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A 3-Model Postural Theory of Non-Specific Low Back Pain (NSLBP)

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ABSTRACT

Non-specific low back pain has become a great challenge to practitioners all around the world the problem being the lack of understanding of its pathology. This work shows how posture can lead to Non-Specific Low Back Pain (NSPLB) and particularly the backward bending. Sprains, strains and bruises mostly occur but misalignment of vertebrae can occur in some extreme cases.

Keywords: Non-specific Low back pain, Weight, Posture, Stress, Innervation.

INTRODUCTION

Since the Bronze Age, Low back pain has been identified with humans. Many causes have been thought to be responsible for the low back pain; causes such as Spirits, inflammation of or damage to the nerves, with Neuralgia and Neuritis being the frequently mentioned cases. However, during 20th century the popularity of such proposed causes decreased. In the 1920s and 1930s, new theories of the cause arose, with physicians proposing a combination of nervous system and psychological disorders such as nerve weakness (neurasthenia) and female hysteria. Muscular rheumatism (now called fibromyalgia) was also cited with increasing frequency. X-ray, CT, and MRI technologies made the vertebral disc model of low back pain took over between 1938 and 1940s. However, the discussion subsided as research showed disc problems to be a relatively uncommon cause of the pain. Since then, physicians have come to realize that it is unlikely that a specific cause for low back pain can be identified in many cases and question the need to find one at all as most of the time symptoms resolve within 6 to 12 weeks regardless of treatment [1,2]. These many unidentified cases have been called nonspecific low back pain (NSLBP). Non-specific low back pain is tension, soreness and/or stiffness in the lower back region for which it is not possible to identify a specific cause of the pain. It is a multidimensional problem i.e. several structures in the back, including the joints, discs and connective tissues also neurophysiological, physical and psychosocial factors, may contribute to symptoms [3,4]

Muscles Architecture

Researchers have come up with twelve categorizations of the muscles that make up the lumbar spine musculature which include: erector spinae, latissimusdorsi, quadratuslumborum, rectus abdominis, internal obliques, external oblique, psoas major, multifidus, longissimusthoracis pars lumborum, longissimusthoracis pars thoracis, illioscostalis pars lumborum and illioscostalis pars thoracis[5,6,7,8,9,10,11,12,13,14,15]. Some of these categories and their architecture are given in Figure 1.

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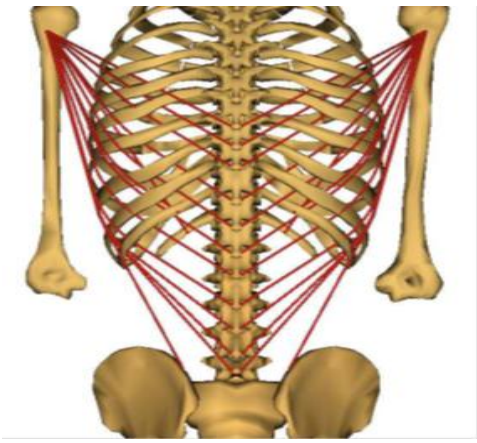
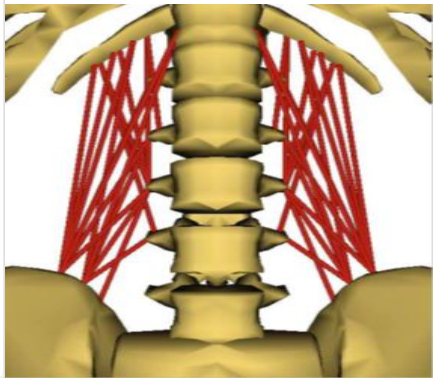
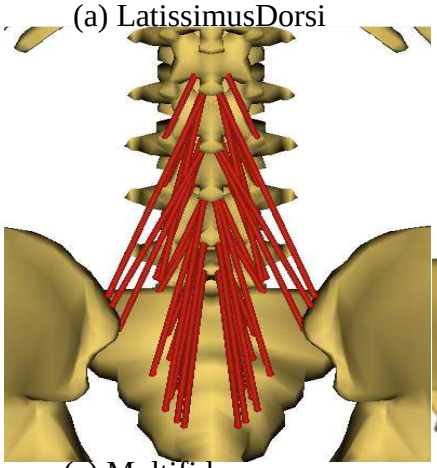


