SPONDYLOLISTHESIS  IN A CITY IN SOUTH SOUTH GEO-
POLITICAL ZONE OF  NIGERIA

UDUMA , FELIX U.,¹* DIM, EDWIN N.,² NOTTIDGE, TIM E.,³
EDUWEM, DIANABASI U.⁴

1-Department of Radiology, Faculty of Clinical Sciences, College of Health Sciences,
University of Uyo, Nigeria.

2- Department of Trauma and Orthopaedics, Faculty of Clinical Sciences, College of Health
Sciences, University of Uyo, Nigeria.
ABSTRACT

Background

Spondylolisthesis is a condition where one vertebra slips over the top of the adjacent vertebra. It is commonest in the lumbar spine.

Objectives

To audit lumbo-sacral spine radiographs for spondylolisthesis with emphasis on localisations, sex distribution, types and grading.

Materials and methods

Patients referred to Radiology Department of University of Uyo teaching hospital, Uyo, Nigeria from 1st May, 2011 to 21st June, 2012 for lumbo-sacral radiography for whatever reason were recruited in a descriptive cross sectional study. Anterior-posterior and lateral radiographs of the lumbo-sacral spine were taken under standardized conditions. Radiographs with spondylolisthesis were identified and analysed statistically using computer SSPS 13.

Results

249 Patients were studied with 132 Males and 117 females. 9.24% (n=23) of the studied population had 25 individual vertebral displacements. 82.61% (n=19) of these patients were females and 17.39% (n=4) were males (female to male ratio of 4.75:1). The mean age for males with vertebral displacement was 44.5 (S.D=10) and mean age for female was 44.5 (S.D=15.81).
The commonest level of vertebral involvement was L4 on L5. This was seen in 56.52\% (n=13) of patients with positive cases of spondylolisthesis. This was followed by L5 on S1 with 30.43\%. 82.61\% of patients had grade 1 displacements.

Degenerative spondylolisthesis was the commonest type with 52.17\% followed by isthmic type 21.74\%, traumatic spondylolisthesis 8.70\% and uncategorised 17.39\%.

Conclusion

The radiographic pattern of spondylolisthesis in Uyo, Nigeria demonstrates the usual female gender bias, L4/L5 localizations but interestingly show predominance in degenerative spondylolisthesis.

Keywords

Spondylolisthesis, Lumbo-sacral radiographs, Degenerative.

*Dr Uduma, F.U.

Department of Radiology, Faculty of Clinical Sciences, College of Health Sciences, University of Uyo, Uyo, Akwa Ibom State, Nigeria.

234-0817 745 0099

felixuduma@yahoo.com
INTRODUCTION

Spondylolisthesis is the anterior or posterior slippage of a vertebra or the vertebral column in relation to the vertebrae below. Forward slippage of one vertebra on another is referred to as anterolisthesis, while backward slippage is referred to as retrolisthesis (Irani, Z. 2004).

Spondylolisthesis was first described in 1782 by Dr Herbinaux, a Belgian obstetrician. He reported in a small number of patients, a bony prominence anterior to the sacrum that obstructed the vagina (Chain, J.C. et al. 2004, Wikipedia, 2008). The term “spondylolisthesis” was coined in 1854, from the Greek words spondylo, meaning spine, and listhesis, meaning to slip or slide (Wikipedia, 2008).

Aetiologically, there are five major types of lumbar spondylolisthesis and this is based on Wiltse classification system (Wikipedia, 2008). These are dysplastic, isthmic, degenerative, traumatic, and pathologic spondylolisthesis (Irani, Z. 2004, Wikipedia, 2012, Eck, J.C. 2012, Li, Y., Hresko, M.T. 2012).

