

Background/Objective: Spinal fusion is a rapidly developing area of spine surgery. Many of the implants often used are not within the reach of the patients in the developing world. In this study, we describe the outcome of a novel technique of posterior spinal fusion using the rush nail and spinous process wire.
Materials and Methods: We prospectively evaluated patients who underwent the technique since October 2006. We reviewed the patients' biodata, clinical diagnosis, imaging studies, indications for surgery, type of operations, and complications related to the implants and the technique. Clinical test of instability was also determined.
Results: The technique was used in 11 female and 19 male patients. The age range was 11-82 years. The indication for surgery was trauma in 15 patients, degenerative disease in seven patients, tuberculosis of the spine in four patients, and four patients had neoplasms. Occipitocervical fusion was performed in three patients, cervical fusion in six patients, thoracic fusion in 10 patients, thoracolumbar fusion in seven patients, lumbar fusion in three patients, and lumbosacral fusion in one patient. The distal segment of the implant backed out in one patient following fracture of the spinal process. The implant was eventually removed. Clinical evidence of instability necessitating external orthotics was also seen in one patient. Two patients had wound infection. These were managed without removing the implants. We did not observe significant complications in other patients.
Conclusion: The technique appears safe and effective in carefully selected cases. The technique needs further evaluation in a larger patient population and with a longer duration of follow-up.

Keywords: Outcome, spinous process wire, vertical strut'

Résumé

'**Contexte/objectif :** Fusion spinale est un quartier en développement rapide de la chirurgie de la colonne vertébrale. Bon nombre des implants souvent utilisés ne sont pas à la portée des patients dans le monde en développement. Dans cette étude, nous décrivons les résultats d'une nouvelle technique de fusion spinale postérieure, utilisant le fil de ruée vers l'ongle et apophyse.
Matériaux et méthodes : Nous avons évalué prospectivement les patients qui ont subi la technique depuis octobre 2006. Nous avons examiné biographiques des patients, le diagnostic clinique, études d'imagerie, indications pour une chirurgie, type d'opérations et les complications liées à l'implant et de la technique. Essai clinique d'instabilité a été également déterminée.
Résultats : La technique a été utilisée chez 11 patients mâles femelles et 19. La tranche d'âge était de 11-82 ans. L'indication pour la chirurgie a été un traumatisme dans 15 patients, maladie dégénérative chez sept patients, tuberculose de la colonne vertébrale chez quatre patients et quatre patients avaient des tumeurs. Occipitocervical fusion a été réalisée dans trois patients, fusion cervicale chez six patients, fusion thoracique chez 10 patients, thoraco-lombaire fusion chez sept patients, fusion lombaire chez trois patients et lombo-sacrée fusion chez un patient. Le segment distal de l'implant régularisées rupture suivant un patient dans le processus de la colonne vertébrale. L'implant a été supprimé par la suite. Des signes cliniques d'instabilité nécessitant des orthèses externes se voit aussi chez un patient. Deux patients avait plaie infection. Elles étaient gérées sans retirer les implants. Nous n'avons pas observé des complications importantes chez les autres patients.

Conclusion : La technique semble sûr et efficace dans des cas soigneusement sélectionnés. La technique a besoin d'évaluation dans une population de patients plus grande et avec une plus longue durée de suivi supplémentaires.

Mots-clés: Outcome, fils de l'apophyse épineuse, support vertical'

Introduction

There is increasing preference for surgical stabilization of the spine because of the reduction in cost of management and morbidity, which may arise from prolonged hospital stay. The cost of instrumentation for spinal fusion is rather high and may not be within reach of many patients in the developing world. Thus, only cheap options such as the use of monofilament wires are left for many of these patients. Wiring alone as described by Rogers, Bohlman, and other workers may be suitable,[1,2] in terms of strength, for cervical spine stabilization, but below this spinal region, stronger instrumentation is required. Sublaminar wiring technique as described in the 1980s has the disadvantage of compromising the canal and the risk of injuring the canal contents on both short and long terms.[3-5] The latter will occur when there is fatigue of the wire.

The foregoing concept has forced us to develop spinal stabilization with cheap but strong vertical implant and to hold this in place with the circlage wire in safebut effectivefashion.[6] In this study, we evaluated the outcome of using the posterior spinal fusion method in our patients.

Materials and Methods

Fusion technique

The details of this novel technique have been previously described.[6] Circlage wire, as often used in plastic and orthopedic surgeries, is thrown into a loop and the ends are passed through a hole made at the base of the spinous process to be instrumented. Vertical rods that have been hitherto contoured are then passed through the wires on both sides of thespinous processes. Thereafter, the free ends of the wire are pulled and twisted snuggly on the vertical rods. We currently use size 18-22 G wire and 3-5 mm Rush nail as the vertical rods; smaller-sized implants are used for the cervical spine and the materials are of stainless steel. Bone graft is applied in the usual manner to encourage bone union/spinal fusion. The occipitocervical fusion is performed as follows. Two burr holes were made on either side of the midline in the occiput. The blind end of the loop of wires was then introduced through the lower hole to come out from the upper hole. This was performed on both sides and the bent rod is passed through the blind end (upper hole) and the free ends (lower hole) of the wire. The free ends were then twisted on the rod. The free ends of the rod are held onto the spinous processes as described above.