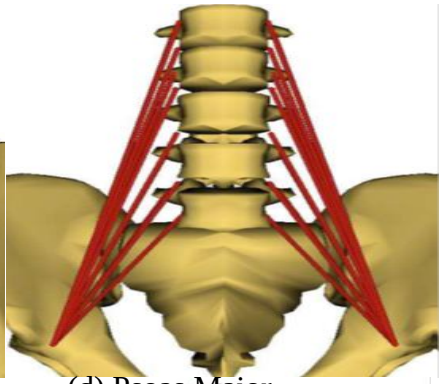
(a) LatissimusDorsi



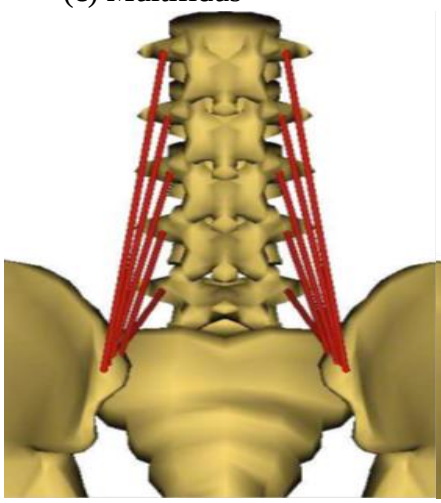
(b) Quadratuslumborum



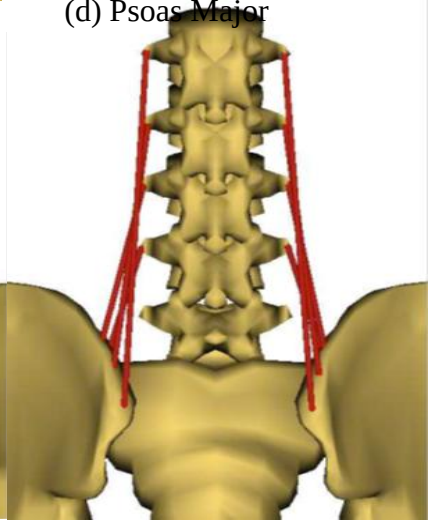
(c) Multifidus



(d) Psoas Major



(e) Longissimusthoracis pars lumborum



(f) iliocostalislumborum pars lumborum

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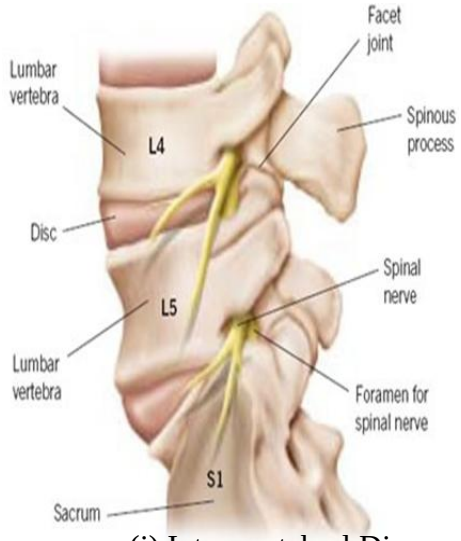

(j) Inter-vertebral Disc and Nerve Roots

Figure 1; Muscles Architecture

Problem statement

Research has established that LBP is a multi-dimensional problem. These dimensions consist of pathoanatomical, neurophysiological, physical and psychosocial factors [16,17,18,3]. What remains unclear is which of the factors predisposes which in the vicious cycle of nonspecific low back pain (NSLBP) mechanism.

Importance of the Study

This work throws more light on the causes and development of non-specific low back pain.

Methodology

Hypothesis

Our hypothesis is that 'Posture, which is a physical factor, is the trigger for nonspecific low back pain (NSLBP)'.

Theory

Mafuyai et al, (2013a) [19] shows that peoples' weight varies with change in posture of the lumbar spine which in turn varies the stress that every anatomical part of the lower back bears. These variable quantities called virtual weight and virtual stress are given, by Mafuyai et al (2013b) [20], as:

$$W_v = \left(\frac{d}{d_N} - 1\right) W_t \quad (1)$$

And,

$$S_v = \left(\frac{d}{d_N} - 1\right) \frac{W_t}{A_0 cos\theta} \quad (2)$$

The two opposite posture of the lumbar spine are concave (lordosic/extension) and convex (flexural) postures [21]. When in a concave posture, virtual weight and stress are positive

