ORIGINAL ARTICLE

Outcome of single stage vertebral column resection in treatment of kyphotic deformity

Mohammad Arif,[1] Abdul Satar,[2] Muhammad Saeed,[3] Zahid Wazir,[4] Mohammad Inam[5]

Abstract

Objective: To find the frequency of deformity correction, functional outcome and complications of single-stage vertebral column resection in patients with kyphotic deformity.

Methods: The prospective case series was conducted at Hayatabad Medical Complex, Peshawar, and Aman Hospital, Peshawar, from January 2012 to December 2013, and comprised all patients who underwent single-stage posterior vertebral column resection. Only patients with severe rigid sharp deformity of different aetiology that required more than 40 degree correction and who had at least 3-month follow-up were included. Data was processed using SPSS 16.

Results: Of the total 18 patients, 11(61.1%) were male and 7(38.9%) were female, with an overall mean age of 28.7±13.6 years (range: 12-60 years). Among them, 8(44.4%) patients had congenital kyphosis, 5(27.8%) had posttraumatic origin, 4(22.2%) had post-tuberculous deformity, while 1(5.6%) had iatrogenic kyphosis. The apex of the deformity was in thoracic spine in 12(66.7%) patients, while in 6(33.3%) patients it was in the lumbar spine. The average pre- and post-operative Cobb's angle was 66.2±18.9 degrees and 18.8±12.8 degrees respectively. Mean correction of deformities was 47.3±13.3 degrees. The mean correction achieved in percentage terms was 73.5±8.6 per cent (range: 56-87%). There were no patients with post-operative deterioration of neurological status. Two (11%) patients underwent re-exploration of the wounds with wash and cultures due to wound discharge.

Conclusion: Posterior vertebral column resection was found to be a very effective method of correction of severe kyphotic deformities in expert hands with acceptable morbidity.

Keywords: Kyphosis, Osteotomy, Vertebral column resection. (JPMA 64: S-22 (Suppl. 2); 2014)

Introduction

Kyphotic deformity or hyperkyphosis refers to sagittal imbalance of the spine in which there is excessive forward bending of the spine in sagittal plane. There are many causes that can lead to this deformity. It may be congenital failure of vertebral column segmentation, leading to growth arrest of anterior column. It may be collapse of the anterior column due to trauma, tuberculosis or metabolic diseases. Removal of multiple level posterior elements can also lead to kyphosis, like in spine tumour surgeries. The effects of the deformity are mechanical, functional and psychological.[1] The spine can compensate for minor deformities, but even then it leads to constant stress and pain. Greater degrees of deformities have significant effect over patient life and may compromise daily life. In the end, it can cause neurological damage and permanent disability.[2]

Although conservative treatment of minor spine deformities has some role in its management, but for sever kyphotic deformity it has little place. Whenever there is focal kyphosis of more than 20 degrees, surgical correction is recommended.[3] Surgical decision not only takes into account the magnitude of the deformity, but also the patient functional status, pain, neurology, type and progression of the deformity and bone quality. The results of surgery are good, but should always be weighed against the complications.[4] A recent study showed direct correlation between the degree of kyphosis and functional impairment of the patients. It showed significantly poor functional scores for kyphotic deformity greater than 12 degrees at thoracolumbar junction.[5]

Surgical correction of kyphotic deformity must provide a balanced spine for a reasonable correction and acceptable rate of complications. It should improve patient's quality of life.[6] The reare different types of surgeries done for kyphotic deformities correction on the basis of approach used. Correction of different amounts can be achieved from anterior, posterior or combined anterio-posterior instumintation.[7] For severe deformity, usually a combined procedure is required which can be single-stage or two-stage. It may be from separate anterior and posterior approaches or through single posterior approach. Single-

[1,2,4]Department of Orthopedic and Spine Surgery, KGMC, Hayatabad Medical Complex, [3,5]Department of Orthopedic and Spine Surgery PGMI Hayatabad Medical Complex Peshawar.

