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Quantification of Intervertebral Space of Lumbar Spine in Lower Back Pain Affected People

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Abstract

Lower Back Pain (LBP) is the usual medical issue which persist in most of the individuals of different age group. The percentage of people globally would have experienced LBP once in their life time is greater than 80. Lower back is the set of 5 bones named L1 to L5. Degenerative disc is a condition in which one or more number of intervertebral discs depreciate or breaks down and leads to painful state. In this work the intervertebral space where an elastic rubbery disc is present is visualized. The lumbar region is concentrated and the intervertebral distance between each bone pair of lumbar spine is quantified. The X-ray images were processed and analyzed in LBP affected people.

Keywords: *Lower back pain, Lumbar spine, Image processing, Intervertebral space*

1. Introduction

Lower back pain (LBP) is the common issue all over the world. The lumbar spine (low back), consists of a intricate network of interconnecting bones L1-L5, tendons, ligaments, joints, nerves and muscles. Any malfunctioning in and around these area causes LBP. Degenerative disc, herniated discs, spinal stenosis, osteoarthritis, spondylolisthesis etc. are a few major causes of LBP. Out of which degenerative disc are too common in old and obese patients. It is affecting the people of all ages from children to elders. The LBP can be acute, sub-acute or chronic. There are a few risk factors results in LBP namely, age, obesity, body posture, occupation, and body mass index [1]. Fig.1 shows anatomy of lumbar spine. The various imaging modalities have been used in the diagnosis of this musculoskeletal pain. The imaging modalities include conventional X-ray, magnetic resonance imaging (MRI) conventional scintigraphy, computed tomography (CT), digital radiology and ultrasonography (US).

Fig.1. Lumbar spine

There are a good number of research outcomes and studies reported in the literature. Walter et al discussed the different modalities useful in analysis of musculoskeletal pain and identified the techniques used for origin of musculoskeletal pain [2]. Few of the modalities are not suitable for the diagnosis of LBP and they lead to adverse effects and serious complications. Ben et al

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illustrated the harms due to inappropriate imaging of LBP [3]. David [4] classified the disorders as mechanical and non-mechanical. The lumbar spinal stenosis and osteoarthritis fell under mechanical disorders whereas rheumatologic, endocrinologic, vascular and infectious, neoplastic and gynecologic were considered to be the non-mechanical disorders.

In the study carried out by Hoy et al [5], shown LBP as a global issue, its influence and prevalence period were analyzed. Louma [6] carried out a study on 164 subjects with various occupation and showed that there is an elevated threat of LBP with respect to all signs of disc degeneration. Podichetty et al [7] discussed the degeneration frequency, and showed that lumbar degeneration elevates sharply with age and is observed as a main source of discogenic LBP. Minna et al [8] showed the presence of progressive association between degenerative lumbar disk disease and LBP in youth using the MR imageries of LBP and asymptomatic subjects. Christina et al [9] steered a study and determined that LBP is related with physical activity at work, relaxation time, certain lifetime routine and demographic characteristics. Gregory et al [10] piloted a study on the twin pairs and sibling pair subjects using the risk features like occupation, smoking, physical exercise, MRI and body weight. Their results concluded that degeneration of lumbar disc and genetic influences were the key threat factors for LBP in women. A study was made to examine irregular lumbar spine MRI findings, and their pervasiveness and relativeness with LBP among 40 year old men and women by Per et al [11]. The results showed that most degenerative disc irregularities were reasonably associated with LBP. The toughest relations were revealed for anterolisthesis and modic changes.

Steven et al [12] analyzed low back pain in overweight children and adolescents, and found that musculoskeletal pain was common. The hip joints and knee, were certainly connected with additional bodyweight. Rahman et al [13] et al determined that overweight and obesity elevate the threat of LBP. Overweight and obesity also have the toughest relationship with seeking care for LBP and its chronic ailment. Feyer et al [14] analyzed that the physical and psychological factors play a major role in occupational LBP. Their findings has shown that administration of the inception of occupational LBP may be improved by supervision of psychological distress. In this work the significant feature like the intervertebral space of the lumbar spine of the subjects suffering from LBP were obtained. After studying the literature, the objectives were set to extract features of LBP from X-ray using image processing techniques. These features are further analyzed to comprehend the impact of aging and BMI on LBP.