Dysplastic or congenital spondylolisthesis is caused by a defect in the formation of the facet of a vertebra that allows it to slip forward (Irani, Z. 2009, Eck, J.C. 2012). Hereditary lesions like malformation of the lumbosacral junction with small, incompetent facet joints,

Isthmic or spondylolytic spondylolisthesis is due to a defect (spondylolysis) in a portion of the vertebra called the pars interarticularis (Niggemann, P. et al. 2012). Pars interarticularis is defined as the parts of the neural arch that lies between the superior and inferior articular facets (Irani, Z. 2009, Sirkis, H.M. 2005). It is also roughly the region of the junction of the pedicle and lamina. Isthmic spondylolisthesis can be caused by repetitive trauma and this is more common among athletes (Irani, Z. 2009, Eck, J.C. 2012, Toueg, C.W. et al. 2010).

Toueg, et al. 2010 observed in their study that 75% of spondylolysis cases develop into spondylolisthesis.

Degenerative spondylolisthesis occurs due to cartilage degeneration and arthritic changes in the joints of the vertebrae (Irani, Z. 2009, Eck, J.C. 2012). It is more common in older patients with slippage occurring in an intact neural arch (Eck, J.C. 2012).

Traumatic spondylolisthesis is due to direct trauma or injury to the vertebrae. This can be caused by a fracture of the pedicle, lamina or facet joints that allows the anterior portion of the vertebra to slip forward with respect to the posterior portion of the vertebra (Irani, Z. 2009, Eck, J.C. 2012).

Spondylolisthesis is equally graded and this is based on severity of slip. The most commonly used is Meyerding grading system (Wikipedia, 2008, Niggeman, P. et al. 2012). This is based on the ratio of amount of slippage to vertebral-body width obtained as a percentage (Irani, Z. 2009, Wikipedia, 2008, Huang, K. et al. 2009). This is best achieved with lateral lumbo-sacral radiographs where measurements of the distance from the posterior edge of the superior vertebral body to the posterior edge of the adjacent inferior vertebral body is made. This distance is then reported as a percentage of the total superior vertebral body length. (Irani, Z. 2009, Wikipedia, 2008). Grade 1 is a ratio of 0-25%, grade 2 is 25-50%, grade 3 is 50-75%, and grade 4 is 75-100% (Irani, Z. 2009, Bock, C., Sock, K. 2004, Stanislavky, A., Gaillard, F. 2005).

When slippage is over 100%, it is called Spondyloptosis. In this condition, the vertebra completely falls off the supporting vertebra. (Wikipedia, 2008, Bock, C., Sock, K. 2004, Stanislavky, A., Gaillard, F. 2005). This was later added as grade V describing the ptosis of the cranial vertebra (Niggeman, P. et al. 2012).

Another grading system simply categorises spondylolisthesis as low or high grades. Low grade spondylolisthesis is a slip that is less than 50% whereas high grade occurs when the slip is greater than 50% (Wikipedia, 2008).


Spondylolisthesis is one of the diagnoses conventional radiography is unambiguous about. In this regard, lateral view can be used both for grading and classification. Lateral view is specifically useful in detecting spondylolisthesis as it may demonstrate the pars defect. (Irani, Z. 2009, Niggeman, P. et al. 2012). This in combination with other views can hazard instigating pathology. In addition, such ancillary conditions related to spondylolisthesis like vertebral formation anomalies, spondylosis, osteoid osteoma, Paget disease, fractures and osteolytic lesions are readily detectable with conventional radiography (Irani, Z. 2009),
To explore spondylolisthesis in a Nigerian population should be considered meaningful since when symptomatic can increase work absenteeism thereby taking a toll on economic resource of a developing nation. Our objective is therefore to audit lumbo-sacral spine radiographs for spondylolisthesis with emphasis on localisations, sex distribution, types and grading.

MATERIALS AND METHODS
Consecutive Patients who came for lumbo-sacral radiographs on any account were studied prospectively from 1\textsuperscript{st} May, 2011 to 21\textsuperscript{st} June, 2012. These patients were referred to Radiology Department of University of Uyo Teaching Hospital, Uyo, Akwa Ibom State, Nigeria both from within and outside the hospital. Their clinical and demographic data were extracted, Patients’ consents were sought prior to radiographic examinations. Lumbo-sacral spine radiograph for each patient was taken according to standard protocol with centring point at L2.