Correspondence: Abdul Satar. Email: satardr@yahoo.com

stage procedure through only posterior approach is preferred these days.[8] There are three types of osteotomies of spine for the correction of kyphotic deformity: Smith-Petersen Osteotomy (SPO), Pedicle Subtraction Osteotomy (PSO) and Vertebral Column Resection (VCR). Apart from other factors, the selection of an osteotomy depends on the amount of correction required. A single-level SPO will provide about 20-degree correction, PSO 30 to 40, and VCR above 50 degrees.[9]

VCR is done in those selected cases of rigid sharp kyphotic deformity where a significant amount of correction is required. It is one of the most challenging and demanding spinal procedures. It involves at least complete resection of single spinal segment. VCR was first performed in 1922 by MacLennan for the treatment of severe scoliosis. The posterior VCR (PVCR) was first done in 2002 and later popularised by others.[10]

In the current study, we present our results of single-stage PVCR in terms of deformity correction and functional outcome measured with Visual Analogue Score (VAS) and Oswestry Disability Index(ODI).[11]

Patients and Methods

The prospective case series was conducted at the Orthopaedic and Spine Department, Hayatabad Medical Complex, Peshawar, and Aman Hospital, Peshawar, from January 2012 to December 2013, and comprised patients who underwent single-stage PVCR. Inclusion criteria comprised severe rigid sharp deformity of different aetiology which required more than 40-degree correction and who had at least 3-monthfollow-up.Informed written consent was obtained in all cases. In all the subjects stabilisation was obtained through posterior segmental pedicle screw fixation and rods.

Pre-operative thorough detailed history was obtained and focus was kept not only on the deformity and its functional impact on the patient's life, but also on the cardiopulmonary and nutritional status of the patient. Cardiologists, pulmonologists and anaesthesiologists were consulted in all cases. Pre-operative radiological assessment of the deformity was performed on plain anterio-posterior and lateral radiographs. Cobb's angle was measured on lateral radiographs for each patient and was documented, while 3D computed tomography (CT) scan and magnetic resonance imaging (MRI) was obtained in selected patients.

All procedures were performed in prone position under general anaesthesia. After anaesthetising the patient, posterior midline incision was made. Para-spinal muscles were dissected sub-periosteally from the laminae and spinous processes, exposing facet joints and tips of transverse processes. Dissection was done at least two levels above and below the site of osteotomy. Pedicle screws were then placed below and above the level of osteotomy on both sides. Fluoroscopic guidance was used where required. At the level of osteotomy, decompression was done wide enough to avoid any cord compression at the closure of osteotomy. The exiting roots were identified and isolated. Dissection was done along the lateral wall of the body at apex. A temporary rod was placed on one side. Osteotomy was performed using sharp osteotoms alternatively from both sides. Anteriorly, cage or bone grafts were placed if found that closure will lead to excessive shortening and pressure on the cord. At thoracic level, a single nerve root was compromised if required for better visualisation anteriorly. Then final rods were placed and with contouring of rods, correction was achieved. Neuro-monitoring was done by wake-up test or with intra-operative neuromonitor. The wound was closed over a suction drain in layers. Patients were given intravenous (IV) antibiotics for five days post-operatively. Pain management was done on individual basis.

On the first post-operative day, patients were mobilised and all tubes were removed. Post-operative radiographs were taken. Cobb's angle was calculated for each patient. Amount of correction in percentages were also calculated. Stitches were removed on the 14th day. Follow-up was made at 2 weeks, monthly for 3 months, every 3 months up to a year, and then yearly. At each follow-up, radiographs were taken and functional status was assessed using Oswestry Disability Index (ODI). Data was processed using SPSS 16.

Results

Of the total 18 patients, 11(61.1%) were male and 7(38.9%) were female, with an overall mean age of 28.7±13.6 years (range: 12-60 years). Overall, 8(44.4%) patients had congenital kyphosis, 5(27.8%) had posttraumatic origin, 4(22.2%) had post-tuberculous deformity, while 1(5.6%) had iatrogenic kyphosis (Table-1).

The apex of the deformity was in thoracic spine in 12(66.7%) patients, while in 6(33.3%) patients it was in the

Table-1: Cause of deformity.

	Frequency	Percent
Congenital	8	44.4
Iatrogenic	1	5.6
Trauma	5	27.8
Tuberculous	4	22.2
Total	18	100.0

Table-2: Level of deformity.