2. Methodology

The data set was collected from hospital and research center. The study is done on 30 subjects with the average age of 46.6 years which includes male and female subjects. The X-ray images of the individuals suffering from LBP were acquired by the hospital and were collected to create the dataset. The ethical committee of the hospital approved the study and participants' informed consent was obtained during the procedure.

The image processing steps involved in the process are depicted in Fig. 2.

Fig. 2 The steps of LBP Analysis

The Gaussian filter is used as a part of preprocessing and is applied to the images to minimize noise and without losing the edge information in the images. The edges were preserved for the further analysis. The convolution operation using horizontal and vertical filters is done for detection of edges and results are shown in Fig.3.

The intervertebral space between each lumbar spine pair (L1-L2, L2-L3, L3-L4, L4-L5) is measured using the Euclidean distance approach at three points namely (a) Lateral -

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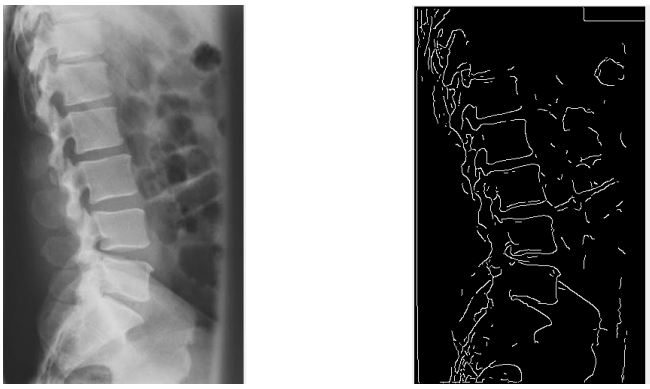
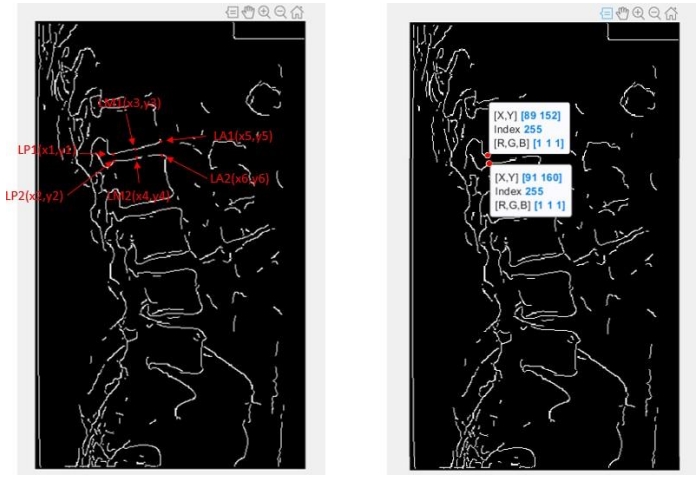


(a) **(b)**

Fig.3 Edge detection in lumbar spine (a) input X-ray image (b) edge detected image

Anterior (LA) (b) Lateral-Middle (LM) (c) Lateral-Posterior (LP). The measurements in LA, LM, LP regions for each subject are carried out manually three times to avoid intra observer variability and the average value is calculated as the intervertebral space. The measurements based on edge detected image are depicted in Fig. 4.



(a) **(b)**

Fig. 4 Measurement of intervertebral space (a) pair of LA,LM,LP points marked (b) coordinates at each marked point

3. Results

All the lumbar spine X-ray images of the dataset were processed and the intervertebral space is quantified. The intervertebral space measured in a typical LBP affected individual is tabulated in Table 1.

