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CORRELLATIONS OF RADIOGRAPHIC FINDINGS IN LUMBO-SACRAL DEGENERATIVE DISC DISEASES IN UYO, NIGERIA: A CROSS-SECTIONAL STUDY OF 1400 DISCS

Felix U. Uduma † [1], Ngozi R. Njeze [2] and Tim E. Nottidge [3]

ABSTRACT

Background: Degenerative disc disease (ddd) is an age related morphological changes of intervertebral discs and facets joints. Objectives: Determining frequency of radiographic occurrence of disc space narrowing, osteophytes, endplate sclerosis, and vacuum phenomenon in lumbo-sacral degenerative disc diseases. Materials and methods: A cross-sectional study from 1st may, 2011 to 25th july, 2012 on patients consecutively referred to radiology department of university of uyo teaching hospital, uyo, nigeria for lumbo-sacral radiography. Standard radiographic positioning was maintained with centering at l2 and radiographs were restricted to antero-posterior and lateral. L1/l2, l2/l3, l3/l4, l4/l5 and l5/s1 of each radiograph were analyzed for the four components of ddd. Statistical analysis was done using ssps 15. Results: 280 patients (151 males and 129 females) aged 10-89 with mean age of 49.5 were studied. Predominant populations (n=222, 79.28%) were 40years and above with 93.26% of them having ddd. A total of 1400 individual disc spaces were studied. Degenerative changes were seen in 780(55.71%) disc spaces. These 780 disc spaces were associated with a total of 950 identifiable separate lesions .Of this, the commonest lesion was osteophytosis with n=729 (76.74%). Others were disc space narrowing n=137 (14.42%), end-plate sclerosis n=51 (5.37%) and vacuum phenomenon n=33 (3.47%). Marginal osteophyte was the predominant. (47.32%). All four radiographic features of ddd had peak frequency at l4/l5 disc space. Conclusions: Osteophytosis, disc space narrowing, end-plate sclerosis and vacuum phenomenon is the order of decreasing frequency of radiographic components of lumbo-sacral degenerative disc diseases in uyo, Nigeria.

KEYWORDS: Degenerative, Disc space,Osteophytes.

INTRODUCTION

Degenerative disc disease refers to morphological changes of intervertebral discs and facet joints with clinico-pathological and radiological features. It results from abnormalities of metabolism, vascularity and nutrition of intervertebral disc cartilages [1]. Its aetiologies are variable but cardinal is advancing age [2, 3]. Degeneration and aging have been found to be very similar processes, albeit occurring at different rates [1]. The consequences of disc degeneration are disc desiccation, disc herniations, annular fissuring, narrowing of the disc space, sclerosis of the endplates, and osteophytosis at the vertebral apophyses [1].

The major cartilaginous joint (amphiarthrosis) of the vertebral column is the intervertebral disc [1]. The zygoapophyseal or facet joint is a diarthrodial articulation consisting of superior articulating process of one vertebra which is separated from the inferior articulating process of the vertebra above by a synovium-lined joint [1]. Like all diarthrodial synovium lined joints, the lumbar facet joints are predisposed to arthropathy with alterations of the articular cartilage [1].

Degenerative disc disease (DDD) is ubiquitous with high prevalence among symptomatic and asymptomatic individuals [1]. Symptomatic cases frequently presents as low back pain. Low back pain on its own is a common clinical presentation with as much as 80% of people having such complaint in their life time [2].

Radiological signposts of DDD are the presence of osteophytes, end-plate sclerosis and disc space narrowing [1,2.4-7]. An additional radiological finding is vacuum phenomenon or phatom disc. These four features are all adequately displayed by radiological tools like conventional radiography, computed tomography (CT) and magnetic resonance imaging (MRI). The last two are modern neuroimaging techniques which have improved the diagnosis and detection of DDD [2]. But they are expensive imaging modalities that are not usually available in several of our communities. Consequently, conventional radiography is still used in the initial assessment of lumbo-sacral spine for low back pain whose aetiologies include DDD [2]. Therefore since the four aforementioned radiological diagnostic parameters for degenerative disc diseases are succinctly displayed with conventional radiography coupled with its cheapness and availability, we feel obliged to use it in this study.