	Frequency	Percent
D10-D11	2	11.1
D12	2	11.1
D2-D3	1	5.6
D3-D4	1	5.6
D4-D5	1	5.6
D6-D7	1	5.6
D8-D7	1	5.6
D9	1	5.6
D9-D10	2	11.1
L1	2	11.1
L2	1	5.6
L2-L3	1	5.6
L3	1	5.6
L3-L4	1	5.6
Total	18	100.0

Table-3: Disability severity.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		4	22.2	22.2	22.2
	Minimal	8	44.4	44.4	66.7
	Moderate	6	33.3	33.3	100.0
	Total	18	100.0	100.0	

Table-4: Paired samples statistics.

		Mean	N	SD	P-value
Pair 1	Preoperative COBB'S Angle	66.2222	18	18.87904	0.000
	Postoperative COBB'S Angle	18.8333	18	12.80280	
Pair 2	Preoperative VAS	6.8889	18	.83235	0.000
	Postoperative VAS	2.8333	18	.70711	
Pair 3	Preoperative ODI	48.1250	8	6.37938	0.000
	Postoperative ODI	17.2500	8	5.11999	

lumbar spine. In 4(22%) patients the apex was above or at D6 level. In 9(50.4%) patients the deformity was near the thoracolumbar junction (Table-2).

The mean pre- and post-operative Cobb's angle was 66.2±18.87degrees and 18.8±12.8 degrees. Post-operatively, the mean ODI improved from 48.12±6.37 to 17.25±5.11, while VAS improved from 6.88±0.83 to 2.83±0.70. Post-operatively, the range of ODI and VAS was 10-34 and 2-4 respectively. Post-operatively there was no patient with severe disability (ODI>40). Eight (44.4%) patients were with minimal disability, while 6(33.3%) with moderate, and in 4(22%) patients ODI could not be calculated (Table-3).All the three parameters were significantly improved (p=0.000 each) (Table-4).

Mean correction of deformities was 47.3±13.3 degrees (range: 30-77 degrees). The average amount of correction in percentage terms was 73.5±8.6% (range: 56-87%). In post-traumatic patients the magnitudes of deformities were not high, but VCR was done for corrections because of the nature of the deformities and some patients were with fracture dislocations.

There was no patient with post-operative deterioration of neurological function. According to American Spinal Injury Association (ASIA) ImpairmentScale, 12(66.6%) patients had their neurology static, while in 6(33.3%) cases it showed improvement. In 3(16.6%) cases the improvement was by one grade, in 2(11%) patients it was by 2 grades, and in 1(5.55%) patient it improved by 3 grades from ASIA B to E. Two (11%)o patients underwent re-exploration of the wounds with wash and cultures due to wound discharge. All were done early within 2 weeks and all responded well to antibiotics. There is no implant failure till date in these patients, and no functional abnormality. The mean follow-up was 12±7.3 months (range: 5-28 months).

Discussion

Severe kyphotic deformity not only carries the risk of neurological injury, but can also affect cardio-respiratory system. Correction of these deformities itself is the most challenging procedure of spinal surgeries and carries the risk of morbidity. Now it is well established that PVCR is equally effective as the traditional two-stage VCR. PVCR also carries less morbidity than the two-stage procedures. However, PVCR is technically more demanding and has a very steep learning curve.[12]

Suk et al in 2005 presented their results of PVCR in terms of correction and pain improvement measured by VAS.[13] They reported an average of 40-degree kyphosis correction from mean 35±25 degrees to -5±11 degrees. There was an average of 60% scoliotic deformity correction. All patients with neurological compromise showed some improvement and there was reduction of preoperative pain by 50% at last follow-up. The work is a landmark in the development of PVCR as an effective technique for severe spinal deformity corrections. Similarly, the study of Lenke et al is one of the early studies and it further confirms the effectiveness of PVCR.[14] They reported the results of different corrections with PVCR in paediatric population. There were 10 patients with severe angular kyphosis ranging from 45 to 135 degrees. In these patients, they achieved 51(58%) degrees correction on average. Our deformity correction rate seems better than these studies. We achieved on average 47.3 degrees (73.5%) correction and our sample was more

uniform than theirs. The mean VAS in our study improved from pre-operative 6.8 to post-operative 2.8, which is above 50% improvement.

