

The Application of Sport-Specific Core Strength Training for Table Tennis Players

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Abstract. Table tennis is a sport that is requiring more and more core strength of an athlete. In this paper, the functional mechanisms of sport-specific core strength in table tennis, training methodologies, and practical implications systematically emerge. Studies have shown that the core is an important point of transmission of forces between the lower and upper limbs. It is able to increase hitting power efficiently, the efficiency of movement transition, dynamic body stability and lessen the risk of injury, especially in the lumbar area. The training must follow a progressive principle, starting with the basic stabilization and dynamic stability and rotational power and functional integration. The use of such equipment as Swiss balls, medicine balls, resistance bands, etc should be involved in this process, careful planning of training load and periodization. Evidence: Case studies and experimental data support the claim that systematic core stability training can significantly enhance core endurance, balance, agility and certain specific technical proficiencies (e.g. forehand attack and backhand block) in both adolescent and high-level players. Moreover, it has demonstrated good outcomes in injury prevention and performance support in Olympic preparation of elite athletes. It is suggested that further training should be more geared towards incorporation with sport-specific methods, develop a system of scientific evaluation and be able to incorporate new ideas such as the integration of rehabilitation and physical conditioning, to holistically improve the competitive ability of table tennis players.

Keywords: Table Tennis, Sport-Specific Core Strength, Training Methods, Technical Stability, Sports Injury Prevention

1. Introduction

Table tennis qualifies as a skill-based sport although with increase in training and competition among the high-level players, physical fitness has a direct influence to the level of competitive performance. Sport-specific physical conditioning involves strength needs of all the table tennis techniques, such as explosive power, coordination, and speed of reaction. Here, core strength is the crucial connection between the lower and upper body. It is important in keeping the body in dynamic stability, allowing the effective transfer of force between legs and arms, accelerating the relationship between strokes, and reducing the risk of any athletic injuries [1, 2]. The mass and volume of the ball also increased since the two changes in ball specifications (in 2000 (38mm to

40mm) and in 2014 (40mm to 40+mm)) did not only increase the mass of the ball but also its volume. This development has elevated the physical training of the athletes and has changed the style of play mostly to be in the mode of a mix of speed attacks and loop drives. Today, when a player lacks a main force, he or she is not able to maintain high rallies and the number of injuries tends to be more frequent.

Consequently, the discussion of the use of certain core strength training in table tennis players is not only useful in addressing the typical problems inherent in the existing core training methods and enhancing the specific movement skills of an athlete, but also possesses significant practical importance in terms of preventing injuries, the effectiveness of training, and the longevity of an athletic career.

2. Functional effects of core strength in table tennis moves

The force of a table tennis stroke is created by pushing on the ground with the feet. This energy flows up the middle and to the upper extremities. The wholeness of the core determines the smoothness of this chain of kinetic functioning. In case of insufficient core strength, the kinetic chain may fail and the lack of explosive force and weak shots will be observed. During the instant of a power stroke, the core muscles (transverse abdominis, erector spinae and obliques) contract to stiffen the torso. This forms a kind of pillar effect which does not allow the energy produced by the leg drive and waist rotation to dissipate in the trunk. It directs the force upwards so that the legs and hips momentum is passed on to the playing arm with minimal leakage. This permits making of heavy spin at a very small swing. The core musculature is similar to an amplifier. In case the core is loose, much of the lower body and torso force is wasted in the transfer. The stricter the core is thus closed, the more explosive power there is in the stroke.

As the athlete moves, such as in performing maneuvers such as sidestepping, lunging to the forehand or moving sideways, the core muscles constantly change their tension levels to ensure a neutral trunk position. This will ensure that the torso remains stable and prepared to make the best ball contact by ensuring that the upper body is not pressed over when making sudden stops, change of direction or long strides. This stability significantly enhances shot predictability and control of placement. This is particularly in the case of the back hand techniques that depend greatly on an instantaneous contraction of the core to stabilize the trunk and give a sound foundation on which to generate the force. Also, following a hit on the ball, the core muscles quickly release their tightness then tightens once more to draw the body back to the ready position to make the next shot. What is important is the rate of this contraction-relaxation cycle and this is directly proportional to the effectiveness of connecting one stroke to another so as to avoid being caught in an exposed position as a result of a slow recovery.