Patient population

Patients were informed about the technique and availability of other spinal fusion options and potential advantages and disadvantages were also discussed. Only candidates who opted for the technique were operated. All patients who underwent the procedure from October 2006 to June 2011 formed the population for the study. We obtained their biodata, diagnosis, neuroimaging findings, complications related to the technique and implants as well as clinical evidence of instability. The latter is defined by increasing back pain, new or worsening deformities, and new or worsening neurological deficits at mobilization. Clinical evidence of instability was used as primary outcome measure, whereas other related complications were considered as secondary outcome measures.

Follow-up: Follow-up was by routine clinical evaluation and serial X-ray of the spine as appropriate. All the patients had immediate post-operative images and as indicated subsequently.

Results

A total of 30 patients were operated using the technique. There were 19 males and 11 females. The age range was from 11 years to 82 years with a mode at the 7th decade. The age distribution is shown in Table 1.

Trauma was the etiology of the spinal pathology in 15 (50%) patients, degenerative disease occurred in

Table 1: Age distribution

Age range	Frequency
10-19	2
20-29	3
30-39	5
40-49	3
50-59	5
60-69	6
70-79	4
80-89	2
Total	30

7 (23.3%), tuberculosis of the spine in 4 (13.3%), and neoplasms occurred in 4 (13.3.2%) patients. The patients with degenerative disease had cervical spondylosis, multilevel laminectomies, and lumbar spondylolisthesis. The neoplasms were hemangioma, metastasis from advanced carcinoma of the prostate, lymphoma, and multiple myeloma. All the patients had spinal instrumentation because of instability (established or anticipated).

Ten of the 30 procedures were performed in the thoracic region, seven in the thoracolumbar, six in the cervical, three each in occipitocervical and lumbar, and one in the lumbosacral region.

Most of the patients were followed up for at least 6 months after surgery before they defaulted or were lost to follow-up. The longest duration of follow-up is about three and a half years.

Table 2 shows implant-related complications. The patient with implant migration was the first patient to have the technique and a bursa developed at the distal end of one of the rods. In addition to these complications, two patients demonstrated evidence of instability. Post-operative X-ray imaging did not show evidence of canal encroachment in any of the patients.

One of the two post-operative infections was deep. Despite the infection, the patient responded to a course of parenteral antibiotics and wound dressing without the need to remove the implants. He has sustained progressive neurological improvement, satisfactory bony union without evidence of recurrent infection almost 3 years after surgery.

The patient with stiff neck had occipitocervical fusion using the technique to hold the implant distally in the cervical spine.

All the patients who presented with pain had at least significant resolution of their pain. Neurological deterioration occurred in two patients. In one of these, the deterioration was not related to the implant. The other patient had neurological deterioration after mobilization post-operatively. She, however, improved following reoperation and application of external orthotics.

Table 2: Post-operative implant related complications

Wound infection	2
Implant migration	1
Post-operative instability	2
Spinous process fracture with implant backout and wound breakdown	1
Implant related bursa	1
Stiff neck	1

Figures 1-3 illustrate the X-ray images of a 29-year-old patient showing fracture of the T12 vertebra with disruption of the posterior

Figure 1: Plain lateral thoracolumbar X-ray image of a 29-year-old patient showing fracture of the T12 vertebra

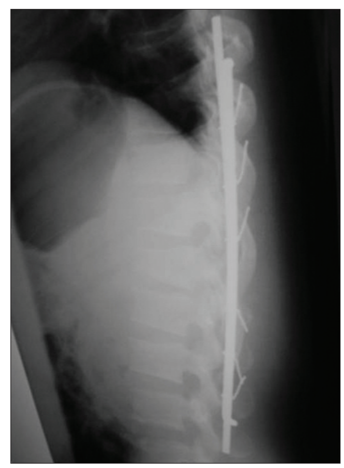

Figure 2: Plain lateral thoracolumbar X-ray image of this patient as in Figure 1 showing internal fixation with rush nail and spinous process wiring from T9 to L2

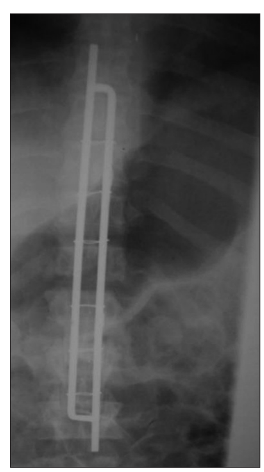

Figure 3: Plain anterioposterior X-ray image of this same patient as in Figure 2

tension band. He subsequently had T9-L2 spinal fusion using the technique.