In a group of 8 patients with congenital, post-traumatic and post-tuberculous kyphosis, Qi Q et al reported satisfactory deformity correction with PVCR without any major complication.[15] They reconstructed anterior column after resection with cage filled with bone graft in all cases. The pre-operative average kyphosis was 73 degrees, which reduced to 8.3 degrees post-operatively. Their average correction was 88.6%, which is quite high compared to ours (73.5%).They attributed better results to the use of cage anteriorly although their sample was small. This study showed that cage could be safely put from the posterior, which prevents excessive shortening of the cord, buckling of dura, and provides good support anteriorly.

Recent studies also confirmed the better outcome of PVCR in terms of deformity correction and complications though functional outcome is still very scarcely studied. A study dealing with correction of rigid deformities of more than 100 degrees reported the result of 28 patients.[16] With PVCR it achieved very good correction in all patients with rigid deformities like kyphosis, scoliosis and kyphoscoliosis. In the kyphosis group, the mean pre-operative Cobb's angle improved from 109 to 32 degrees, about 70% correction. Spiro et al reported correction of congenital kyphosis with PVCR from pre-operative average of 59.9 degrees to post-operative 17.5 degrees.[17] Ozturk C et al reported improvement of kyphosis from 87 to 36 degrees without any major complication.[18] All these studies along with our findings confirm that correction of severe deformities can be done through single posterior approach instead of combined anterior and posterior approaches.

Our search did not yield any local study on this topic.In one of our studies, we reported the correction of sagittal deformity with PSO using single approach.[19] The correction achieved with PSO was 30.6 degrees on average from pre-operative mean of 41 to post-operative 10.9. With PVCR we achieved significantly high correction, 47.3 degrees on average, and were able to treat more complex deformities.

No doubt that PVCR is a very effective procedure for the correction of rigid deformities. It gives the surgeon freedom of manipulation after 360-degree release. But at the same time it is technically very demanding, lengthy and not without complications. It is one of the lengthiest and most tiring surgeries with reported mean operative time of more than 4 hours, and average blood loss of above 2000ml.[13,15] This requires teamwork and great efforts from surgical and anaesthesia staff. One of the greatest concerns of a spine surgeon is new onset neurological deficit, which is not very uncommon in these patients. One study reported 3.4% occurrence of new neurological deficit in 321 patients with severe deformities treated with either PSO or PVCR.[20] Patients were monitored during surgery with somatosensory-evoked potentials and Stagnara wake-up test. The high risk for new neurological deficit was pre-existing neurological deficit. A study reported the incidence of complications in 152 patients in whom PVCR was done.[21] Overall complication rate was 39.5% with 13.8% transit neurology, 3.3% permanent neurology, 6.6% infection and 10.5% dural tear. We had no patient with new neurological deficit. In 12 patients, the ASIA grading was static, while in 6 it showed improvement. We had re-exploration of the wound in two cases due to suspicion of deep infection. All responded to early wash and post-operative antibiotic therapy.

The age of our study population ranged from 12 to 60 years. This diversity was due to the fact that patients with kyphosis of different origin were included. Congenital kyphosistends to present early, while kyphosis due to trauma and tuberculosis can present at any age. Likewise, congenital malformation of the spine was the most frequent cause of sagittal imbalance followed by trauma and tuberculosis in our study. It was because congenital malformation commonly leads to gross kyphotic deformity and similarly tuberculosis not treated properly in our part of the world leads to spinal deformity.

Conclusion

PVCR was found to be a very effective method of correction of severe kyphotic deformities in expert hands with acceptable morbidity. It needs team effort with close monitoring of the patient overall and neurological status specifically. Larger sample size is required to achieve more meaningful results.

Acknowledgment

We are grateful to Mr. Amjad Khan for editorial assistance.

References

1. He Q, Xu J. Transpedicular closing wedge osteotomy in the treatment of thoracic and lumbar kyphotic deformity with different etiologies. Eur J Orthop Surg Traumatol 2013;23:863-71.
2. Youssef JA, Orndorff DO, Patty CA, Scott MA, Price HL, Hamlin LF, etal. Current status of adult spinal deformity. Global Spine J 2013;3:51-62.
3. Munting E. Surgical treatment of post-traumatic kyphosis in the thoracolumbar spine: indications and technical aspects. Eur Spine J 2010;19:69-73.