In anterior-posterior view, patient lies supine in the centre of an xray couch with the arms and hands to the side of the body. Patient shoulders are supported on pillows. The knees are raised with the soles of the feet resting on the couch top to reduce lumbar curve to minimum. The trunk is ensured to be straight and the pelvis is not rotated. Patient’s raised legs are supported on a pillows to immobilize the patient. Anatomical marker is placed, beam collimated and gonad shield applied. Centring point is midline at L2. The direction of central ray is directed 90 degrees vertically to the centre of the film. Focal film distance is 90cm and exposure is made at arrested respiration in a 30 X 40cm detail or fast screen cassette.

In lateral view, patient lies in left lateral position but with the arms raised to the head with the head supported with pillow. The hips and knees are flexed and the legs are placed in a comfortable positions using sandbags. Centring point is 10cm anterior to the spinous process of L2. Direction of central ray is also vertical at 90 degrees to the film.

Paired radiographs of anterior-posterior and lateral per patient were used for evaluation of any vertebral displacements and associated pathology. Lateral radiographs were specifically used for grading of spondylololisthesis using Meyerding grading system.

Exclusion criteria included non-optimal and non-standardized radiographs as well as patients without complete bio-data.

Results were analysed using SPSS 13.0 for Windows software package (SPSS, Chicago, Ill).
RESULTS

249 Patients were studied with 132 Males and 117 females giving a male to female ratio of 1.13 : 1. The youngest age range of the studied population was second decade of life. This studied population in both sexes increased progressively down the ages, peaking at 5th decade of life and subsequently decreasing progressively to 8th decade of life. At the population peak, males were 30 (22.73%) in number and females were 38 (32.48%).

Twenty-three patients constituting 9.24% of the studied population had vertebral displacements. Of this number, 19 patients (82.61%) were females and 4 patients (17.39%) were males giving a female to male ratio of 4.75:1. The mean age for males with vertebral displacement was 44.5 (S.D=10) and mean age for female was 44.5 (15.81). 25 individual vertebral displacements were seen in these 23 patients. In females, the modal age for vertebral displacement was 54.5 while it is 44.5 for males.

The commonest level of vertebral involvement was L4 on L5 seen in 13 patients constituting 56.52% of positive cases of spondylolisthesis. This was followed by 7 patients (30.43%) at vertebral L5 on S1. L1 displacement on L2 and L3 on L4 were seen in 2 patients (8.70%) each.

21 (91.30%) patients had Grade 1 displacements with female to male ratio of 6 : 1. Grade 2 had 4.35% (n=1), grade 3 0% and grade 4 had 4.35% (n=1) with one spondyloptosis. All the patients with grades 2 and 4 spondylolisthesis were less than 50 years of life. Whereas 61.90% of patients with grade 1 spondylolisthesis were above 50.

Degenerative spondylolisthesis was the commonest type with 52.17% (n=12). Isthmic type were 21.74% (n=5), traumatic type 8.70% (n=2) and uncategorised 17.39% (n=4). 100% of all degenerative spondylolisthesis had disc space narrowing at the site of listhesis.
The first case of traumatic spondylolisthesis was a 33 year old lady with retrolisthesis of L1 on L2 with consequent focal lumbar spinal stenosis and spondylosis. The second case was a 32 year old male with spondyloptosis of T12 and L1 on L2 complicated by paraplegia. Anterolisthesis (91.30%, n=21) predominates over retrolisthesis (8.70%, n=2). Retrolisthesis were seen in a 33 year old female with L1 on L2 and 35 year old female with L5 on S1.

