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# Weightlifter Lumbar Physiology Health Influence Factor Analysis of Sports Medicine

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**Abstract:** Chinese women's weightlifting project has been in the advanced world level, suggesting that the Chinese coaches and athletes have many successful experiences in the weight lifting training. Little weight lifting belongs to high-risk sports, often leading to the lumbar spine injury; some young good athletes, often due to lumbar trauma, had to retire, and the national investment and athletes toil is regret things. This article, based on weightlifting athletes training situation analysis, presents suggestions from the perspective of sports medicine, aimed at avoiding lumbar injury, guaranteeing the health of athletes. In this paper, first of all, 50 professional women's weightlifting athletes were investigated, and it was found that 82% of the athletes suffered from lumbar disease symptoms. The reason was mainly lumbar strain of high intensity and motion error caused by three factors. On the basis of sports medicine and the characteristics of the structure of human body skeleton athletes lumbar structural mechanics analysis, find out the lumbar force's two biggest technical movement, study, and regulate the action standard, so as to minimize lumbar force, for athletes to contribute to the health of the lumbar spine.

**Keywords:** Biological mechanics, Movement biology, Sports medicine, Strain of lumbar spine, Athletes, Technical movement.

## 1. INTRODUCTION

Weightlifting reveal human ultimate divine power, loved by the audience, the Chinese women's weightlifting is the traditional advantage project, in nearly four Olympic Games, has achieved good results of the 14 golden 1 silver, worth people proud and proud. Little weight to the lumbar spine injury, however, many athletes have the symptoms of lumbar spinal damage, severe cases have to end his career ahead of time, the national investment and athletes toil is very pity. This article from the perspective of sports medicine, lumbar stress analysis and put forward Suggestions, aimed at reducing the lumbar spine injury of athletes [1].

Study weight lifting project lumbar spine injury of the efforts of many people, including xiang-qin based on finite element theory based on the lifter snatch action lumbar spine segment mechanical characteristics analysis is put forward under the weightlifting snatch completely standing posture, vertebral body's main stress distribution in the small joints and pedicle, intervertebral disc contact pressure are mainly concentrated in the fiber ring back, if the weight of the barbell is too big, the waist strength shortage athletes, not fully tighten the waist and back muscle, can lead to the unstability of the lumbar spine joints, intervertebral disc extrusion excessively, make lumbar injury [2].

History, and training for the 27th Olympic Games women's weightlifting team sports injury investigation found that the waist injury in the weight lifting accounted for the first place, the main reason for the lack of rigour, scientific training, sports medicine security is not enough, need to strengthen health supervision, give full play of the role of doctor in disease prevention and treatment of lumbar spine [3]; Hu Xianhao in high standard for Chinese women's weightlifting athletes waist injury of the article put forward to adjust the training load, pay attention to rhythm, to prevent the body of the local load is overweight, accumulate over a long period to cause lumbar damaged [4].

Based on the previous conclusions and Suggestions, according to the structure characteristics of the human lumbar spine bone from medical Angle of lifting force analysis on the key action steps, concluded that lumbar mechanical calculation formula of shear stress, combined the technology of mechanics formula for action to regulate, aims to alleviate the athletes of the lumbar spine shear and pressure, guarantee the lumbar health of athletes.

## 2. LUMBAR STRUCTURAL ANALYSIS BASED ON MEDICAL PERSPECTIVE

Lumbar spine (Fig. **1**) is one of the most important part of the body, can be said to be the girder of the body. It bears the weight of the human body, when the body's natural stand, lumbar bear the weight of the body, when the body weight, lumbar bear attached weight of oppression, the weight, the greater the pressure, the greater the load is too large, the load time is too long, can lead to strain of lumbar muscles, causing diseases. Lumbar nerves and blood vessels of all stripes inside connected to, in a very important position in the human body, if appear lumbar disorders, may be on the nerve oppression, light numbness, pain, or lower limb paralysis, bedridden. Lumbar structure is very complex, once the disease is difficult to treat. Lumbar spine is the most

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important of human body structure, so the waist must be carefully take care of, lest appear lumbar disease.

