Review Article
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Symptomatic unilateral spondylolysis associated with non-spodylolytic lateral clefts in adults-guidelines for a rare condition

Abstract

Non-spondylolytic lateral clefts of the lumbar neural arch (laminolysis and pediculolysis): are rare pathologies, which usually occur consequent to repetitive stress injuries in patients with unilateral spondylolysis. These lesions are different from the usual bilateral spondylolytic defects; and their management depends upon the chronicity and the type of bony defect. We hereby discuss the verdict of current literature on underlying patho-mechanics and ideal management guidelines of these rare lesions.

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Introduction

Lytic spondylolisthesis typically results from a bilateral defect in the pars inter-articularis, which occurs following acute fractures or stress/fatigue failures.[1] Such a defect usually exists bilaterally. However, in situations of chronic, unilateral pars lysis, the neural arch tends to fail elsewhere on the contra-lateral side, secondary to recurrent strains imparted across.[2] These unusual situations result in the development of defects in the non-isthmic portions of neural arch: either involving the contra-lateral pedicle or lamina.[3] We hereby discuss comprehensively the patho-mechanism behind these uncommon lesions and recommend the appropriate management protocols in such situations.

Discussion

The earlier concept of benign nature of unilateral lytic lesions of the pars inter-articularis has been controverted by recent literature reports confirming the existence of regional instabilities generated across the vertebral segments with asymmetric pars defects.[4–6] In chronic unilateral spondylolysis, the posterior vertebral elements gradually tend to yield elsewhere on the contra-lateral side.[4] The most common ensuing defect in such scenarios is a defect at the contralateral pars itself.[4] However, on rare occasions, the neural arch may give way at the contralateral pedicular or laminar levels under the influences of persistent mechanical stresses. These lesions have been classified as non-spondylolytic lateral clefts of lumbar vertebral arch.[3]

Non-spondylolytic clefts of the lumbar vertebral arch were described in 1983 by Johansen et al.,[3] which include retro-somatic (pedicle defect) or retro-isthmic defects (lamina defect). The pedicle defects were described in detail by Gunzburg et al,[2] who coined the term "pediculolysis" for chronic pedicular stress fractures. Miyagi et al classified laminolytic defects into hemilaminar (sagittal fracture-line orientation) and inter-laminar subtypes (coronal orientation) based on their morphological appearance.[7] Both these defects (pediculolysis and laminolysis) occur following similar mode of failure, as in spondylolysis: recurrent extension loading of the posterior vertebral elements, with super-added rotational stresses. The initial description of unilateral pars lysis was made in 1953 by Stewart[4] and the clinical significance of such asymmetric lesions have remained controversial. Porter et al.[4] described the biomechanical implications of unilateral pars defects and demonstrated their association with wedging of vertebral body, hypoplasia of ipsilateral neural arch, rotational mal-alignment of spinous processes and vertebral hemilisthesis. Under such altered biomechanical environment, the existence of significantly increased mechanical stress elements on the contralateral neural arch (12.6 fold greater stresses) was established by the in-vitro experimental model created by Saiyro et al.[6] The vertebra tends to fail more commonly at the contralateral pars inter-articularis; although rare reports of non-spondylolytic lateral vertebral arch clefts occurring in patients with contralateral pars lysis have been described. Although acute injuries can cause such disruptions of the posterior spinal elements, the more common underlying mechanism has been reported to be chronic stress fractures. Recurrent microtrauma following repetitive hyper-extension and rotational stresses delivered across a relatively hyperlordotic or hypo/dysplastic lumbar spine lead to gradual failure of neural arch.[8] More commonly, these lesions have been described in active labourers[9,10] or adolescent sportspersons who are prone to repeated, chronic injuries.[6] Nevertheless, certain reports have also described[10] single or multilevel insufficiency pedicle fractures in elderly patients in association with severe osteoporosis or renal osteodystrophy. Rarely, can these lateral non-pars clefts be visualised on plain roentgenograms. Plain stress radiographs can demonstrate intervertebral instability at these affected vertebral levels. However, CT scan gives the most accurate picture regarding the extent of such bony defects. Chronic stress fractures usually present with rounded, sclerotic margins, in contrast to acute failures.[7] In order to understand the actual phase of healing and plan the appropriate treatment, MRI scan is in fact a better modality.[11] On the basis of MRI scan,[12] spondylolysis has been traditionally graded as stress reaction (grade 1), incomplete stress fracture (grade 2), acute, complete pars fracture (grade 3) and chronic, complete pars fracture (grade 4). Similarly, the reparative phases of lytic defects of the pedicle and lamina may also be classified, based on MRI appearance as acute healing phase (hypointense marrow on T1WI and hyper-intense signal on T2 WI an

STIR sequences) or chronic hypertrophic fibrous union (hypo-intense T1 and T2 WI signals and hypertrophied pedicle morphology).