Discussion

This study demonstrates the use of the technique in different spinal lesions, including degenerative, trauma, neoplasms, and infection. It was useful in stabilizing the spine in obvious and imminent (anticipated) instability whether before surgery or intraoperatively when bone removal would cause instability of the bony spine. This was the case in all but two patients who demonstrated evidence of instability. One was a 12-year-old girl who had tuberculosis of the thoracic spine with paraplegia. She had hemilaminectomy, post-erolateral decompression of the cord, and partial corpectomy with stabilization of the spine using our novel technique. Few days after surgery, when mobilization was commenced, she developed fracture of the upper instrumented spinous processes with worsening deformity and pain. The implants had to be removed at another surgery. She was subsequently put on bed rest and external orthotics.

The other patient with failure of the technique had haemangioma of the body of T5. She was one of the cases reported by Adeolu *et al*. with this condition.[7] She was paraparetic from compression by the lesion. She subsequently underwent one-stage transthoracic T corpectomy and iliac crest graft as well as hemilaminectomy, excision of the extradural mass, and stabilization with our technique. She initially made progressive neurological recovery post-operatively; however, she suddenly developed pain and worsening of her neurological deficit soon after mobilization. Repeat thoracic spine computerized tomography scan CT scan showed extrusion of the iliac crest graft in the thoracic cavity.[5] She subsequently underwent redo-thoracotomy and repositioning of the graft. She was put on bed rest and removable thoracic jacket using a scotch cast. She has made remarkable neurological improvement and currently walks unaided.

The technique failed in the first patient because the spinous processes were probably small and could not retain the wires under tension for a prolonged period. Extension of the instrumented level to more spinous processes below and above would have reduced the strain on the two spinous processes above and below as was performed in the patient. We think the implant failed in the second patient because of the extent of instability and also the patient's size. The experience also supports the fact that the implant is not reliable in preventing rotational movement because of its closeness to the midline. It is perhaps good for preventing motion in the saggital plane. An anterior stabilization with plates and screws would have prevented the complications observed. The use of external orthotics, as was eventually performed in the case, would have probably prevented the complication.

The only patient with implant migration and implant-related bursa was the first patient who underwent the procedure. The complication is prevented in subsequent patients by bending one end of the vertical strut and ensuring that this hooks the base of the spinous process during final tightening[6] [Figure 3]. The fusion could be further strengthened by twisting the free ends of the adjacent loops together or inserting fresh loops of wires and twisting them together as in the Rogers technique.[1] This will convert the fusion to a "triple" fusion technique. This is particularly suitable for the lumbar region where greater strength is required and the large spinous processes in the region can easily accommodate this. The efforts will also prevent the loop of wire from sliding on the vertical rod by holding the spinous processes together especially during extension. Thus, the use of smooth vertical rod, which could have been a disadvantage, is fully beneficial because making grooves on the rods to prevent migration would have weakened the rod strength.

Our technique is similar to some previously described techniques. Notable among these are the Bohlman technique and the one described by Drummond *et al*.[2,8] In the former, slabs of bone, as against rigid metal, are used as vertical strut to aid ossification. Thus, the immediate stability of the construct may not be as strong as in our technique. In the latter technique, a loop of wire is passed through some special buttons. Our technique does not involve the use of any buttons.

A major complication of the wiring technique is accidental canal encroachment during passage of the wire. This may not be evident at surgery, but could be suspected clinically when there is immediate post-operative neurological deterioration compared with preoperative neurologic status. Post-operative spinal X-ray or CT scan will confirm the suspicion. This complication is one of the reasons for abandoning spinal stabilization techniques that utilize sublaminar or spinous wires.[3-5] A review of all the post-operative X-ray studies of our patients did not reveal this complication. A spinal CT scan is probably better to evaluate this complication, but cost and availability precluded us from requesting it in most of the patients. Although this may be a limitation, absence of clinical evidence of canal encroachment is enough to justify our conclusion.

Another challenge of posterior stabilization with the monofilament wire is the difficulty with removal, especially in sublaminar wiring.[5] We have had to remove the implant in only one patient and the procedure was accomplished without significant difficulties.

The average total cost of stainless steel Rush nail and circlage wire is about 8,000 naira (about 60 United State Dollars USD). This is much cheaper compared to other implants used for posterior stabilization. For example, pedicle screws and rods will cost about 16,000 naira (about 120 USD) per screw if it is stainless steel and much more if the material is titanium. At least four of these will be required. If the cost of the vertical rods is added, the advantage of using our technique becomes more obvious.

Table 2 suggests the high complication rate; however, there were more than one complications in some of the patients and many occurred during the initial development of the technique. For example, the bursa and migration occurred in the first patient to be operated. These complications are very unlikely to occur again because the technique now involves hooking one end of the construct to the spinous process among other modifications.[6] We have recorded two cases of wound infections following the procedure. We do not know whether these were owing to the implants or the technique. Contamination of instruments probably occurs in one of the cases during repositioning into prone position in a single-stage anterior and posterior approach. The infection rate in our study compares with other established fusion techniques.[9]

The technique appears safe and effective in treating spinal instability. It is obviously cheap when compared to other available spinal implants. It is easy and quick to perform. Ability to perform it without requiring any intraoperative X-ray monitor is also an important advantage. All these attributes prove it a very suitable alternative to existing spinal stabilization techniques. Longer period of follow-up, further biochemical studies especially compared with other spinal fusion techniques, and larger study populations are required to evaluate this technique.

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