[1] Department of Radiology, Faculty of Clinical Sciences, College of Health Sciences, University of Uyo, Nigeria
[2] Department of Radiology, Faculty of Health Sciences and Technology, College of Medicine, University of Nigeria, Enugu, Nigeria
[3]Department of Trauma and Orthopaedics, Faculty of Clinical Sciences, College of Health Sciences, University of Uyo, Nigeria

AIM

To determine the frequency of occurrence of four radiographic components of degenerative disc diseases of lumbo-sacral spine namely the presence of disc space narrowing, osteophytes, endplate sclerosis, and vacuum phenomenon.

MATERIALS AND METHODS

This is a cross-sectional descriptive study of the paired lumbo-sacral radiographs of patients referred for lumbo-sacral x-rays to Radiology department of University of Uyo teaching hospital, Uyo, Nigeria. These were consecutive patients referred on any account. The study period covered was from 1st May, 2011 to 25thJuly, 2012. Standard radiographic positioning was maintained in all the radiographs with centering at L2 level. Investigations were restricted to paired antero-posterior and lateral views of plain lumbo-sacral radiographs as these were adequate for our study and secondly to minimize radiation dose to our patients. Radiographs were reviewed by the researchers who are trained Radiologists and Orthopaedic Surgeon. The data was then entered and analyzed using SPSS (statistical package for scientific solution) version 15.

The four features of disc degenerative diseases which we are studying such as disc space narrowing, osteophytes, endplate sclerosis and vacuum phenomenon were sought for. The presence of osteophytosis and endplate sclerosis were documented for the vertebra (e) involved. The locations of the osteophytes were entered as anterior and posterior where present using lateral radiographs. Whereas osteophytes lateral to vertebra using anterior-posterior radiographs were recorded as marginal (lateral) osteophytes. The presence of disc space narrowing and vacuum phenomenon were documented for the disc space level involved. Only consenting patients with complete bio-data sourced either from request form or interrogations were recruited in this study. Non-reportable radiographs were excluded.

RESULTS

A total of 280 patients aged 10-89 with mean age of 49.5 were studied. Males were 151 with median of 13 and females were 129 with median of 5.5. Male to female ratio of studied population was 1.17:1. Predominant populations were 40years and above constituting 79.28% (n=222) of studied population. This was shared into males (54.05%) and females (45.95%). 272(97.14%) of all studied patients had presenting complaint of low back pain. A total of 1400 individual disc spaces were studied and these consist of L1/L2, L2/L3, L3/L4, L4/L5 and L5/S1 disc spaces. Degenerative changes were seen in a total number of 780 disc spaces constituting 55.71% of all studied disc spaces. These 780 disc spaces were associated with a total of number of 950 identifiable separate lesions. Of this, the commonest lesion was osteophytosis with n=729

(76.74%). Others were disc space narrowing n=137 (14.42%), end-plate sclerosis n=51 (5.37%) and vacuum phenomenon n=33 (3.47%). The predominant osteophytosis was marginal osteophytes with a total of 345 (47.32%) and male to female ratio of 1.24:1. This was followed by anterior osteophytes n=334 (45.82%) with male to female ratio of 1.40:1. Posterior osteophytes were the least with a total of 50 (6.85%) and male to female ratio of 1.27:1. The peaks of osteophytosis were noted in the 5th and 6th decades. This was seen in all types of osteophytes.

