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Abstract To study the correlation of lower limb muscle strength at different angular velocities and dynamic balance among female college students in football. **Methods**: 30 college students from Zunyi Medical University had a regular football training than 16 weeks. The ISO-MED2000 was used to test the peak flexion and extension torque of the hip, knee and ankle at different angular velocities, and the Y-Balance was used test system to test the dynamic balance of lower extremities. **Results**: The relative peak of hip flexion and extension was associated well with balance ability at an angular velocity of 180〫s; the relative peak of flexion and extension of the knee was well correlated with the balance ability at 30〫s and 180〫s ($P<0.01$); the ankle flexion was well correlated with balance ability at 30 〫s and 90〫s($P<0.01$). **Conclusions**: At different velocity，the three joints of lower limbs play different effect on lower limb balance ability.

Keyword：soccer; isokinetic strength; dynamic balance capability

Football is a combination of multiple sports modes such as jumping, acceleration, steering and technical movements such as shooting and passing, these require fast, powerful and stable under support movements. Force is the main cause of generating speed and maintaining the balance. It is helpful for players to complete the move and decrease the athletic injury to have a dynamic balance ability. A good movement complete successfully need the chain of lower limb muscle, that is the coordinate of muscle from the joint of hip, knee and ankle.

Lower limb muscle strength using isokinetic system test and balance ability can predict the occurrence of injury, but this conclusion has not been reach an agreement[1,2]. there may be several reasons for this result：the choice of subjects is different, such as the different level of football player; different angular velocities from 30°/s to 300°/s at isokinetic training; the reason of injury, such as confrontation or non-confrontation makes injury; injury at different region, such as ankle, hip. The improve of the lower limb dynamic balance ability can prevent the occurrence of

these injuries[3]. There for, it is essential to study the related of muscle strength and dynamic balance ability at different angular velocities, which can provide the theoretical basis for college football training.

1 Subjects and Methods

1.1 Subjects

A total of 30 college students from Zunyi Medical University were selected. They experienced 16 weeks of football training, each training session was 120 minutes and lasted 5 times per week. age (20.57 ± 1.47) years, height (161.03 ± 5.99) cm, weight (55.37 ± 5.65) kg. Subjects requirements: Subjects who has the organic diseases of the main organs and the motor system were excluded, the range of motion of the bilateral lower limbs joint is normal and voluntarily participate in this test were selected.

1.2 Methods

The IsoMed-2000 was used to test the peak of the flexion and extensor torque of the hip, knee and ankle joints of the lower limbs at the velocity of 30 °/s, 90 °/s and 180 °/s, the Y-Balance test system was used to test the dynamic balance of both lower extremities[4].

1.2.1 Data Acquisition

Hip flexion and extension muscle strength test[5]: Subjects lied on the test chair of the isokinetic muscle strength test device(German IsoMed-2000 isokinetic muscle force testing device), fixed the test arm on the middle of the thigh bone of the advantage legs while fixed the trunk on the test chair, hands hugged around on the chest, according to the test plan, the isokinetic concentric contraction have been tested angular velocities of 30°/s, 60°/s and 180°/s at the range of the hip's joint motion is from 15° to 115°. The indicators used are relative flexion and extension peak torque, relative flexion peak torque is the ratio of flexion peak torque (Nm) and weight (kg) .

Knee flexion and extension muscle strength test[5]: The subjects sat at test chair with kept the hip angle at 95°, in order to prevent to compensatory force we need the trunk and the middle of the thigh bone were fixed, fix the test arm on the one third of the lower tibia of the advantage legs. The range of the knee's joint motion is 80°, the test pattern is the same as the hip.

Ankle flexion and extension muscle strength test[6]: Adjusted the angle of the back and horizontal plane to 70°, the flexion of the subject's knee is 90°, in order to bear the gravity of the lower limb place the tibia at supporting platform, we had fixed the tibia parallel with the ground, place foot on pedal and secure with two strap. The center of axis rotation is aligned with the center of ankle joint. The range of the ankle's joint motion is 80°, the test pattern is the same as the hip.

