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Case Report

Measuring one's ability to alter, change, and reduce lumbar flexion under load: A case report

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ABSTRACT

One cannot completely avoid spinal flexion while deadlifting, but is it possible to reduce it? The hypothesis of this case study is: "One can reduce their lumbar flexion under load voluntarily and immediately by simply being requested to do so." This case study documented an experienced powerlifter modifying his lumbar flexion under a barbell-loaded isometric weight of 150 kg. The participant was instructed to perform a 45° angled static hip hinge for 25 s for two sets – with a 10-min rest period between sets. The sacrum and lumbar spine were measured using a digital inclinometer, covering the two key positions designated "max-flexion" and "max-neutral." The inclinometer was placed over S1/S2 and L5/T12 for all measurements. The participant's standing neutral (lordosis) was measured with a digital inclinometer at –35°. For a max unloaded flexion, the participant was asked to touch his toes, and a second measurement was taken at 69°. Between the initial max-flexion and set 2's loaded "max-neutral," the lifter could avoid flexing 40° or 58% of his max flexion merely from being requested to do so. The participant maintained 42% of his max flexion while under a significant load for 25 s.

Keywords: Barbell, Biomechanics, Lumbar flexion, Pain, Spine

INTRODUCTION

Loaded lumbar flexion has been documented as problematic and provocative toward injury and pain throughout many peer-reviewed published research articles.[1-15] The recommendation to minimize loaded lumbar flexion during exercise and functional tasks is supported by decades' worth of *in vitro* studies as well as biomechanical modeling, imaging, surface electromyographic (SEMG) biofeedback, and epidemiological studies.[16-19] Maintaining the lumbar spine in a relatively neutral lordosis posture allows the extensor muscles that span the lumbar spine to bear the majority of the responsibility for offsetting the moment forces created by the load rather than the ligaments or discs. Conversely, the more the spine is flexed, the more force is transferred to the passive structures. Biomechanically speaking, lumbar flexion will dictate the amount of force required by the active muscular system and the passive substructures (ligaments, facets, and discs) to meet the extensor-moment demand of the lift.[18,19]

This mechanism was documented first in"Changes in lumbar lordosis modify the role of the extensor muscles".[6] Investigators showed, through high-resolution ultrasound, various changes

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to lower back muscles and their fiber orientation or direction when in different lumbar positions. In a relatively neutral lumbar spinal posture, the iliocostalis lumborum pars lumborum and longissimus thoracis pars lumborum form a 25–45° angle between the sacrum/iliac crest and the lumbar vertebrae through their attachment sites. This alignment allows these muscles to aid in the ability to resist shear forces through the lumbar spine and, more specifically, resist the anterior shear of the superior vertebra on its inferior counterpart. The study reported that as the spine was flexed, the oblique angle of these muscles was reduced to 10°, which, in turn, greatly diminished the back-extensor muscles' leverage to resist shear force [Figure 1].[8] Increased lumbar flexion not only elongates the iliocostalis lumborum pars lumborum and longissimus thoracis pars lumborum, altering the force-length-tension relationship but also reduces muscle function, therefore, increasing force as well as stress on the passive lumbar spinal structures and tissues.[15] This may be problematic as studies have shown that tissues under load over time in high degrees of lumbar flexion have high levels of creep and inflammatory cytokines, which can directly impact pain.[5]

Although it is understood that one cannot completely avoid spinal flexion while bending or lifting (deadlift/squats) – can one alter, change, or reduce their lumbar flexion? Many believe you are unable to avoid 80% of max flexion. Mawston *et al.* (2021) reported that the participants in his 2021 study were able to modify and change their lumbosacral flexion with the help of postural biofeedback, which he concluded lowered their risk of low back injury when repeatedly lifting.[20] However, this investigation had the participants lifting boxes. Other studies that have shown similar results have used kettlebells, pens and even used fixed harnesses, all while using lighter loads.[12,13,14,20] This case study set out to document and measure an experienced powerlifter altering, modifying, and reducing his lumbar flexion at will, on call, and under a significant isometric load of 150 kg, using a barbell.

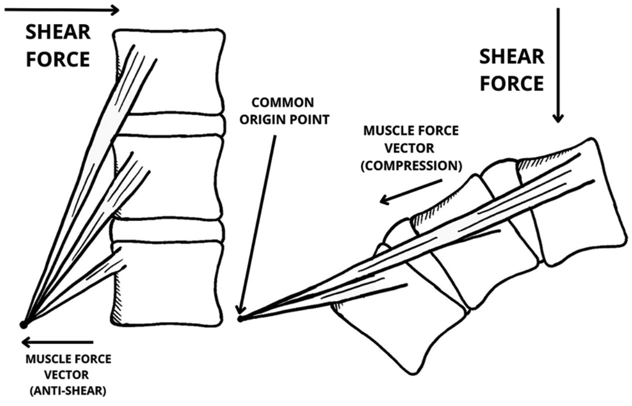

Figure 1: Muscle and spine force vectors.