All 4 radiographic features of degenerative disc diseases like disc space narrowing, osteophytes, end-plate sclerosis and vacuum phenomenon increased down the disc level peaking at L4/L5. For example, total osteophytes were 35 (4.80%) in number at L1 level, 92 (12.62%) at L2, 205 (28.12%) at L3, 226 (31.00%) at L4 and 171 (23.46%) at L5. L1/L2 disc narrowing were 6 with male to female ratio of 5:1., L2/L3 were 16 with male to female ratio of 2.2:1, L3/L4 were 38 with male to female ratio of 2.8:1, L4/L5 were 45, L5/S1 were 9 with male to female ratio of 3.5:1. Vacuum phenomenon was also commonest at L4/L5 followed by L5/S1. End-plate sclerosis at L1/L2 were 0, L2/L3 were 3(all in males), L3/L4 were 10 with male to female ratio of 9:1, L4/L5 were 21 with male to female ratio of 1.6:1. The total number of individual components of DDD in patients who were 40years and above were 886 in number corresponding to a percentage of 93.26% of total population individual radiographic lesions. The predominant lesion in this age cut-off was osteophytes with 93.26% (n=679) of total number of osteophytes irrespective of type.

DISCUSSIONS

From the foregoing, degenerative disc disease (DDD) is an age related phenomenon as our harvest of population sample and radiographic findings of DDD were predominantly among enrollees 40years and above. Age is known to be a significant factor in DDD aetiogenesis despite other contributory factors. Such considered contributions are aging, apoptosis, collagen abnormality, vascular supply anomaly, mechanical stress, inflammation, abnormal proteoglycan and genetics [1,2,4,7,8,] [2] Aging appears so paramount that Igbinedion and Akhigbe observed that 100% of their studied patient above 80years had radiographic features of disc degeneration[2].

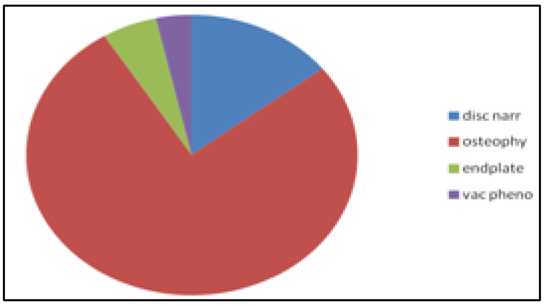

Figure 1. Pie-Chart Showing Percentages of Radiographic Components of DDD.

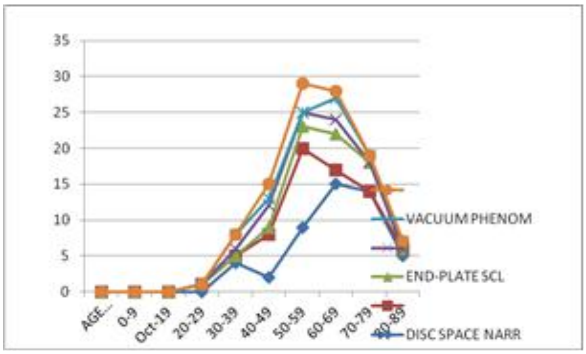

Figure 2. Graph Showingdisc Space Narrowings, Endplate Sclerosis and Vacuum Phenomenon Changes at L4/L5 Disc Space

DDD is a chronic process that is characterized in part by progressive loss of proteoglycans and water content in nucleus pulposus[8]. It includes any or all of the followings like desiccation, fibrosis, disc space narrowing, diffuse bulging of the annulus beyond the disk space, extensive fissuring (ie, numerous annular tears), mucinous degeneration of the annulus, defects and sclerosis of the endplates, synovial cyst, alignment disorders intravertebral herniation (Schmorl's node), osteophytes, central vacuum phenomenon, intervetebral disc osteochondrosis (or fused disc) and spondylosis deformans[1]. This study is limited to only four parameters which are disc space narrowing, osteophytes, endplate sclerosis and vacuum phenomenon