Table I. Intervertebral space between L1-L5

Iterations	Lumbar Spine Pair	LP mm	LM mm	LA mm	Mean mm	Inter-vertebral space mm
I	L1-L2	8.25	10.05	16.12	11.47	**11.28**
II		9.22	10.20	15.13	11.52	

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III		8.00	10.20	14.32	10.84	
I	L2-L3	10.20	13.60	14.32	12.71	**12.63**
II		10.20	13.15	15.52	12.96	
III		10.00	12.16	14.56	12.24	
I	L3-L4	11.05	18.03	19.42	16.16	**15.74**
II		10.05	16.76	19.10	15.30	
III		11.00	17.11	19.11	15.74	
I	L4-L5	10.69	17.32	23.29	17.10	**16.31**
II		12.38	17.23	19.23	16.28	
III		10.26	17.20	19.20	15.55	

LP-Lateral-Posterior, LM-Lateral-Middle, LA-Lateral-Anterior

Similar measurements were made on the processed X-ray of various cases of LBP subjects in the dataset and are tabulated in Table 2.

Table II. Intervertebral space between L1-L5 for all subjects

Region	L1-L2 mm	L2-L3 mm	L3-L4 mm	L4-L5 mm
Lateral Posterior	8.642	10.166	10.527	11.441
Lateral - Middle	10.062	13.395	17.271	17.257
Lateral Anterior	15.582	14.795	19.139	22.151
Mean Value	**11.428**	**12.785**	**15.646**	**16.950**

The Fig. 5 depicts the measurements between each lumbar spine pair. The dots in the graph represents the mean values of the measurement of intervertebral space between the lumbar spine pairs at LA, LM and LP. Further, these values obtained after three iterations are enumerated and the mean value of intervertebral spaces is calculated and represented as dots. The Table 2 shows the mean values of the intervertebral spaces between each lumbar spine and the graphical representation is made in Fig. 6.

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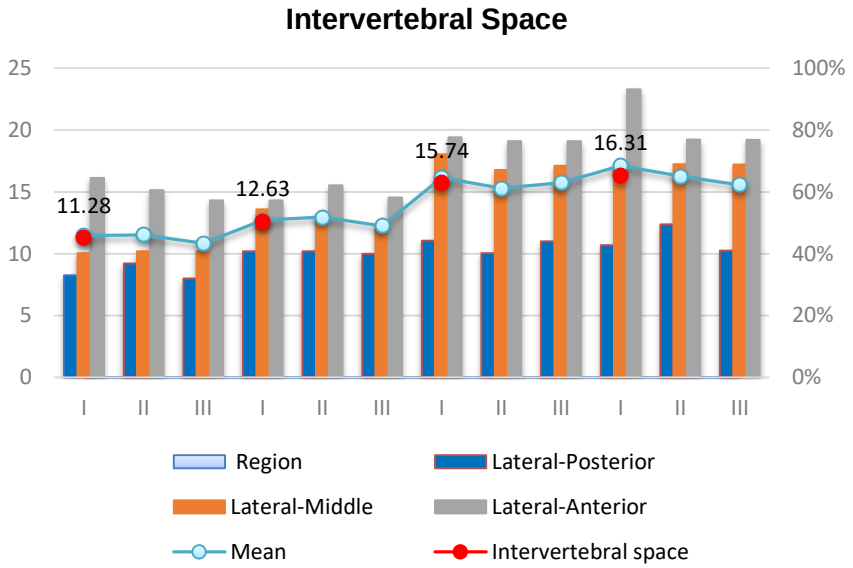

Fig. 5 Graphical representation of intervertebral space

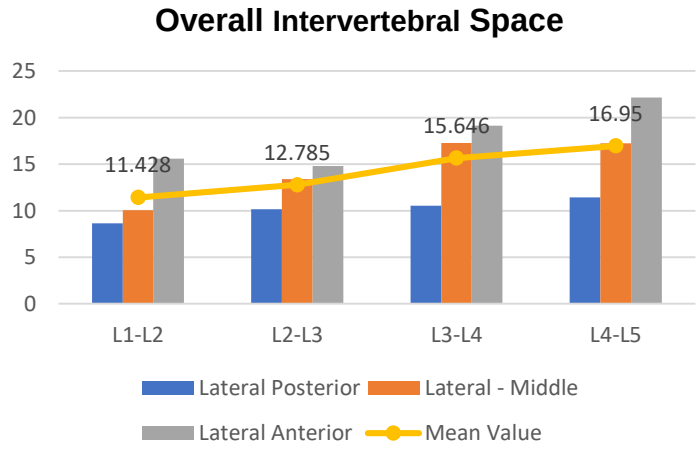

Fig. 6 The mean values of intervertebral disc space between L1-L2, L2-L3, L3-L4, L4-L5