The hypothesis

One can reduce one's lumbar flexion under load voluntarily and immediately by simply being requested to do so.

CASE REPORT

An experienced open-division male powerlifter was recruited for this single-participant case study. The participant was instructed to perform a 45° angled static hip hinge for 25 s for two sets – with a 10-min rest period between sets. A standard 20 kg weightlifting barbell with 4–25 kg and 2–15 kg Elite EZI-GRIP High-quality cast iron PVC dipped Olympic lifting plates were used. The total load was 150 kg/330 lbs. The participant's lumbar spine was measured using a digital inclinometer, covering the two key positions designated "max-flexion" and "max-neutral." The inclinometer was placed over S1/S2 and L5/T12 for all measurements. The lifter was encouraged to abide by Dr. Johnson's pillars of lumbopelvic proficiency movement: Hip-centric rotation, neutral spine, posterior powered movement, proficiency-led range of motion, and unloaded knee positions.[3] The primary investigator recruited the participant due to his experience with high loads. The chosen participant's anthropometrics were 179 cm in height and 165 kg in weight. His powerlifting experience consisted of over a decade of powerlifting experience, including participation in elite levels, including national and international competitions.

The participant's unloaded standing neutral (lordosis) was measured with a digital inclinometer at −35°. For a max unloaded flexion, the participant was asked to touch his toes, and a 2nd measurement was taken at 69°. Prior to the commencement of set 1, the lifter was calibrated into a stacked neutral spine (0°) - this was to ensure the measured starting point was under load. For set 1, the participant held a 45° hip hinge isometric hold for 25 s. The participant was instructed to adopt a lumbar position of "max-flexion" under load (150 kg), – which was measured during set 1 at 65°. During set 2, the participant held the same position, with the same weight, and for the same length of time. However, this time it was requested to adopt a lumbar "max-neutral" posture under load – it was explained prior that the purpose of this was to maintain as neutral posture as possible for the duration of the 25 s. This "max-neutral" position was measured at 29°. Between the initial max-flexion and set 2's loaded "max-neutral," the lifter could avoid flexing 40° or 58% of his max flexion merely from being requested to do so. The participant was able to maintain 42% of his max flexion while being under a significant load for 25 s, supporting the researchers' hypothesis [Figure 2].

DISCUSSION

There has been recent opposition to the biomechanical literature where clinicians, coaches, and some researchers

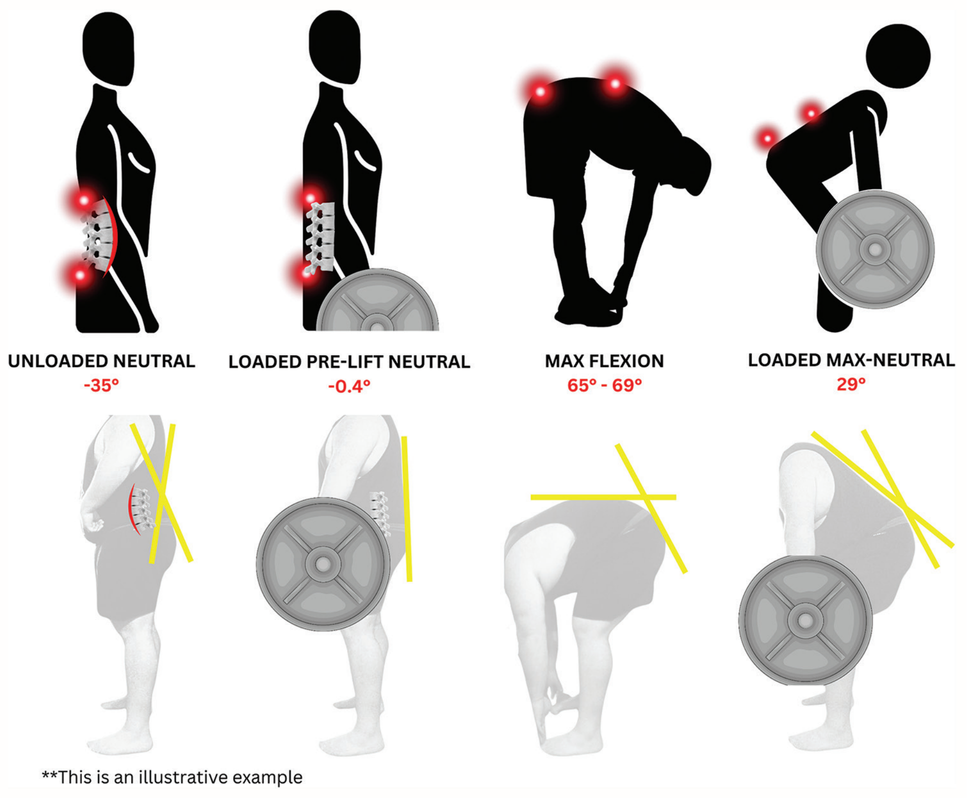

Figure 2: Spinal measurements.

have advocated against minimizing the amount of lumbar flexion under load.[21] There are limitations to the studies which they have cited in recent years. The literature utilized by that camp includes various levels of evidence ranging from case studies to meta-analyses that assess lumbar flexion with loads seen in home and work settings but not in a gym setting, where the increase in loaded lumbar flexion appears.