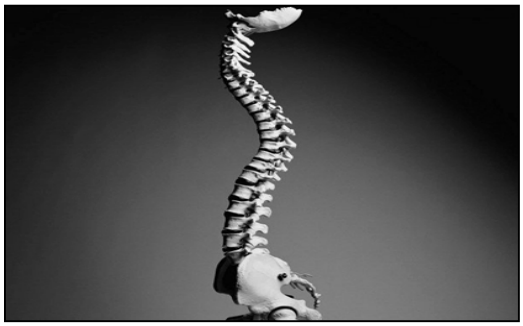

**Fig. (1).** Lumbar.

Lumbar disease condition is complicated and intricate. Common disease of the lumbar spine disorders including, lumbar disc, strain of lumbar muscles, lumbar spine bone hyperplasia, lumbar sprain, rheumatic or rheumatoid waist pain, the wind cold dampness, waist pain, blood stasis sex lumbago. Any kind of disease can make people suffered from great pain.

Common symptoms of lumbar disease are as follows:

1) low back pain: 90% of the patients the symptoms. Conscious patients with lumbar pain continuously, aggravated when standing, recumbent, relieve, generally fair stand, severe symptoms, unbearable, need to stay in bed, and seriously affect the life and work.
2) lower limb radiation pain: 80% of the patients the symptoms. Main show is the waist until the calf radioactive irritation and numbness. Performance of the waist to a foot appear when heavy shocks hurt light person can walk, appear limp, the person that weigh pain, need to lie down in bed, relieve the pain.
3) lower limb numbness, a few patients characterized by pure numbness, consciously lower limbs cold, cold. Most of the patients with lower limb numbness and pain with.
4) horsetail nerve symptoms: below the waist of numbness, tingling, sphincter dysfunction, the person that weigh even without all wears out of control and the double lower limb palsy.

Common causes induced:

1) weight: suddenly waist load suddenly increases, the lumbar generate large force, easy cause herniated.
2) the waist injury, lumbar trauma could spread fiber ring, cartilage plate structure, such as the degeneration of the herniated.
3) professional factors: different from all walks of life to the damage degree of the lumbar spine. In the same position for a long time or long term weight, etc Characteristics of the lumbar spine injury is serious.

## 3. THE LIFTER OF LUMBAR SPINE DAMAGE INVESTIGATION AND ANALYSIS

According to the above lumbar disease symptoms, 50 professional women's weightlifting athletes were investigated in China, found that 82% of the athletes is lumbar disease symptoms. For professional weightlifting athletes, therefore, lumbar disease is so common; need to carefully treat and treatment. The existence of lumbar disease symptoms 41 athletes can get the reason (Fig. **2**).

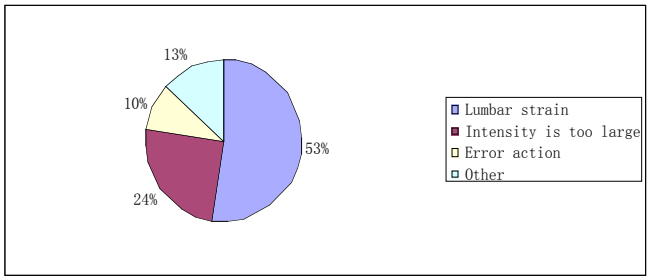


**Fig. (2).** Lumbar injury main causes.

Fig. (**2**) illustrates the lumbar spine injury reason mainly divides into the waist strain, strength is too big, the movement error types, accounting for 87% of the number of the lumbar spine injury, only 13% of the number of other reasons. The three factors is closely connected with the load stress distribution of lumbar, lumbar strain is caused by high intensity oppression on long, hard to avoid, can only try to reduce the damage by means of scientific training. Too much intensity is due to blindly pursue result regardless of its own security, therefore in day long training to strengthen the understanding of their own capabilities, training step by step, avoid by all means is blind pursuit of performance. Movement error is caused by athletes training is not scientific and inattention, in daily training to improve the scientific nature of the action. Next main actions in this paper, the lifting force analysis and standardize its main technology from the perspective of medical action, reduce the damage in the lumbar spine.