**DISCUSSION**

It is pertinent that the commonest type of spondylolisthesis we observed was degenerative. This is contrary to previous studies that observed predominance of isthmic spondylolisthesis (Irani, Z. 2009, Chain, J.C, 2004, Wikipedia. 2008). This may not be unconnected with sample bias, choice of radiological modality and the radiographic views we deployed in this study. The sample bias was beyond our control as our study was simply a reflection of who gets referred for x-ray of the lumbo-sacral spine. Also, since the symptomatology revolves on low back pain (LBP), the epidemiology of the studied population naturally skewed towards mid- and older age groups. Studies have found the incidence of LBP is highest in the third decade, and overall prevalence increases with age until the 60-65 age group and then gradually declines (Hoy, D. et al. 2010). In our environ, LBP is treated with levity and dismissed as inconsequential needing no investigations. Investigations become compelling when the LBP becomes intractable, persistent or chronic. Therefore, any local study on LBP will invariably mean advancing age inclusive study. Little wonder our studied population subsets that were 40 years and above were 78.31%. This will have an implication on the predominant type of spondylolisthesis. Degenerative type of spondylolisthesis is peculiar to this category of age group unlike isthmic type which is
peculiar to young athletics (Zukotynski, K. et al. 2010). In fact, it is a disease of the older adult and rarely occurs before the age of 50 years (Wikipedia, 2008, Eck, J.C. 2012, Ulmer, J.L. et al. 1994). The relationship to age is because it is a sequella of facet arthritis and facet remodelling (Chain, J.C. 2004, Wikipedia, 2008). As the facets remodel, they take on a more sagittal orientation, allowing a mild slip to occur (Wikipedia, 2008). Unlike isthmic spondylolisthesis, degenerative type is not associated with a neural arch defect meaning that the forward slip of the vertebral body also causes narrowing of both disc space and central spinal canal at the level of the translation (Wikipedia, 2008, Toueg, C.W. 2010). This narrowing of the canal has been termed the "napkin ring effect", a description that imagines the spinal canal as a series of napkin rings with one of the rings sliding forward relative to others (Wikipedia, 2008).

Another reason for predominance of degenerative spondylolisthesis in this study is its asymptomatic nature though it can be associated with symptomatic spinal stenosis (Eck, J.C. 2012, Niggemann, P. et al. 2011). In corollary, these patients will naturally present for lumbo-sacral radiography at an older age when the spondylolisthesis has now been made symptomatic by an attendant vertebral or disc disease. This will elevates the incidence of degenerative spondylolisthesis. The diagnosis of degenerative spondylolisthesis is made when in addition to vertebral displacement, other features like osteophytosis, disc space narrowing, end-plate sclerosis are seen (Pye, S.R. et al. 2007). But these features being antecedental or sequential to spondylolisthesis are precarious.

The spectrum of disease in isthmic spondylolisthesis range from bone stress (earliest sign) through spondylolysis (a non-displaced fracture of the pars interarticularis) and spondylolisthesis (Zukotynski, K. et al. 2010, Ulmer, J.L. et al. 1997). Bilateral pars defect is needed to allow slippage in isthmic spondylolisthesis and this is harbingered by trauma and fractures (Irani, Z. 2009, Bock, C., Stock, K. 2004). Sport specific maneuvers with repetitive twisting rotation and hyperextension (like gymnasts, football linemen and ballets)

Therefore the low percentage of isthmic spondylolisthesis in our study unlike other studies is two pronged. Our recruitment was less of young people and our methodology was bereft of bilateral oblique-lateral lumbo-sacral spine radiographic views. In oblique-lateral views, pars interarticularis is aptly demonstrated as the collar in the Scottie dog appearance of vertebral components (Irani, Z. 2009).
Spondylolysis may not always be visible on lateral radiographs (Irani, Z. 2009). But defect in pars articularis(spondylolysis) is the sine qua non in diagnosis of isthmic spondylolisthesis and higher sensitivity is achieved on exploit of right and left oblique-lateral radiographic views (Chain, J.C. et al. 2004). Since the later was not at our disposal, a few spondylolytic lesions may have been missed, resulting in misclassification of some identified spondylolisthesis (Chain, J.C. et al. 2004). These were regarded as uncategorised in this study as they have neither pars interarticularis defect, degenerative changes, bone pathology nor arose from trauma.

