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RESEARCH ARTICLE

The RELATIONSHIP BETWEEN ANTERIOR CRUCIATE LIGAMENT INJURIES AND TRANSVERSUS ABDOMINIS WEAKNESS: A MATCHED CASE CONTROL STUDY

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ABSTRACT

Background: Anterior cruciate ligament (ACL) injury is associated with various consequences all over the knee (e.g. meniscal tear and osteoarthritis). Spinal core stabilizers play an important role in stabilizing the knee and preventing injury, but with minimal supporting evidence. **Objective**: To identify the relationship between non-contact ACL injury and core muscles weakness. **Methods**: Sixty subjects with their ages ranged from 20 to 40 years old, allocated into two equal groups; Group A(ACL group): with non-contact ACL injury, and Group B (control group): Age matched healthy volunteer all are free from chronic or acute knee injuries. Each participant was assessed for Transversusabdominis (TrA) thickness (in static and dynamic situations) using rehabilitative ultrasound imaging (RUSI) and endurance of TrA using pressure biofeedback. **Results**: There were a significant decrease in static and dynamic muscle thickness and TrA endurance in ACL group compared with that of normal group ($p \leq 0.01$), weak positive significant correlations for TrA endurance with dynamic thickness ($r = 0.27$, $p = 0.03$) **Conclusion**: TrA strength and endurance can help in prevention and treatment of non- contact ACL injury.

INTRODUCTION

The anterior cruciate ligament (ACL) has been shown to be under stress when the knee is in extension or only minimally flexed (such as 5–20 degrees as opposed to 60 degrees) and when it is under valgus stress (also often described as knee internal rotation). Most non-contact ACL injuries occur while the individual is landing from a jump, rapidly stopping, cutting, or suddenly decelerating with change in direction (1).
History of ACL injury is associated with various consequences, including chronic knee problems, knee instability, meniscus tears, cartilage injuries and development of osteoarthritis, all of which can be debilitating (2). Injury to the ACL can lead to marked instability of the knee and potentially stressful kinematics (3). An ACL-deficient knee is also more vulnerable to injury or deterioration of other structures (e.g menisci) (4). Core stability refers to the ability of core musculature to stabilize the spine (5). It is required to increase stiffness of the trunk and hip in preparation for, and in response to, spinal loading, to prevent instability of the vertebral column and to facilitate return to equilibrium following perturbation (6).The core plays an important role in stabilizing the lower extremity and knee movement during activity. During reaction- based tasks (e.g. running, landing) the TrA/internal obliques are key dynamic stabilizers of the spine, lumbopelvic region, and the whole trunk-pelvis segment. The TrA is the first muscle activated during lower body movements (7). Neuromuscular control of the core plays an important role in lower extremity mechanics and may influence ACL and lower extremity injury risk, but with minimal supporting evidence (8,9). Despite clinicians implementing prevention programs (10), ACL injury incidence rates remain high (11). So there is a crucial need to identify the factors that most significantly correlate to ACL injury that might provide information about possible prevention and new intervention strategies (12). The purpose of this study was to identify the relationship between ACL injury and core muscles weakness.

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METHODS

Participants: The study included sixty subjects with their ages ranged from 20 to 40 years old, after filling the informed consent, they were allocated into two equal groups as follows;

Group A: Consisted of Thirty patients with non-contact ACL injury

Group B (control group): Consisted of thirty age matched healthy volunteer all are free from chronic or acute knee injuries.

Inclusion criteria

- Patients and healthy males and females with non-contact ACL injury (pre-surgical).
- Patients' age range from 20-40 years old.
- BMI < 30 kg/m^2.
- Waist circumference <80 for females and <94 for males.
- Less than two months duration after injury.

Exclusion criteria

Patients were excluded if they had one of the following

•Previous history of orthopedic conditions in spine and lower limbs (e.g. trauma, fractures and ligamentous injury) within last year.

Instrumentation

The following instruments were used

- **Ultrasonography (US):** Rehabilitative ultrasound imaging (RUSI) was used to assess muscle activation by measuring the change in muscle geometry during contraction **(13)**.
- **Pressure biofeedback:** was used to assess endurance of TrA.