This evaluation is necessary as bulging degenerated intervertebral disc as well as posterior and some exuberant lateral osteophytes may impinge on the intervertebral foramina or central spinal canal [2]. This consequently leads to radiculopathy, myelopathy, central spinal stenosis, disc herniations and intermittent claudication[2,8,9]. But the degree of degeneration is by no means a marker for duration or severity of symptoms as DDD have been shown in asymptomatic individuals [2,4]. Multi-level disc involvement explains why the number of affected disc spaces outweighed the number of affected patients in this study. Lesion co-existence on a single disc level also explains why the number of components of individual radiographic features of DDD outweighed the number of disc level involvement. This co-existence were commonest with anterior and marginal osteophytes and osteophytes and disc space narrowings. In agreement with other studies, all our 4 studied components of DDD were commonest at L4/L5 followed by L3/L4 and L5/S1 [2,10]. [10]Kasai et al reported that the degree of disc degeneration tended to be higher in L3–L4, L4–L5, and L5-S1 than in L1–L2 and L2–L3. Lower lumbar disc spaces are the point of maximal force of transmission of the weight of the upper part of the body to the pelvic girdle [2].

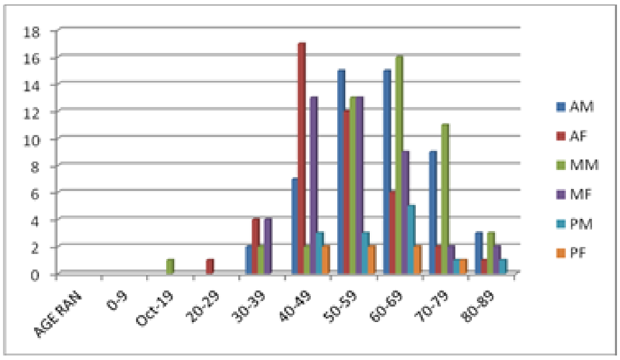

Figure 3. Bar Chart Of Osteophytosis at L3 (AM=Anterior osteophytes in males, AF=in females, MM=marginal osteophytes in males, MF=in females,PM=posterior osteophytes in males, PF=in females)

As mentioned previously,radiologic diagnostic markers of DDD are the presence of disc space narrowing, osteophytes, end-plate sclerosis and vacuum phenonmenon[1,2,4, 5, 6,7]. The intervertebral disc (IVD) is composed of the nucleus pulposus (NP) centrally, the annulus fibrosus (AF) peripherally, and the cartilaginous endplates cranially and caudally at the junction to the vertebral bodies [7]. The nucleus pulposus is eccentrically located and more closely related to the posterior surface of the intervertebral disk, encouraging disc herniation [1]. The NP has an abundance of proteoglycans which allows for absorption of water conferring on it the power to handle axial loads [1,7]. It is known that the matrix of a healthy nucleus pulposus is rich in type II collagen, whereas the annulus fibrosus is rich in type I collagen [8]. The proteoglycan content of the disc declines with age, a process that partly reflects decreased synthesis of these macromolecules by the disc cells and a greater water loss from the nucleus pulposus than from the annulus [7.8]. This explained the observed progressive decline in disc space with age in our study.Nucleus dehydration results in decreased hydrostatic properties of the disk, with an overall reduction of hydration in both areas to about 70% a from over 85% by volume in juvenile [1]. Disc dehydration also leads to increased ratio of keratin sulphate to chondroitin sulphate with reduction of disc tensile strength, decreased disc height and altered load-bearing capacity[1,4,8]. The disc becomes progressively more fibrous,disorganized, with the end stage represented by amorphous fibro-cartilage with no clear distinction between nucleus and annulus[1]. This gives an overall picture of disc space narrowing. Disc space narrowing in our study increased with age peaking earlier in females (5th decade) unlike 6th decades in mals. This earlier female peak may not be unconnected with sex hormonal influence. The process of degeneration compares to the process of aging in many ways but disc degeneration often occurs at a faster rate, making DDD a condition often encountered in patients of working age [7]. 75.18% of our patients with disc space narrowing belonged to the working age. Whatever the etiology, by the age of 50 years, 85%–95% of adults show evidence of degenerative disk disease at autopsy[1].The highest freqency of disc space narrowing was at the level of L4/L5 (47.77%) followed by L3/L4 level. Failure of disks seen as disc space narrowing is more common in areas where there are the heaviest mechanical stresses, such as the lower lumbar region [1, 4].