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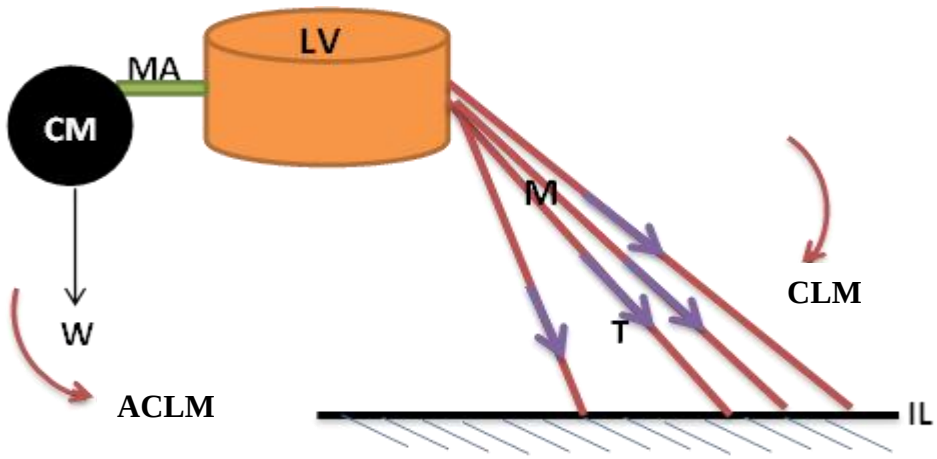
thereby adding to the original weight and stress borne by the lumbar spine. In a convex posture, the virtual weight and stress are negative thereby reducing the original weight and stress borne by the lumbar spine.

Proof of the Hypothesis

The primary function of lumbar spine is weight bearing hence every structure and physiological property is a direct consequence of the weight borne. The proof of the hypothesis is given base on the following three models: (1) Lumbar-illiocostalis Model, (2) Lumbar-thoracis Model (3) Inter-vertebral disc Model. These models consider all the innervated components of the lumbar spine.

Lumbar-illiocostalis

This considers muscles that start from a lumbar vertebra and end at illiocosta. In convex posture (extension) i.e. when bending backward, the center of mass moves backward and the moment arm increases [21]. Hence by equation (1), the weight W increases and this leads to large clockwise moment. For the vertebra to be stable at that posture the anti-clockwise moment must be equal to clockwise moment and this is possible only if the tension T in the muscles increased significantly since the moment arm of the muscles is constant. This increased tension can strain the muscles and cause pain since the muscles are innervated. And when the elastic limit of the muscles is exceeded the muscles snapped and this may lead to more complicated defects in the lumbar spine; defects such as misalignment of the lumbar vertebra since the muscles cannot return it to its appropriate position.



LV is Lumbar Vertebra, CM is Centre of Mass, MA is Moment Arm, M is Muscles, T is Tension in the Muscles, IL is Illiocosta, W is Weight, CLM is Clockwise Moment and ACLM is Anti-Clockwise Moment

Figure 2: Lumbar- illiocostalis

Lumbar- thoracis Model

This considers muscles that start from a lumbar vertebra and end at thorax or other upper parts of the skeleton. In concave posture (flexion) i.e. when bending forward, the center of mass moves forward and the moment arm decreases [22]. Hence by equation (1), the

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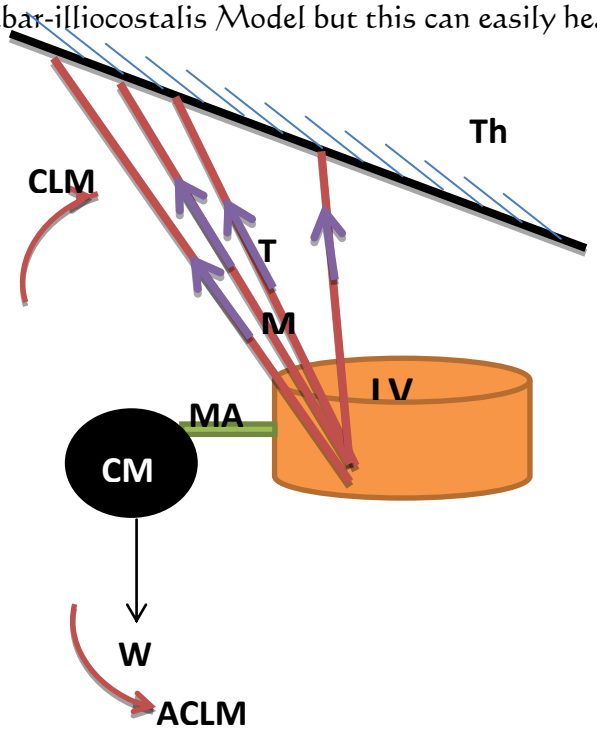
weight W decreases and this leads to reduction in clockwise moment. For the vertebra to be stable at that posture the anti-clockwise moment must be equal to clockwise moment and this is possible only if the tension T in the muscles decreased significantly since the moment arm of the muscles is constant. This model shows that bending forward does not cause much damage to the lumbar spine even though sprain may result in the muscles of the Lumbar-illiocostalis Model but this can easily heal.