Thus, based on the MRI appearance, the lateral, non-spondylolytic clefts of the lumbar arch can be classified into four different groups:

i. Acute, healing pediculolysis

ii. Chronic pediculolysis with fibrous non-union

iii. Acute, healing laminolysis

iv. Chronic laminolysis with fibrous non-union.

MRI scan can also help in assessing the status of central and foraminal stenosis; and root compression. Scintigraphy is another modality which can indicate the acuteness of the lesion.[13] Active reparative mechanism within the lesions may be demonstrated by enhanced uptake in the pedicle marrow. Five major factors which need to be considered in the treatment of these vertebral lesions include a. Age of the patient b. Underlying systemic pathology contributing to insufficiency fractures c. Physical demand (based on the activity level of patient) d. Chronicity of the lesion (as demonstrated on MRI scan) e. Degree of inter-vertebral instability. Acute (pediculolysis and laminolysis) lesions with hyperintense morphology on MRI are known to respond well to conservative management. Majority of these lesions have been typically described in adolescent (skeletally immature) athletes. A trial of conservative treatment for a period of three to six months (including relative rest and abstinence from sports activities) should definitely be considered in these individuals before any option of surgical intervention is conceived upon. Some authors also advocate lumbar bracing to enhance healing.[13] Conservative management with orthosis and concomitant anti-osteoporotic medical therapy has also been successfully employed in the management of acute, osteoporotic pedicle fractures.[10]

However, in these chronic lesions arising out of repetitive stress injuries, one should understand the existence of inherent instability, which has in fact led to the development of fibrous, hypertrophic non-union. These patients, when symptomatic definitely need to undergo surgical intervention for healing of bony defects.[13,14] The surgical options described in literature for such lesions include direct repair of the lytic lesion,[2–15] postero-lateral fusion, trans-foraminal or posterior lumbar interbody fusion (single or double level TLIF or PLIF).[10] In young athletes with chronic pediculolysis without evidence of intervertebral instability, direct repair of the pedicular cleft using compression screws has been described as a treatment option.[2–15] Such motion-preserving surgeries may obviate the need for segmental fusion procedures in patients with high physical activity. However, any evidence of intervertebral instability or significant degenerative spondylosis precludes such a conservative approach. These patients definitely benefit from intervertebral fusion procedures. The surgical management in chronic laminolysis (L5) with contralateral spondylolysis (L5) should be a single level (L5-S1) transforaminal interbody fusion. However, the levels of vertebra which need to be fused in chronic pediculolysis have remained controversial.[5–7,10] Most of the literature evidence regarding these non-spondylolytic lesions describes early fractures in adolescent athletes. Since these lesions are extremely uncommon, thorough pre-operative evaluation and planning are of utmost relevance to ensure timely diagnosis (when conservative management can be considered) and appropriate treatment. In patients with L5 pediculolysis, who undergo surgical fusion, the need to extend the level of fusion proximally to L4 pedicle has to be cautiously assessed. Some patients present with significantly hypertrophied L5 pedicle, where complete decompression of L5 nerve root may necessitate partial removal of the pedicle itself. As a result, the fixation may need to be extended proximally by one level.

Conclusion

A good pre-operative planning and careful understanding is of utmost importance in the management of these rare lateral non-spondylolytic lesions. In carefully selected patients, both conservative and surgical management can give good outcome. A vital part of surgical planning includes the identification of ideal candidates for isolated repair of the defect or single/double level fusions. We believe that the guidelines thus purported, can help in making the critical distinction between these different patient groups and aid in providing better results in such rare scenarios.

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Conflict of interest

The author declares no conflict of interest.

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