Osteophytes are intra-articular osteochondral tissues, which are usually found at the margins of degenerating synovial joints [11]. They are sclerotic or hyperplastic changes at the edge of the vertebral body heralded by intervertebral disc degeneration [2]. The aetiology or pathogenesis of osteophyte has been a subject of protracted debate [11]. Disc degeneration causes increasing flexibility between the vertebral bodies and consequent mechanical stress on the ossification centers of bones under the cartilage of the vertebral body leading to formation of osteophytes [2]. The continuity between the cartilage mantle of osteophyteso and the adjoining normal articular cartilage may suggest that in the formation of osteophytes, the chondrocytes from the adjoining normal articular cartilage greatly influence the mesenchymal tissue precursor of osteophyte to differentiate along a chondrocytic pathway initially. With subsequent vascular invasion probably from the periosteum, the neocartilage develops a bony core with a completely separate blood supply from that of the adjoining subchondral bone [11]. Other reasoning is that Like the syndesmophytes, osteophytes may be caused by the ossification of the anterior longitudinal ligament and the annulus fibrosus of the intervertebral disc [10,12].Be that as it may, osteophytes help in the stabilization of the spine that has suffered cartilage loss or biomechanical stress[4,12].Like other studies, osteophytosis was the most frequent radiographic feature of DDD [4].

Osteophytic co-existence was a commonplace in this study and this was commonest with anterior and marginal osteophytosis. In all types of osteophytosis, males are more affected than females as noted in other studies due to heavy physical activities [2,10]. More than 90% of our patients have osteophytes more than at least one vertebral level like other studies[22][10] This multi-level involvement implies no disc is spared by degeneration albeit at different degrees. The commonest sites of osteophytic location in this study are L4 and L3 [2]. 30.31% at L4, 28.12% at L3 and 23.46% at L5, 12.62% at L2 and 4.94% at L1. Lower lumbar vertebrae are the sites that are most prone to vertebral instability thus requiring stabilization with osteophytes [10]. Osteophytes are age-related phenomenon occurring in increasing frequency with advancing age[2,13].99.18% of osteophytes were seen in our enrollees aged 30years and above. This is similar to the remarkable frequency of osteophytes in patients above 31 years where most of the working population and elderly falls into [2]. Marginal osteophyte is the commonest type of osteophytosis we noted (47.82%) against 45.82% of anterior osteophytes This is in contrast to another study in Benin, Nigeria where anterior osteophytes were more common than marginal osteophytes [2]. They adduced the instability and mobility of the anterior part of the vertebral body as being the predisposing factors for the formation of anterior osteophytes[2]. Posterior osteophytes were seen to commence later in life from 4th decade. Posterior osteophytes(6.86%)were the least as in other studies[1,2].

The intervertebral joint is a three-joint complex consisting of endplate-disk-endplate [1]. In the course of DDD, a supportive phenomenon occurs in the form of endplate osteosclerosis and chronic reactive bone marrow changes. This thickening and eburnations of end plates correlates with extensive bony sclerosis on plain radiographs and as type 3 Modic changes on MRI where the endplates appear as decreased signal intensity on both T1- and T2-weighted images [1,14]. This is not surprising when one considers the histology. The sclerosis seen on plain radiographs is a reflection of dense woven bone within the vertebral body, whereas the MR changes are more of reflection of the intervening marrow elements [1]. Endplate sclerosis was first observed by us in the 4th decade of life and their frequency increased down the disc spaces until the 4th disc spaces. Mechanical impact which is antecedent to disk degeneration leading to endplate damage is worst in the lower disc levels [1].

