

In Vivo Intradiscal Pressure between Sitting and Standing

Subjects: Rehabilitation

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Non-specific low back pain (LBP) is highly prevalent today. Disc degeneration could be one of the causes of non-specific LBP, and increased intradiscal pressure (IDP) can potentially induce disc degeneration. Sitting causes higher loads on the lumbar spine than standing in the normal discs, but recent studies do not support this conclusion. Furthermore, the degenerated discs showed no difference in IDP in both postures.

Keywords: low back pain ; intradiscal pressure ; in vivo measure ; posture

1. Introduction

Low back pain (LBP) has become the leading cause of disabilities and absenteeism worldwide ^{[1][2]}. More than 500 million people globally suffer from this symptom and are affected by concurrent comorbidities such as depression, diabetes, and other musculoskeletal disorders ^{[3][4]}. These problems, when chronic, put heavy economic and psychological burdens on patients. For example, in the US, approximately \$784 million was spent on surgery and \$1.8 billion on conservative treatments in 12-month care in 2018–2019 ^{[5][6][7]}.

Intradiscal pressure (IDP) is the hydrostatic pressure measured in the nucleus pulposus of the intervertebral disc (IVD). As the innervated structure of the IVD ^{[8][9]}, it is recognized as one of the potential causes of LBP. Studies have discovered that an increased IDP may accelerate the process of disc degeneration ^{[10][11][12]}. In the degenerated disc, the amount of incompressible fluid decreases, and the nucleus pulposus cannot maintain even pressure on the adjacent annulus fibrosus and endplates, which could be a mechanical cause of LBP ^[13]. Thus, understanding the factors that could affect the IDP could help clinicians and scientists to develop and modify the strategy for managing LBP.

2. In Vivo Intradiscal Pressure between Sitting and Standing

2.1. Effect of Posture Variety in IDP Measurement

Sitting induces a higher load on the lumbar spine than standing, which is consistent with earlier recommendations to avoid long sitting times in daily life ^[14]. However, most results were based on data from more than 30 years ago. In 2001, Wilke et al. ^[15] found that sitting and standing have similar effects on the lumbar spine IDP. They used a new implant transducer, a smaller apparatus, and their findings highly agreed with anthropometric data in many finite models. This improved equipment could stay securely in the IVD, thus ensuring that the measure is highly accurate and reliable. Rohlmann et al. ^[16] used internal spinal fixators and reported similar results in 1999. The implant of the vertebral body could restore normal load-bearing in the spine and collect the three degree-of-freedom force and moment data. Their results revealed that there is a higher load on the lumbar spine in standing because the upright position increases axial loads. The increase in lumbar lordosis in standing also raises the concave-sided compression force. These findings indicated that the improvement in measurement technique may lead to a dramatic difference in the observed in vivo IDP.

The subgroup analysis that separated studies before and after the 1990s showed that there is no difference between the sitting and standing postures in more recent studies. However, only three studies ^{[16][17][18]} conducted in vivo IDP measurements after the 1990s and only 21 participants were involved. Therefore, these results should be interpreted with caution.

2.2. Effect of Disc Conditions and Levels on IDP Measurement

Because the measurements are of the pressure of the nucleus pulposus ^[19], according to previous studies, degenerative changes may affect the measure outcomes ^{[20][21]}. The bulging lamellae are squeezed by compressive load, and a

disrupted disc partially loses the function of weight-bearing, thus showing higher stress in the annulus while reducing the nucleus pressure [22]. Considering the potential effects of pathological conditions in the disc, scholars performed a subgroup meta-analysis of the normal and the degenerated discs. Possibly, there is no difference of IDP between sitting and standing, and the degenerative changes do not change the comparison result, as both demonstrated the decreased measured value in general. Referring to the differences between disc levels, the results show no significant change in the effect size estimation, and indicated that the effect of posture could be similar on the two spinal segments.

2.3. Large Variation in Outcomes

The variability of the IDP measure is high, even in similar disc conditions and in the same study, possibly because of the various types of transducers used. The earliest measurement [23] used a polyethylene-tipped liquid-filled transducer and obtained data nearly twice that of later measurements [18][24], 11 atmospheres compared with 5–6 atmospheres. Measurements using a piezoresistive needle and implanted transducers obtained similar outcomes, although confounding factors such as muscle activation and ligament responses still existed. Another possible source of error is the measurement process. The sequence of sitting and standing changes the body height, and prolonged standing reduces the disc height, thus lowering the spine loads [25] and eventually impacting the results.

Moreover, considering individual factors, people with a higher weight will put more upper limb pressure on the same disc. Females with small nucleus pulposus areas along the spine will possibly have relatively lower IDPs. Thus, the variability of the IDP can be high if the participants have diverse body builds.

There is also some variation in the VBR measurement [16][17][26][27]. The location of each patient's surgery level is varied, resulting in different outcomes. Moreover, in the early stages after surgery, patients may suffer from pain and psychological factors that restrict motion; therefore, the outcome difference may appear on the left and right sides and existing regional variations sometimes. Considering the implants in different spine levels and surgery setups within patients, sintered cancellous bone and bridged intact disc induce relatively high loads, while slight compression for implant mounting shows relatively lower loads [28].

2.4. Clinical Implication

The previous viewpoint may not be correct, given the inconsistent findings of the more recent studies. Knowledge regarding the lumbar spinal loads in daily life is essential in LBP management [29]. Well recognized factors such as flexion and lifting weights result in a high spinal load [17][30][31]. The 'postural perturbations' strategy proposed recently can induce a high IDP, which interacts with the degenerated disc [32]. Existing conclusions are still controversial regarding the effect of the sitting and standing postures on IDP. Regardless of which posture induces a higher IDP, any prolonged posture is not recommended [33].

3. Conclusions

In conclusion, sitting induces higher loads on the lumbar spine than standing. Furthermore, degenerated discs have a smaller IDP, and they show no difference in IDP in the sitting and standing postures may possibly result from the evenly distributed structures being ruptured. Furthermore, to maintain the well-functioning of the lumbar spine and manage LBP symptoms, any prolonged posture should be prohibited.

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