## 4. THE LIFTING TECHNOLOGY ACTION STEP FORCE ANALYSIS AND RECOMMENDATIONS OF THE LUMBAR SPINE

Weights are divided into two kinds, the snatch and the clean and jerk, class action is as important as the result of general record snatch and the clean and jerk in the game to the results of the competition.

### 4.1. The Clean and Jerk Movement Analysis

Action the clean and jerk consist of preparing positions, the bell on the chest, in three stages.

ready to pose: Hands ready to clean and jerk posture is to athletes barbell, big toes first joint in the barbell directly, the distance between the two heel 20 ~ 30 cm. Toes slightly outward slant, calf clingy rung, knee bend, make ham and crus 90°. Hip bend flexion 45° thighs and the upper lumbar spine. Two arms relaxed freedom unbend hold rung, the small of the back straight shoulder slightly before the rung, as shown in Fig. (**3**).

Cleans can be divided into the split and the squat. Such two posts have their own features and both are widely used.

1) To split, first utilize leg strength, extend two legs to lift barbell, upper body remains original post without

changing. In order to arrive at higher speed of barbell in the next stage, mighty strength should be used to lift barbell from the very beginning, enable it possesses relative higher onwards accelerated speed $a$ .When barbell arrives at the height of knee joint (Fig. **4-A**), it should faster extend hip joint and make barbell accelerate and rise again. When barbell arrives at the middle height between knee joint and hip joint, two legs and upper body elevate onwards at the maximum speed, body strength entirely explodes, and barbell receives the highest onwards speed under such explosive force. After explosive force, due to barbell weight too large it would quickly fall, weight lifters then need to make greatest efforts to hold back falling height so as to prevent lose their labor. Therefore, body mush quickly squat under barbell, turn the barbell to the chest, and hold back barbell falling with the support of whole body, as Fig. (**4-B**) shows. Follow on two legs gradually draw close as Fig. (**4-C**) shows.

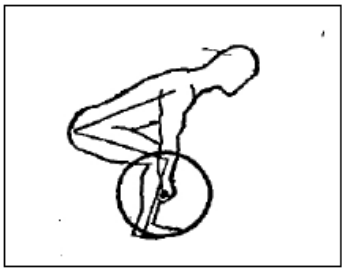

**Fig. (3).** Jerk position at bar.

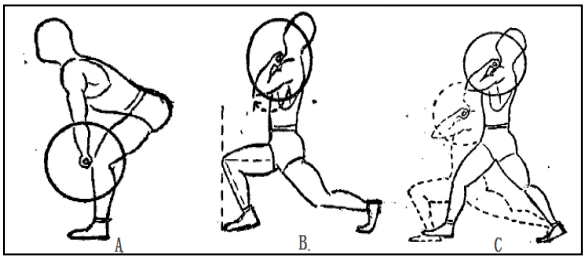


**Fig. (4).** Split clean stage schematic figure.

2) To squat, the difference between the squat and the split is body gravity center is lower in squat (Fig. **5**), therefore it is no need to lift barbell very high as the split. Therefore it is easier in the earlier stage of squat, higher barbell can be lifted in the earlier stage, but the difficulty in squat post is two feet lateral splitting cannot be too large, the larger two feet split, the more dispersal leg strength would be. But less splitting would also have great negative influences, which would affect stability in squat and prone to generate gravity center unstable and happened to dump, it is very dangerous.

After finish cleaning, body stands firmly can start jerking. For jerk, firstly should do squat beforehand as Fig. (**6-A**) shows, then quickly extend legs jerk and straighten the arm, and lift the barbell. During process from Fig. (**6-A**) to Fig. (**6-B**), barbell mostly rises by inertia, arms strength cannot arrive at barbell weight, therefore the process is quite short, leg splitting, squat, arm extending, barbell supporting motions should be completed before barbell falling back, it will fail if done it later. Waist load suddenly increases in the process, produce greater impulse force to lumbar that is prone to injure lumbar.