Procedures

Pressure Biofeedback

- With the subject prone, the cuff was placed horizontally under the abdomen with its lower edge just below the anterior superior iliac spine (centered under the navel).
- The device was inflated to 70 mmHg.
- The subject performed a drawing in maneuver.
- Subject was asked to maintain the pressure drop for 10 seconds for 10 repetitions.
- Muscle endurance (holding or tonic capacity) of the TrA was measured by the number of 10- seconds holds (up to ten) (14). Fig. (1).

Fig. 1. Transverse abdominis endurance test; Test of the abdominal drawing in action in a prone position, monitoring of the contraction of TrA with pressure biofeedback unit, placed horizontally below umbilicus

The target level (68–60 mmHg) that the subject could hold steadily for 10s using the correct TrA action was identified. Secondly, the number of repetitions of a 10s hold that the patient could perform at their target level were counted. Performance was scored as the pressure level that the subject was able to achieve (activation score) multiplied by the number of repetitions they could perform. For example, if a subject could achieve the second level of the test (66 mmHg) and perform 6x 10s holds with the correct action of TrA., then the performance index was 4 × 6 = 24 (15).

Rehabilitative Ultrasound Imaging (RUSI)

- Each participant assumed crock lying position and was asked to do active straight leg raising (SLR), which has been tested once in regard to reliability of RUSI measures (16).
- The ultrasonography was set on M-mode image which represents changes in thickness, or depth of a structure, over time and is, therefore, referred to as "time-motion" mode (17).

Data analysis: Subject characteristics were compared between groups using unpaired t test. Chi- squared test was used for comparison of sex distribution between groups. Normal distribution of data was checked using the Shapiro-Wilk test for all variables. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Unpaired t test was carried out for comparison of waist circumference, static and dynamic thickness and TrA endurance between groups. Pearson Correlation Coefficient was conducted to determine the correlation between TrA endurance with waist circumference, static and dynamic thickness. The level of significance for all statistical tests was set at $p < 0.05$.

RESULTS

Subject characteristics: Subjects' characteristics were summarized in table 1. There was no significant difference between both groups in the mean age, weight, height, BMI and sex distribution ($p > 0.05$).

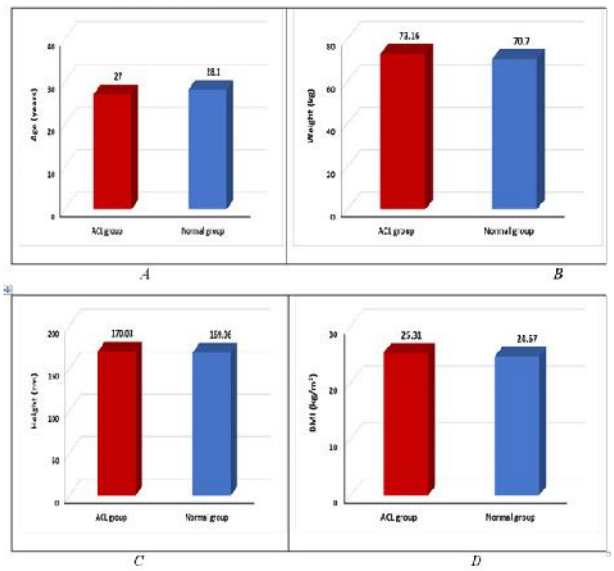

Fig. (2). Demographics of 2 groups; A) Age, B) Weight, C) Height, and D) BMI

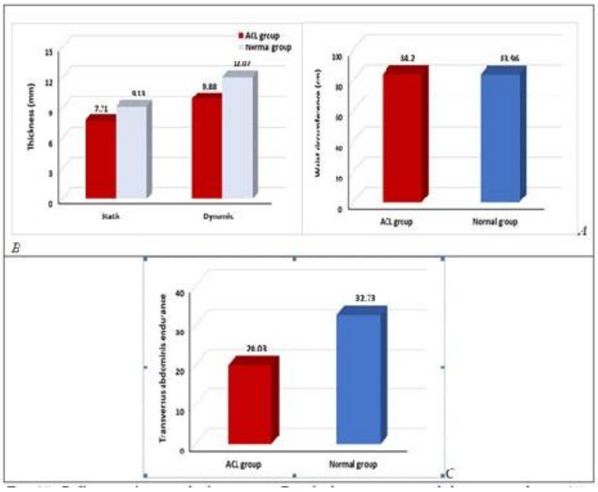

Fig. 4. Differences between both groups in TrA thickness at static and dynamic conditions (A), waist circumference (B), and TrA endurance (C)

Comparison of waist circumference, static and dynamic muscle thickness and TrA endurance between ACL and normal groups.