LV is Lumbar Vertebra, CM is Centre of Mass, MA is Moment Arm, M is Muscles, T is Tension in the Muscles, Th is thorax, W is Weight, CLM is Clockwise Moment and ACLM is Anti-Clockwise Moment
Figure 3: Lumbar- thoracis Model

Inter-vertebral disc Model

This model makes use of two vertebrae say L1 and L2 with an inter-vertebral disc. At neutral posture (Figure 4a), the vertebrae are incline at angle $\theta = \theta_0$hence no pain may result since the end plates of the inter-vertebral disc are not innervated. However, during backward bending the inclination angle increase as in Figure 4b and by equation (2) the stress on the posterior side of the inter-vertebral disc increase greatly thereby squeezing the innervated side of the inter-vertebral disc. In this position a slight twisting of the vertebrae will cause injuries on the innervated side since friction will increase. Also the anterior side of the inter-vertebral discmay snap. These injuries can cause pain. During forward bending, the inclination angle decrease (Figure 4c) and by equation (2) the stress also decrease greatly and since the end plates are not innervated, no pain results

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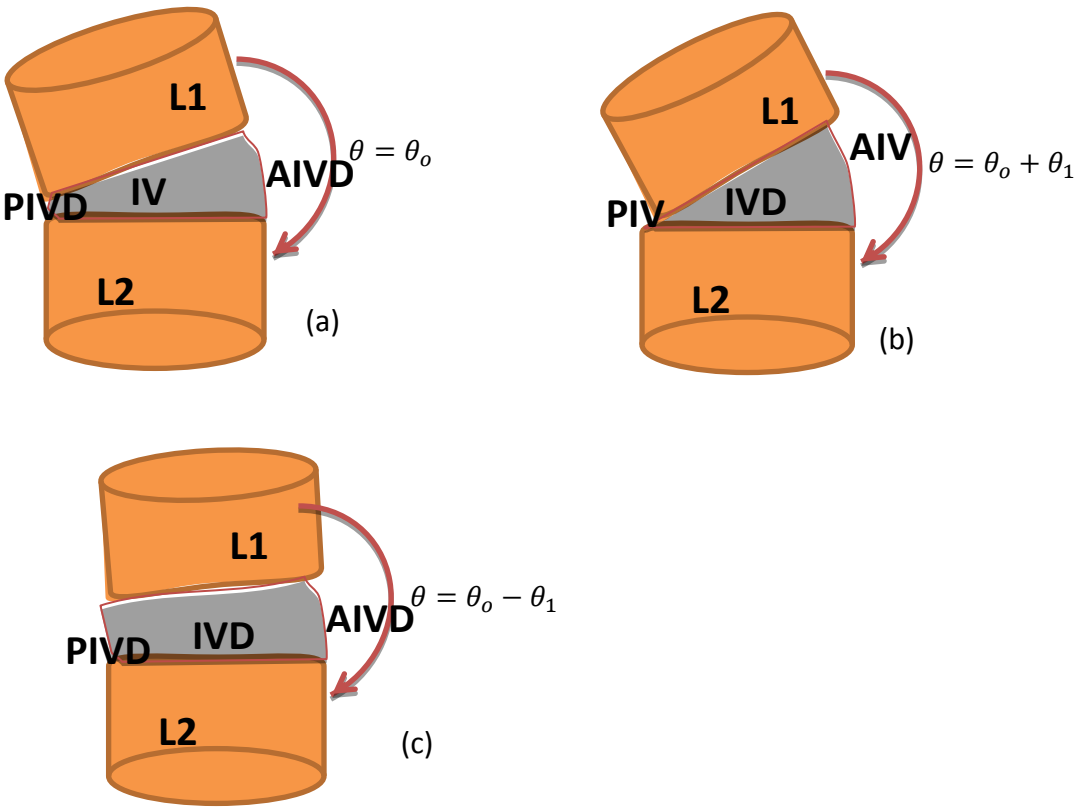

IVD is inter-vertebral Disc, PIVD means Posterior side of inter-vertebral Disc, AVID means anterior side of inter-vertebral Disc
Figure 4: Inter-vertebral disc Model

RESULT DISCUSSION

The three models validated the hypothesis since in all the cases there is a change in loading condition of tissues and muscles which has the tendency of producing injury. The increase in moment arm of the center of mass results in excessive loading of tissues and muscles than the decrease and this occur during backward bending (Extension).

CONCLUSION

This work shows that backward bending can trigger non-specific low back and that forward bending is less dangerous to the lumbar spine and this may account for the reason people bend forward at old age.

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