4. Conclusion

The X-ray images were processed for visibility of lumbar spine. The lumbar space is measured for each pair in three different regions. Lumbar space is quantified in various cases of LBP subjects of the dataset. The procedure is based on image processing and is noninvasive. The quantified values are useful as features for further analysis of LBP. The quantified results are helpful in the progressive study of LBP patients by the doctors and treatment planning. The results indicate there seemed to be a slight deviation in the intervertebral spaces in aged and obese subjects which would be a result of various medical issues.

References

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[1] Taimela S, Kujala UM, Salminen JJ, Viljanen T. “The prevalence of low back pain among children and adolescents: a nationwide, cohort- based questionnaire survey in Finland”, Spine, Volume 22, Number 10, 1997, pp1132–1136.

[2] Walter Grassi, Emilio Filippucci, Marina Carotti, Fausto Salaffi, "Imaging modalities for identifying the origin of regional musculoskeletal pain", Best Practice & Research Clinical Rheumatology, Volume 17, Number 1, 2003, pp 17–32.

[3] Ben Darlow, Bruce B Forster, Kieran O’Sullivan, Peter O’Sullivan, "It is time to stop causing harm with inappropriate imaging for low back pain", British Journal of sports medicine, 2017. pp 414-415.

[4] David G. Borenstein, "Chronic low back pain", Rheumatic Disease Clinics of North America, Volume 22, 1996, pp 439 – 456.

[5] Damian Hoy, Christopher Bain, "A systematic review of the global prevalence of low back pain", American College of Rheumatology, Volume 64, Number 6, 2012, pp 2028–2037.

[6] Luoma, Katariina, MD, Riihimäki, Hilkk “Low back pain in relation to lumbar disc degeneration” Spine, Volume 25, Issue 4, 2000, pp 487- 492.

[7] Podichetty VK, “The aging spine: the role of inflammatory mediators in intervertebral disc degeneration.” Cell Mol Biol (Noisy-le- grand), Volume 53, Number 5, 2007, pp 4-18.

[8] Minna O. Erkintalo, Jouko J Salminen, “Development of degenerative changes in the lumbar intervertebral disk: Results of a prospective MR imaging study in adolescents with and without Low back pain”, Pediatric Radiology, Volume 196, Number 2, 1995, pp 529-533.

[9] Christina Björck-van Dijken, Anncristine Fjellman-Wiklund, “Low back pain, lifestyle factors and physical activity: a population-based study” J Rehabil Med, Volume 40, 2008, pp 864-869.

[10] Gregory Livshits, Maria Popham, Ida Malkin, Philip N Sambrook, Alex J MacGregor, Timothy Spector, Frances M K Williams, “Lumbar disc degeneration and genetic factors are the main risk factors for low back pain in women: the UK Twin Spine Study”, BMJ Journals, 2014, pp 1740 – 1745.

[11] Per Kjaer, PT, Charlotte Leboeuf-Yde, “Magnetic resonance imaging and low back pain in adults: a diagnostic imaging study of 40-year- old men and women”, Spine Volume 30, Number 10, 2005, pp1173– 1180.

[12] Steven D Stovitz, Perrie E Pardee, Gabriela Vazquez, Sue Duval, “Musculoskeletal pain in obese children and adolescents” , Foundation Acta Pediatrica, Volume 97, 2008, pp 489-493.

[13] Rahman Shiri, Jaro Karppinen, Paivi Leino-Arjas, Svetlana Solovieva, and Eira Viikari-Juntura “The association between obesity and low back pain: a meta-analysis”, American Journal of Epidemiology, Volume 171, Number 2, 2009, pp 135-154.

[14] Anne-Marie Feyer, Peter Herbison, Ann M Williamson, Indira de Silva, John Mandryk,Leigh Hendrie, Max C G Hely, “The role of physical and psychological factors inoccupational low back pain: a prospective cohort study”, Occup Environ Med, 2000, pp 116-120.

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