Dynamic balance test[7]: The Subjects will have a test experience before the real test. Before the real test, all subjects will have received a standard language and visual guidance, the test index include: height, weight and leg length. (1) The test of lower test: Subjects kept at supine position and kept the pelvis at neutral position, at the same time kept the legs straight, kept feet and shoulder width same, tested the distance of the right anterior superior iliac spine to Lower edge of medial malleolus. (2) The subjects kept barefoot, and placed their left foot thumb at the midst of the test board and behind the red line at the same time kept the foot thumb heading straight ahead. Kept hands on the waist, tried their best to extend their right leg to the anterior one time, then tried their best to extend their right leg to the posteromedial one time, finally tried their best to extend their right leg to the posterolateral one time. Repeated appeal action 3 times, the best performance in every directions will be adopted. Subjects will repeat the test if they are lost balance when stand with single leg and when they extend the leg but can't take back to the starting position. They will score 0 .cm if they failed 4 times in this direction. All measurements were accurate to 0.5cm, and the values in each direction were normalized for (%), the standard value is the ratio of longest distance (cm) and the leg length (cm) ×100% ; combined scores is the ratio of the total distance (cm) of three directions and three times' leg length (cm) ×100%.

1.3 Statistical Analysis

Statistical analysis was used SPSS 24.0 software, the bilateral significant level $\alpha=0.05$ was selected and Pearson correlation analysis, the significant level was set to 0.05. Strongest correlation: 0.8-1.0, strong correlation: 0.6-0.8, moderate correlation 0.4-0.6, weak correlation: 0.2-0.4, very weak correlation or no correlation: 0.0-0.2.

2 Results

2.1 Correlation results of the relative peak torque of the joint of hip the and the balance ability

Figure 1 shows the correlation of the relative peak torque of hip and dynamic balance ability, it has weak correlation between anterior balance ability and the flexion relative peak torque of the angular velocities of 90°/s and 180°/s at hip. And it has weak correlation between anterior balance ability and the extension relative peak torque of angular velocities of 90°/s ($P<0.05$). It has moderate correlation between the balance ability in posterolateral directions, combined scores and peak torque of the angular velocities of 90°/s and 180°/s at hip($P<0.01$). The postmedial balance ability correlated with the relative peak torque at the three angular velocity of the hip joint ($P<0.01$), and the correlation increased with increasing angular velocity. The posterolateral balance ability is moderately correlated with the peak extension torque of the hip joint at 90°/ s and 180°/ s ($P<0.01$). The balance score correlated with the peak extension

torque (P <0.01) of the hip at 30° / s, 90° / s and 180 ° / s, and the correlation increased.

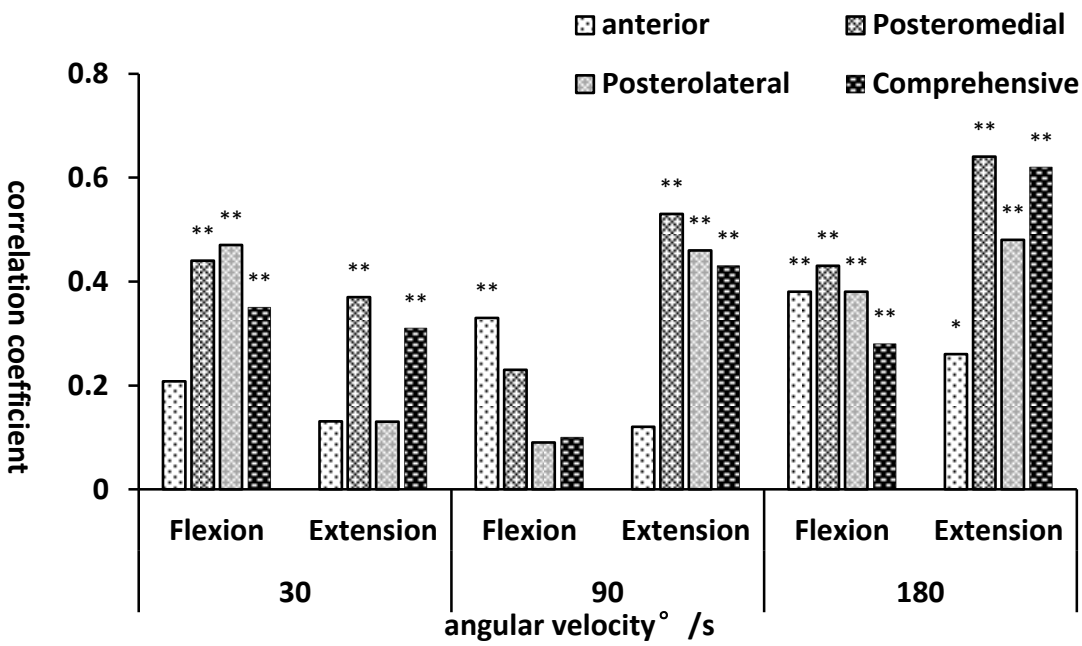

Figure 1 Correlation of the relative peak torque of hip and dynamic balance ability