**Fig. (5).** Squat schematic figure.

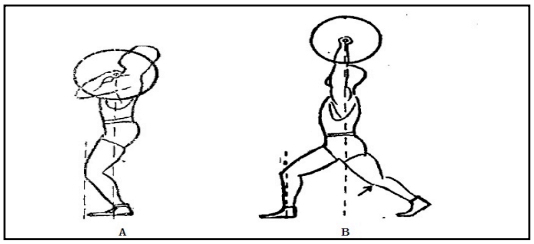


**Fig. (6).** Jerk stage schematic figure.

### 4.2. Analysis of Snatch Motions

Snatch motions has some differences from jerk motion steps, but from medical perspective ,they have no differences in lumbar major pressure and shear force bearing, therefore this paper would not make analysis of snatch motion steps one by one.

### 4.3. Two Key Steps Lumbar Force Analysis and Suggestions

Through above weightlifting steps analysis, it is known that majorly two steps bear the maximum lumbar force, and also danger would happen accordingly that lead to lumbar injury. First is the first half stage of cleaning that is process from Fig. (**3**) to Fig. (**4-A**), which is called step one for short in following text. Second is the process that body should quickly enter barbell and barbell instantly lifts that is the process from Fig. (**4-A**) to Fig. (**4-B**), Fig. (**6-A** to **6-B**), though they are two steps , it can be known from analysis that the both the two steps are barbell instantly rising and then slightly falling ,which can be concluded as one type on lumbar injury from medical perspective, is called step two for short in following text. This paper's analysis of such two steps is as following.

Key step one analysis and suggestions: From mechanics , it is known that waist bears great shear force, combining with lumbar structural features from medical perspective can know that lumbar is connected with one joint that not proper for bearing shear force. Detailed force analysis of the process is as Fig. (**7**).

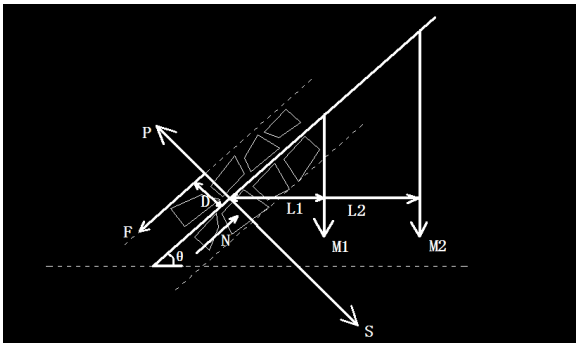


**Fig. (7).** Lumbar force analysis.

Sign convention in Fig. (**7**) is as Table **1**.

**Table 1 Sign convention in Fig. (7).**

| Sign | Definition |
|---|---|
| $M1$ | human trunk quality(unit) |
| $M2$ | neck ,arm and barbell quality integration |
| $\theta$ | Angle forming by Spine forward flexion with ground |
| $F$ | erector spin strength to maintain spine forward flexion |
| $N$ | Extrusion force under spine |
| $D$ | Distance between erector spine and spine |
| $S$ | Spine shear force |
| $P$ | Balance force counters S |

Combine with Fig. (**7**) and according to moment balance $\sum M = 0$ can get formula as following,