Radiographs of the spine have limited sensitivity compared with other imaging modalities in detecting bone stress and acute spondylolysis (Zukotynski, K. et al. 2010). More modern modalities like magnetic resonance imaging (MRI), computed tomography (CT), and single photon emission computed tomography (SPECT) arranged in increasing order of sensitivity in detecting pars articularis defect exist (Irani, Z. 2009). Wide canal sign (increased anterior posterior dimension of a spinal canal) resulting from disruption of vertebral ring present only in isthmic spondylolisthesis is well demonstrated by MRI (Ulmer, J.L. et al. 1994). MRI has the distinct advantage of multi-planarity but spondylolysis may not be readily apparent if there is a mild degree of bony sclerosis (Irani, Z. 2009).

CT is more specific than bone scintigraphy in spondylolysis detection and may predict the probability of ultimate bone healing (Zukotynski, K. et al. 2010). It readily identifies other associations like retro-somatic cleft, disk disease, and spinal canal stenosis (Irani, Z. 2009). However, occasionally spondylolysis can also be missed, since CT scanning occurs in the plane of the spondylolysis or from volume averaging (Zukotynski, K. et al. 2010).

Diagnosis of spondylolisthesis is not made with scintigraphy but if SPECT is negative, pars stress is unlikely (Zukotynski, K. et al. 2010). This is because SPECT is very sensitive for the detection and anatomic localization of bone stress (Zukotynski, K. et al. 2010). This is aided by abnormal uptake of scintigraphic tracer induced by bone stress or local
bone remodeling (Huang, K. et al. 2009). In general, when bone stress or spondylolysis is suspected, bone scintigraphy with SPECT is recommended. If SPECT demonstrates a pars lesion, a thin-cut CT (1 mm axial sequence) through the area of abnormality on SPECT, is recommended to confirm the diagnosis and stage the lesion (Zukotynski, K. et al. 2010).

All our cases of traumatic spondylolisthesis had sinister clinical presentations in the form of paraplegia. The horrendous culprit was road traffic accident (RTA). RTA and falls are the commonest causes of bilateral avulsion of the neural arches from the vertebral body with or without subluxation (Sirkis, H.M. 2005).

It is not surprising that neither dysplastic nor pathological spondylolisthesis was seen in this study since they are rare entities (Wikipedia. 2008, Chadha, M. et al. 2006).

Anatomic predisposition favours the occurrence of spondylolisthesis in lower lumbar vertebrae irrespective of being degenerative or isthmic. Our commonest site is L4 on L5 followed by L5 on S1 as seen in other studies (Eck, J.C. 2012, Huang, K. et al 2009, Bock, C., Stock, K. 2004, Aono, K. et al. 2010). Bone stress is known to be commonest at L5, due to vulnerability to micro-trauma from repetitive flexion, extension, rotational forces or increased loading (Zukotynski, K. et al. 2010, Toueg, C.W. 2010). Also lower lumbar vertebrae have some wedge shape, with progression of the wedge values down the spine encouraging spondylolisthesis (Wilms, G. et al. 2009). This is because anatomically, the size of the vertebral bodies progressively increases from C1 to L5 (Wilms, G. et al. 2009). At thoracic and lumbar level, the vertebral body height increases caudally, except posteriorly where it decreases in the lower lumbar region to create lumbar lordosis (Wilms, G. et al. 2009). Furthermore, the increased incidence of L5 vertebral anterolisthesis could be due to the complementary role of anterior-posterior lumbo-sacral radiograph to lateral view (Gentili, A. et al 2000). It typically shows an inverted Napoleon Hat sign (Gentili, A. et al
This sign which is reserved for spondylolisthesis of the L5 vertebral body will reveal the anterior border of the transverse process of L5 in continuity with the anterior border of the body of the same vertebrae in frontal radiograph. This continuous anterior border of the L5 vertebra will be projected against the shadow of the sacrum, and appear as an upside-down (or inverted) Napoleon hat (Gentili, A. et al 2000).