Note：*：P＜0.05，**：P＜0.01，Pearson correlation calculation。

2.2 Correlation results of the relative peak torque of the joint of the knee and the balance ability

Figure 2 shows the related of the relative peak torque of the knee and the dynamic balance ability at different angular velocities, it has the moderate correlation between anterior balance and the knee flexion peak torque at 90 °/s and 180 °/s (P <0.01), and it has weak correlation with extension peak torque at 180 °/s (P <0.01). The posterolateral balance was moderately associated with the relative peak torque of the knee flexion at 30 °/s and 180 °/s, and with the relative peak torque at 90 °/s and 180 °/s (P <0.01). The combined scores of balance is moderate correlation with the knee flexion peak torque at 30 °/s and 180 °/s, and it has moderate correlation with extension peak torque at 30 °/s and 90 °/s, and it also has strong correlation with extension peak torque at 180 °/s（P＜0.01）.

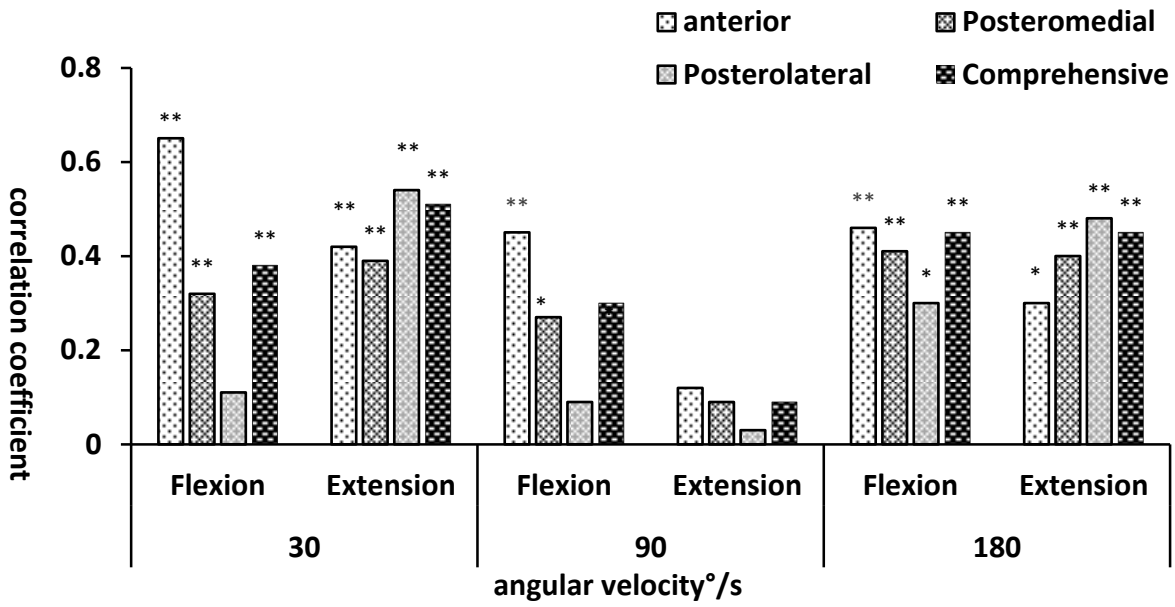

Figure 2 Correlation of the relative peak torque of knee and dynamic balance ability

2.3 Correlation results of the relative peak torque of the joint of the ankle and the balance ability

Figure 3 shows the strong related between relative flexion peak torque of the ankle and the postmedial balance ability （P＜0.05）， and the ankle relative flexion peak torque is related with the combined scores of balance （P＜0.05）; the ankle relative extension peak torque is related with the postmedial balance ability. The ankle relative flexion peak torque is related with the anterior and posterolateral balance balance ability.