Accumulation of gas within the intervertebral disc is called vacuum phenomenon. This was initially described by Magnusson and later by Knutsson[15]. In all ages, it can be identified in 1%-3% of patients but in 20% of elderly patients [15]. Distraction of the joint surfaces or extension of the spine producing negative pressure or both sucks nitrogen from the surrounding tissues[15,16,17,18] It occurs most often in the lumbar region, but can be found at any spinal level[15]. Vacuum phenomenon is, mostly related to degenerative processes, but rare cases have also been reported in pyogenic infections, tumours, pneumorrhachis, dislocations, trauma, pneumothorax, iatrogenic instrumentation such as percutaneous vertebroplasty and spinal surgery[1,18,19,20,21]. This occurs when the vertebral malignancy or infection abuts the cartilaginous end plates interfering with disc nutrition[15]. Occassionally, gas has escaped as bubbles into the spinal fluid or epidural space[15,21].This is because clefts resulting from disc dessication in DDD that initially develop within the central nucleus may eventually radiate to and then subsequently extend through the walls of the annulus fibrosis, permitting the contained gas to escape into spinal canal[15,21].

On imaging studies, a vacuum disc can be recognized as a lucency within either the intervertebral disc or a synovial joint as a direct product of the liberation of a gas consisting of 95% nitrogen and lesser amounts of oxygen and carbon dioxide into the disc as well as joint space [1,15, 22]. CT is the best imaging method of the evaluation of the gas in the lumbar spine due to the heavily negative Hounsfield units of the gas [16,22,]. The gas collection can range in size from a few millimeters to 1 centimeter and in density from – 200 to – 900 Hounsfield units. Rim enhancement can be seen[21]. Vacuum phenomenon is a relatively common radiologic finding, seen in 46% of cases on CT examinations[21]. The vacuum phenomenon within a degenerated disk is represented on MRI spin echo images as areas of signal void on T1- and T2- weighted images. Postgadolinium rim enhancement is seen in both MRI and CT[1.21].

As a limitation of this study, we would not fail to mention that patients referral to our department for lumbo-sacral radiography were beyond our control. Thus, we are planning to conduct a similar study targeting the general population. In that future study, we will attempt to grade these four components of DDD and determine the direction of osteophytes with respect to disc levels. This we hope will serve as template in categorising the severity of DDD.

ESSENTIALS

- In descending order of frequency, the individual radiographic components of degenerative disc disease of lumbo-sacral spine in Uyo, Nigeria are osteophytosis, disc space narrowing, end-plate sclerosis and vacuum phenomenon.
- Anterior osteophytes were the commonest osteophytosis and posterior osteophytes were the least.
- Multi-level disc involvement was predominant and the frequency of co-existence was commonest between osteophytosis and disc space narrowings.
- All four components showed increased frequencies down the disc spaces peaking at L4/L5 disc space.
- They also increased with age peaking at 5th and 6th decades in females and males respectively.

FOOTNOTES

Authors stated no financial relationship to disclose.

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Studied population			
Age ran	Males	Females	
0-9	0	0	
Oct-19	5	2	10
20-29	11	9	24.6
30-39	15	16	34.5
40-49	26	41	44.5
50-59	34	42	54.5
60-69	32	15	64.5
70-79	20	2	74.5
80-89	8	2	84.5
90-99	0	0	
TOTAL	151	129	280

	Disc space narr		Ant	Osteo	Marg	Ost	Post	Osteo	Endplate sclero		Vacuum phenomenon	
Age Ran	M	F	M	F	M	F	M	F	M	F	M	F
0-9												
Oct-19	1				2							
20-29		1	1	3								
30-39	8	4	7	7	9	17					4	0
40-49	4	9	21	49	15	43	7	9	2	6	1	3
50-59	17	20	55	48	50	52	3	6	12	4	1	9
60-69	35	5	55	20	61	27	15	5	13	2	7	1
70-79	23	0	39	7	43	4	2	2	12		3	2
80-89	9	1	17	5	11	11	1				2	0
90-99												
	97	40	195	139	191	154	28	22	39	12	18	15
				334		345		50				

L1/L2						
	Disc space narr		End-plate scl		Vacuum phenom	
Age Ran	M	F	M	F	M	F
0-9						
Oct-19	1					
20-29						
30-39	1					
40-49						
50-59		1				1
60-69	3				1	
70-79						
80-89						
90-99						
		8				