4. Zileli M. Surgery for kyphosis. Adv Tech Stand Neurosurg2014;41:71-103.
5. Schulz R, Melcher RP, Garib MC, Schulz H, Wweissman K, Harms J. Does kyphotic deformity correlate with functional outcomes in fractures at the thoracolumbar junction treated by 360° instrumented fusion?Eur J Orthop Surg Traumatol 2014;24 Suppl 1:93-101.
6. Moon MS, Kim SS, Lee BJ, Moon JL, Moon YW. Surgical management of severe rigid tuberculous kyphosis. Int Orthop 2011;35:75-81.
7. Issack PS, Boachie AO. Surgical correction of kyphotic deformity in spinal tuberculosis. Int Orthop 2012;36:353-7.
8. Wang Y, Zhang YG, Zhang XS, Wang Z, Mao KY, Chen C et al. Posterior only multilevel modified vertebral column resection for extremely severe pott,s kyphotic deformity. Eur Spine J 2009;18:1436-44.
9. Kim KT, Park KJ, Lee JH. Osteotomy of the spine to correct spinal deformity. Asian Spine J 2009;3:113-23.
10. Enercan M, Ozturk C, Kahraman S, Sar?er M, Hamzaoglu A, Alanay A.Osteotomies/spinal column resections in adult deformity. Eur Spine J 2013;22:254-64.
11. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine (Phila Pa 1976).2000;25(22):2940-52.
12. Lenke LG, Sides BA, Koester LA, Hensley M, Blanke KM. Vertebral column resection for the treatment of severe spinal deformity. Clin Orthop Relat Res 2010;468:687-99.
13. Suk SI, Chung ER, Lee SM, Lee JH, Kim SS, Kim JH. Posterior vertebral column resection in fixed lumbosacral deformity. Spine (Phila Pa 1976) 2005;30:E703-10.
14. Lenke LG, O'Leary PT, Bridwell KH, Sides BA, Koester LA, Blanke KM. Posterior vertebral column resection for severe pediatric deformity: minimum two-year follow-up of thirty-five consecutive patients. Spine (Phila Pa 1976) 2009;34:2213-21.
15. Qi Q, Chen ZQ, Guo ZQ, Li WS. New type spinal osteotomy with cage inserting anteriorly and closing posteriorly to correct thoracolumbar kyphosis by a single posterior approach. Zhonqhua Wai Ke Za Zhi 2006;44:551-5.
16. Xie J, Wang Y, Zhao Z, Zhang Y, Si Y, Li T, etal. Posterior vertebral column resection for correction of rigid spinal deformity curves greater than 100°. J Neurosurg Spine 2012;17:540-51.
17. Spiro AS, Rupprecht M, Stenger P, Hoffman M, Kunkel P, Kolb JP,etal. Surgical treatment of severe congenital thoracolumbar kyphosis through a single posterior approach. Bone Joint J 2013;95-B:1527-32.
18. Ozturk C, Alanay A, Ganiyusufoglu K, Karadereler S, Ulusoy L, Hamzaoglu A. Short-term X-ray results of posterior vertebral column resection in severe congenital kyphosis, scoliosis, and kyphoscoliosis. Spine (Phila Pa 1976) 2012;37:1054-7.
19. Satar A,Inam M, Arif M, Saeed M, Wazir IK.Radiological and functional outcome of pedicle subtraction osteotomy. J Pak Orthop Asssoc 2012;24:141-7.
20. Ma HS, Chen ZM, Yang B, Wu JG, Tan R, Wang XP. Analysis of neurological deficits complications in the treatment of spinal deformity with posterior spinal osteotomy. Zhonghua Wai Ke Za Zhi 2012;50:328-32.
21. Kim SS, Chao BC, Kim JH, Lim DJ, Park JY, Lee BJ, etal . Complications of posterior vertebral resection for spinal deformity. Asian Spine j 2012; 6:257-65.