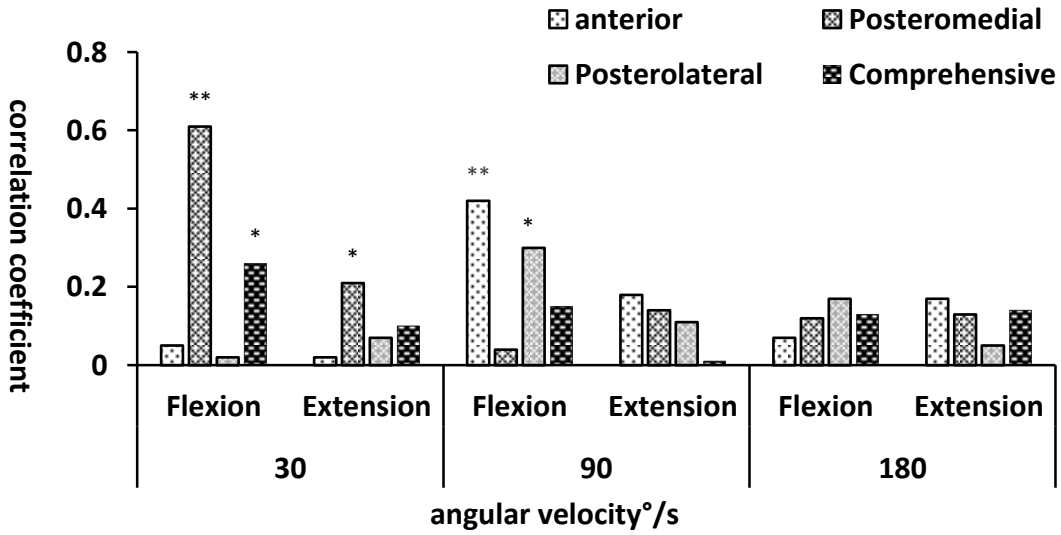

Figure 3 Correlation of the relative peak torque of ankle and dynamic balance ability

3 Discussion

Football is an Intermittent and explosive sport projects, which request high speed, the knee peak torque of the concentric contraction is affected by fatigue and angular velocity[8]. We assessed

the muscle strength at the isokinetic training at the angular velocities from 30° /s to 180° /s [9, 10]. This study tested the hip, knee and ankle of the lower limbs' the maximum peak torque and relative peak torque in the flexion and extension states at the different angular velocity, the correlation of the relative peak torque and balance is also studied at isokinetic in different angular velocities. It was found that the stronger correction hip relative extension peak torque between the balance as the angular velocity accelerated in isokinetic training. It will have the strong related between hip flexion or knee extension relative peak torque at high or slow speed and balance ability; the balance ability of the knee was correlated with both the anterior and postmedial at different angular speeds in isokinetic training, the relative peak torque of the ankle flexion were more correlated with the posteriormedial, in slow and moderate speed, the posterior medial balance; under slow conditions, the ankle extension is moderately associated with balance on the posteriormedial.

Most of the sports modes in the different modes of football are completed in a high speed and unstable state. The completion of this action requires the mutual coordination and cooperation of the lower limbs on both sides, during which the dominant side lower limbs are in a rapid swing state. When the lower limbs swing backward, the hip extension and knee flexion are active muscles, while the hip flexion and knee extension are antagonism; When swing leg swing, the above joints are the opposite, it also shows that the hip flexion and knee extension relative peak torque is related and balance, the associated of the hip extension relative peak torque and balance is similar with the knee flexion, the difference is that the hip extension relative peak torque is related with dynamic balance of the posteriormedial, posteriorlateral, knee extension is related with the anterior of the dynamic balance.

The isometric test method represents the gold standard for clinical strength assessment, This study demonstrated a high correlation between the relative peak torque and balance of the knee joint under rapid isokinetic conditions. The theory fits with some training theories, Various forms of lower limb joint injury can cause asymmetry in the bilateral limbs, unbalanced distribution of muscle forces leads to changes in action structure and reduced efficiency. Buckthorpe et al [11] introduced methods to prevent hamstring injury in elite football, emphasizing the importance of fast running and faster sports in football; Implement comprehensive waist, pelvic and hip stability; optimize physical conditions for football players, for example, strength and cardiovascular health.

4 Conclusion

At different velocity，the three joints of lower limbs play different effect on lower limb balance ability. In slow and medium speed movements, the three joints have different effects on the balance ability in different directions; In rapid movements, the muscle strength of hip and knee joint

plays an important role in lower limb balance ability in all directions.

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