$$F \times D - M1 \times L1 - M2 \times L2 = 0 \quad (1)$$

Then get

$$F = \frac{M1 \times L1 + M2 \times L2}{D} \quad (2)$$

Therefore total extrusion force is

$$N = F + (M1 + M2) \times \sin\theta \quad (3)$$

Shear component force is

$$S = (M1 + M2) \times \cos\theta \quad (4)$$

Combine with human body segment parameters in medicine; it is known that trunk covers around 43% of human quality, neck and arm cover 17% of human quality, therefore can get $M1$ and $M2$ only with human weight information. According lifters CT images, size of $L1$, $L2$ and $D$ can be got. Every lifter has slightly difference in body parameters, therefore his $L1$, $L2$ and $D$ also has slightly differences. When calculating , it can make CT test on every lifter, then bring into formula(2), (3), (4) so that can determine every lifter lumbar force condition. This paper makes body parameters test on a lumbar healthy weight lifter with height of 170cm and weight of 60kg, and assume that his trial barbell quality is 160 kg, input into formula (2), (3), (4)to calculate(transitionally assign $\theta$ as 45°), find the maximum total extrusion force $N$ to lumbar has arrived at 2174kg, shear force $S$ has arrived at 137kg ,which is far beyond the normal load. Combine with medicine can know that lumbar structure relies on centrum connection, which is prone to appear stress concentration. In normal human activities, usually it would not bear shear force; however, in clean stage of weightlifting, around 137kg shear force should be bearing, so it brings huge damage to lumbar. Due to weightlifting career features that it is hard to avoid lumbar injury, therefore only can reduce lumbar injury through specifying technical motions, increasing scientific training, and combining exertion and rest. Through formula(3)、(4) can know that angle $\theta$ should be increased so as to reduce shear force. However, $\theta$ increasing would lead to pressure $F$ increasing , so it need to find a optimized angle $\theta$ ,weigh and balance shear force and pressure injury conditions with medical knowledge, and according to formula (2), (3), (4)can work out that the optimized angle $\theta$ is 45°.Therefore, in future training it needs to ensure that $\theta = 45°$ after ending position at bar when just starting clean to the chest.

Key step two analysis and suggestions: For the process that body should quickly squat under the barbell, from above lumbar diseases inducing causes can know that waist load suddenly increasing produces larger impulse force to lumbar so that tend to generate herniation of the nucleus pulposus. Therefore, during the process, it should try to let barbell produce smaller impulse force to lumbar. Make trajectory figure about key step 2 barbell gravity center rising process can get Fig. (**8**).

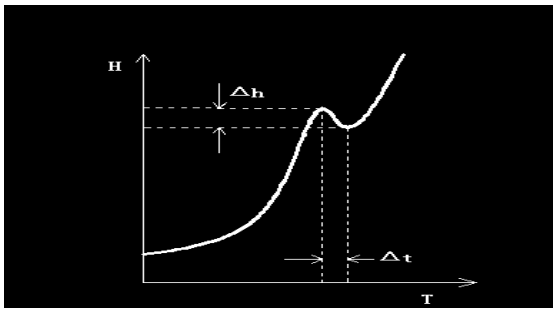


**Fig. (8).** Barbell gravity center trajectory changes followed by time T.

In Figure, $\Delta t$ time phase is barbell falling process, which is also waist load suddenly increasing process. During the process, size of $\Delta h$ is key to the size of lumbar force, combining with mechanics can know that when barbell rises to top point at speed zero, it is the best time for lifters entering beneath the barbell. In this moment, lifters transfer strength to barbell so as to stop it from falling, $\Delta h$ is the buffer process that lifters stop barbell falling; If $\Delta h$ is too small that buffer not working and causes lumbar instantly bear huge pressure; From medical perspective, the bigger $\Delta h$ is, the longer buffer time is , and the instantly force to lumbar would be smaller that is helpful to protect lumbar. However, if $\Delta h$ too big, it would lead to lifters lose their labor so that need them to work more in next step and affects lifters playing, therefore the size of $\Delta h$ is of great

importance. Combine with medicals it should try to reduce falling height $\Delta h$ on the condition that guarantee minimum lumbar injury

## CONCLUSION

This paper investigated on 50 lifters lumbar conditions and found that 82% of them have lumbar diseases symptoms, got by causes exploring that three main factors lead to lumbar injury are waist strain, intensity too large, error action; Made analysis of weightlifting key steps from medical perspective, obtained two key steps with maximum lumbar load, one is first half stage of clean that is the process from Fig. (**3**) to Fig. (**4-A**), two is body quickly enters beneath barbell and barbell instantly rises , such process is from Fig. (**4-A**) to Fig. (**4-B**), Fig. **6-A** to **6-B)**; Made force analysis of key step one and then found key angle that influences lumbar shear force and pressure, according to mechanics formula determined is the optimized angle, therefore in future training it should pay attention to arrive that ;This paper considered from medical safety and health known that to weight lifting event, lumbar strain was hard to avoid due to long term heavier loading, only could reduce lumbar strain through scientific training and careful curing , step-to-step should be done in training and avoided by all means excessive intensity training. Once lumbar get injured, it is hard to cure and even affect lifter whole life. Therefore lifters no matter in training or in competition should take seriously protection of lumbar.

## CONFLICT OF INTEREST

The author confirms that this article content have no conflict of interest.

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Declared none.

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