A recent 2021 clinical trial recruited 26 healthy participants who performed "maximal lifts" while maintaining three lumbar postures.[20] The investigators found through EMG data that lumbar flexion decreased lumbar spinal erector muscle activity, while lumbar extension increased it. This is likely due to the increased moment arm created between the lumbopelvic spine and the weight when lumbar flexion is induced – increasing anterior shear force and shifting the load onto the posterior passive structures of the spine (vertebra, ligaments, tendons, and fascia).[8] As more load is placed on the passive structures, less is distributed onto the musculature [Figure 1].[6] The investigators ultimately concluded that an increase in the recruitment of the posterior passive structures increases the likelihood of larger anterior shear forces that could creep on the lower lumbar spine with repeated exposure.[19]

Despite this established increased risk associated with loading the lumbar spine into high levels of flexion, the authors concluded that lifting with a flexed-back posture was associated with greater strength and efficiency based on a "neuromuscular efficiency" (NME) ratio expressed by normalized extensor moment to normalized EMG. However, these metrics do not reflect an accurate measurement for movement optimization in the context of a cost/benefit relationship. While, a high NME ratio in full lumbar flexion reflects a decrease in active energy expenditure of the back extensors during a lifting task that may not mean it is more beneficial. The rise in the NME ratio likely occurs as the load is shifted to the posterior passive structures of the lumbar spine; if this action repeatedly occurs under load, it is associated with an increased risk of tissue damage.[5] Without this context, the authors' designation of increased "efficiency" may lead to this study being utilized without full appraisal of the study's limitations by clinicians and coaches to suggest or encourage heavy lifting with a relaxed back.[20,21]

A 2020 meta-analysis was conducted that also attempted to draw conclusions regarding the risk of injury when lifting with progressive lumbar flexion but did not analyze loads seen in a strength training program. Instead, it analyzed literature in which loads ranged from weights as low as a pen to, at most, 12 kg/26.4 lbs.[12] For this reason, the results of this meta-analysis cannot be applied to heavy lifting. This case study was, therefore, able to investigate heavier loads further to reach a more accurate conclusion as to the effects of lifting on the lumbar spine.

In addition, a 2021 study from Switzerland recruited 30 participants. It measured shear and compressive forces within the lumbar spine while they lifted a 15 kg box from the floor in three different ways (freestyle, squat, and stoop).[22] They concluded that a stoop-styled lifting technique produced less total and lumbar compressive loads; however, the shear force was greater in the stoop lift across T11/L1, L1/L2, L2/L3, and L3/L4 with the exception of L5/S1. Limitations of this study reported by investigators that there were higher levels of shear force upon "stoop" lifting. As stated earlier, the type of force highly provocative to pain and injury is "shear," as opposed to a compressive force, which has been accepted globally as much more tolerable on the spinal structures. This study used a greater load than the previously mentioned literature but is not sufficient to be accepted as a heavy load, especially if one used this study in the context of barbell training (which many do). The weight placement was in front of them, requiring them to bend over and forward even when "squatting," which does not translate to a loaded squat or a bodyweight squat. Therefore, it does not translate into a gym setting but rather may be more realistic in picking up objects seen around work or living spaces. When a similar study was conducted under more specific conditions to lifting (with a bar), the results were different – all forces were higher on the stoop lift. The authors even concluded: "The results, for the task considered, advocate squat lifting over stoop lifting as the technique of choice in reducing net moments, muscle forces, and internal spinal loads."[23]

Limitations

By nature, a case study is a lower-tier form of research. A single case, or subject of 1, cannot draw strong conclusions or extrapolate any meaningful results to the wider population.

CONCLUSION

Between the initial max-flexion and set 2's loaded "max-neutral," the lifter could avoid flexing 40° or 58% of his max flexion merely from being requested to do so. The participant was able to maintain 42% of his max flexion while being under a significant load for 25 s. Based on the research covered above, an argument can be made pertaining to the importance of technique and the ability to adjust one's lumbar position under heavy loads. The purpose of this case study was to document whether a proficient, experienced powerlifter could change his lumbar position under high loads and to what extent. The results of this case study support the researchers' hypothesis. However, more research and data would be required to determine a statistically significant conclusion. Due to the nature of a case study, we cannot extrapolate our results to the wider population.

AUTHORS' CONTRIBUTIONS

All authors contributed significantly to this paper. BW and AH contributed to the design, planning, organizing and execution of the case study, as well as writing and proof reading. AL and SR were involved in the editing of the study, contributing to the manuscript writing and over all flow of the article. BW was the corresponding and lead author and was responsible for all the manuscript final checks and references. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

ETHICAL APPROVAL

The Institutional Review Board approval is not required.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY FOR MANUSCRIPT PREPARATION

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

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