L2/L3						
	Disc space narr		End-plate scl		Vacuum phenom	
Age Ran	M	F	M	F	M	F
0-9						
Oct-19						
20-29						
30-39	1	1			1	
40-49						
50-59	2	3	1			1
60-69	3	1				
70-79	1		2			
80-89						
90-99						
				17		

L3/L4						
	Disc space narr		End-plate scl		Vacuum phenom	
Age Ran	M	F	M	F	M	F
0-9						
Oct-19						
20-29						
30-39	2	2			0	
40-49	2	3		1		1
50-59	6	3	4			
60-69	9	2	3			
70-79	6		2		1	
80-89	4					
90-99						
		51				

L4/L5						
	Disc space narr		End-plate scl		Vacuum phenom	
Age Ran	M	F	M	F	M	F
0-9						
Oct-19						
20-29	0	1				
30-39	4	1		1	2	
40-49	2	6	1	3	1	2
50-59	9	11	3	2	0	4
60-69	15	2	5	2	3	1

70-79	14	0	4		1	
80-89	5	1			1	
90-99						
				107		

L5/S1

	Disc space narr		End-plate scl		Vacuum phenom	
#	M	F	M	F	M	F
0-9						
Oct-19						
20-29						
30-39				1	1	
40-49			1	2		1
50-59		2	4	2	1	4
60-69	5		5		3	
70-79	2		4		1	1
80-89					1	
90-99						

L1

	Ant osteophytes		Marginal Osteo	Osteo	Post
	M	F	M	F	M
Age Ran					
0-9					
Oct-19					
20-29					
30-39		1		1	
40-49	1	1	1	2	
50-59	5	1	2		
60-69	1		4	1	
70-79	3	1	5		
80-89	1	1	1	2	
90-99					
		36			

L2

Ant	Osteo	Marg	Osteo	Post
M	F	M	F	M
	1			
1	2		3	
3	7	1	3	
8	6	5	4	
9	2	9	2	2
6	1	4	1	1
7	1	1	2	
		92		

L3

	Ant Osteophytes		Marginal Osteo	Osteo	Post	Osteo
	AM	AF	MM	MF	PM	PF
Age Ran						
0-9						
Oct-19			1			
20-29		1				
30-39	2	4	2	4		
40-49	7	17	2	13	3	2
50-59	15	12	13	13	3	2
60-69	15	6	16	9	5	2
70-79	9	2	11	2	1	1
80-89	3	1	3	2	1	
90-99						205

L4

Ant	Osteo	Marg	Osteo	Post	Osteo
M	F	M	F	M	F
1	1				
2		4	6		
7	15	7	16	2	3
17	15	16	18		2
16	7	18	10	5	2
11	2	14			
3	1	3	2		
					221

L5

Ant	Osteo	Marg	Osteo	Post	Osteo
M	F	M	F	M	F
		1			
2		3	3		
3	9	4	9	2	4
10	14	14	17		2
14	5	14	5	3	1
10	1	9	1		1
3	1	3	3		
					171

	Disc Nar	L1/L2	L2/L3		L3/L4		L4/L5		L5/S1	
	M	F	M	F	M	F	M	F	M	F
Age Ran										
0-9										
Oct-19	1									
20-29										
30-39	1		1	1	2	2	4			
40-49					2	3	2			2
50-59		1	2	3	6	3	9			
60-69	3		3	1	9	2	14		5	

70-79			1		6		14		2	
80-89			4		3		2			
90-99										
	5	1	11	5	28	10	45	0	7	2

Vac Phe	LI/L2		L2/L3		L3/L4		L4/L5		L5/S1	
	M	F	M	F	M	F	M	F	M	F
Age Ran										
0-9										
Oct-19										
20-29										
30-39					1		2		1	
40-49						1	1	1		1
50-59		1		1				3	1	4
60-69	1						3	1	3	
70-79					1		1		1	
80-89							1		1	
90-99										
	1	1	0	1	2	1	8	5	7	5