There was no significant difference in waist circumference between groups ($p > 0.05$), while there was a significant decrease in static and dynamic muscle thickness and TrA endurance in ACL group compared with that of normal group ($p < 0.05$) (Table 2).

Relationship of TrA endurance with static and dynamic thickness: There were weak positive non significant correlations with static thickness ($r = 0.09$, $p = 0.49$) and weak positive significant correlations with dynamic thickness ($r = 0.27$, $p = 0.03$) (Table 3).

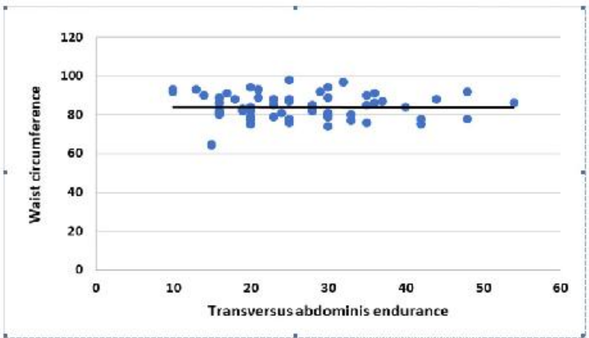

Figure 5. Correlation between TrA endurance and waist circumference

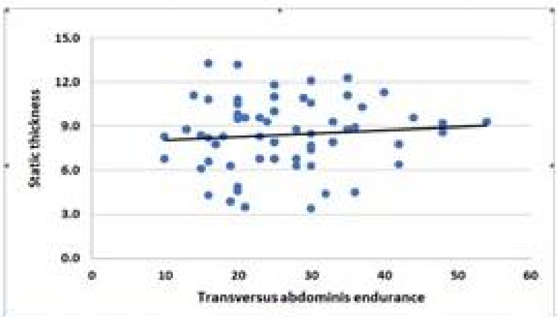

Figure 6. Correlation between TrA endurance and static thickness

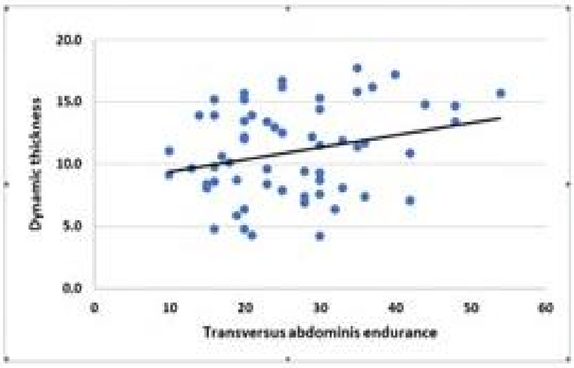

Figure 7. Correlation between TrA endurance and dynamic thickness

DISCUSSION

The current study showed that TrA strength and endurance may be very important in injury prevention and treatment of non-contact ACL patients as they were significantly weaker in those population compared to normal matched controls. Core musculature provides dynamic stabilization to the spine and proximal appendicular skeleton, as well as movement information to the neural control subsystem (18). Results of the present study agree with Zazulaket al. (19) who reported that core-specific factors were able to predict knee ligament injury with 91% sensitivity and 68% specificity. Finding of the current study support the notion that poor core stability is linked to development of lower extremity injury (20) and over-use injuries of the knee (21). As well, agree with the notion that neuromuscular control of the core (8) plays an important role in lower extremity mechanics and may influence ACL and lower extremity injury risk (9). The current study also, revealed that there is a weak positive significant correlations for TrA endurance with dynamic thickness ($r = 0.27$, $p = 0.03$) with no correlation with static thickness or waist circumference. This finding ensures the important role of TrA activation during lower limb movement, thus may help prevent injury and re-injury.

Conclusion

Transversusabdominis strength and endurance may be important in injury prevention and treatment of non- contact ACL injured patients as they found to be significantly weaker compared to normal matched controls.

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