Despite the unintended male bias in our population recruitment, in general there is still an overriding incidence of spondylolisthesis among females (See figure 1). This female tilt has been noticed in other studies (Chain, J.C. et al. 2004, Wikipedia, 2008, Eck, J.C. 2012, Wilms, G et al. 2009). This disproportionate sex ratio has been unaccounted in the literatures. Future studies on interrelationship of spondylolisthesis and sex hormone profiles will therefore be exciting.

Grade 1 spondylolisthesis predominates just like in other studies (Wikipedia, 2008, Eck, J.C. 2012). (See figure 2). Degenerative slippage rarely exceeds 30% of vertebral width. [Eck, J.C. (2012)]

The majority of low-grade slips are asymptomatic and do not progress past a patient’s initial presentation (Wikipedia, 2008). Prospective studies on children with low-grade slips have demonstrated that once a slip occurs, it rarely worsens, even after 40 years of follow-up (Wikipedia, 2008). High-grade slips on the other hand are much rarer, representing less than 10% of all isthmic slips, and the vast majority present during adolescence. (Wikipedia, 2008). However, high-grade slips do continue to progress in many cases and are much more likely to cause pain and significant amount of lumbo-sacral kyphosis. (Wikipedia, 2008, Dernard, P.J. et al. 2010). Some cases do eventually progress to complete spondyloptosis and prevention of progression is the primary focus of surgery for high-grade slips. (Wikipedia, 2008, Sirkis, H.M. 2005).
The treatment of spondylolisthesis is conservative but surgery is contemplated in the presence of treatment unresponsiveness, intractable LBP or radiculopathy (Tender, G.C. 2011). Conservative treatment consists of activity modification, chiropractic treatment, pharmacological intervention and physical therapy consultation. (Wikipedia. 2008, Weinstein, J.N. et al. 2007). Surgical treatment is only considered after at least 6 weeks and often only after 6–12 months of non-operative therapy has failed to relieve symptoms. (Wikipedia. 2008). The surgical goals are neural decompression and solid bony fusion. (Tender, G.C. 2011). Surgical methods include posterior interlaminar fusion, in situ posterolateral fusion, in situ anterior fusion and in situ circumferential fusion (Wikipedia. 2008), Tender, G.C. 2011).

The limitation of this study is the non-utilization of bilateral oblique-lateral views. This may probably increase the incidence of isthmic type of spondylolisthesis in our environment but our patients were not just ready to tolerate further receipt of radiation dose. Nevertheless, we think this drawback does not understate our findings as lateral radiograph still serves as alternative in detecting the spondylolytic component of isthmic spondylolisthesis.

CONCLUSIONS

There is a disproportionate female gender bias in spondylolisthesis in Uyo, Nigeria. While the typical predominance of grade 1 and slippage localisation of L4 on L5 are obeyed, contrariwise, degenerative spondylolisthesis predominates over the usual isthmic type.

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Staff of Radiology Department, UUTH, Uyo, Nigeria

Competing interests
The authors declare that they have no competing interests

Authors' contributions

This work was done in collaboration with all authors. UFU conceived and designed the study. UFU and DEN wrote the protocol and the first draft of the manuscript. UFU, DEN, NTE, EDU managed the analysis, literature searches and tables/figures. All authors revised and approved the revised manuscript.

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TABLE 1
SEX DISTRIBUTION
OF
SPONDYLOLISTHESIS

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TABLE 2
VERTEBRAL DISPLACEMENTS WITH AGE RANGE

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Fig. 1. Sex distribution and age range of spondylolisthesis.

AGE RANGE
SERIAL 1=MALES, SERIAL 2=FEMALES
Fig. 2. Grading of spondylolisthesis.

Fig. 3. Lateral lumbo-sacral spine radiograph showing traumatic spondylolisthesis of L1 on L2 with focal lumbar spinal stenosis and anterior wedging of L1.