3. Techniques and practical implementation of the core strength training in table tennis

3.1. Typology of training methods and laws of progression

Table tennis core strength training is not a monotonous routine of exercises. Instead, it is a progressive procedure that follows scientific laws and proceeds in phases. According to the technical requirements of table tennis and physiological functions of the core musculature, the content of the training is usually divided into four separate but not independent phases. The main concept of this progression model is to add the complexity and sport-specificity to the drills step by step. It starts

with the basic proprioceptive awareness and finally, the goal is to allow the automatic use of core strength in high-speed matches.

3.1.1. Phase one: basic stabilization

The first stage is concerned with primitive stabilization. This is mainly aimed at stimulating the deeper stabilizing muscles (like the multifidus and transverse abdominis) which are not easily recruited voluntarily and to enable the athlete to gain an appropriate feeling of core recruitment. The exercises involved in the training are primarily the ones that involve holding the body in a static posture, such as the famous front plank, supine bridge (also known as a glute bridge), and prone back extension (also known as Superman hold). The exercises are normally carried out on a stable surface and much focus is made on proper posture and the ability to sustain the posture. The aim is to guide the athlete on how to handle the positioning of his/her spine and pelvis in a stationary environment. This is a very crucial phase especially among the younger athletes who are yet to master their basic techniques or those who are in the process of rehabilitating due to injury, as it forms a good foundation to all the advanced training that follows.

3.1.2. Phase two: dynamic stabilization

As soon as the athlete displays the skill in holding a position, the second phase of training can be the dynamic stabilization. In comparison to the initial stage, the stage adds dynamic aspects and unpredictable surfaces, making use of devices such as Swiss balls, balance pads or suspension trainers (e.g., TRX). Examples of typical exercises are using the Swiss ball to do crunches or bicycle kicks or push-ups with the feet lifted on the ball. These activities force the core muscles to act in a continuous manner to stabilize as the limbs move or as the base of support is unstable. This is very similar to the needs of the real world of table tennis, where players need to maintain a steady center of gravity and move very fast and make big swings. This stage is useful in increasing the dynamic control ability of the core and body coordination during movement [3].

3.1.3. Phase three: rotating power development

The third is rotational power development. It is the most closely related training element to the particular technical requirements of table tennis. The key to the force production in table tennis is the "waist and hip drive. Such movements like the forehand loop and backhand flick are based on the quick rotation of the trunk. Accordingly, the main objective of this stage is to develop rotational explosiveness at the core muscles. Some of these training aids involve different rotational throws with medicine balls, such as seated or standing Russian twists with a toss, and side throws. Moreover, anti-rotation and rotational motions with the use of resistance bands or free weights (resistance band side twists or dumbbell side bends) are effective in targeting and strengthening the internal and external oblique muscles that allow the trunk to rotate. In the process, coaches during this stage give special attention to the velocity and fluent movement, with the aim of imitating the force generation patterns observed in real-life competition.

3.1.4. Phase four: functional integration

The last level is the highest level of training: functional integration. The aim here is no longer to isolate and train core strength as an independent entity. Rather, it is intended to integrate the functions that had been acquired in the previous three phases into complete and sport-specific

technical movements in a seamless fashion. This requires the athlete to apply core strength in the dynamic setting of simulated match play. Training modalities such as: doing resisted stroke practice with the racket in hand but using elastic bands or resistance tubing; and doing footwork exercises on soft mats, sand, or multi-directional movement platforms and at the same time performing stroke actions; are common. This form of training makes the core work naturally and effectively in the chain of kinetic processes, with a proper flow of forces between lower and upper limb. The final objective is frictionless transfer of training to real competition performance.

3.2. Training load and periodization

The general guideline is that the core strength training should be scheduled two to four times per week interchangeable with the core technical training sessions. Every exercise session is to include four or six exercises. The athlete is to do three to four sets per movement with a rest period of thirty to sixty seconds. A regular routine of about twelve weeks ought to be adequate to show significant gains in the core endurance, strength, and coordination.

In the framework of a training cycle annually, the preparatory period of the training should focus on basic and dynamic stability exercises. Rotational power and functional integration drills should be given center stage in the competitive season. Lastly, recovery period must entail a reversion to the initial stabilization exercises as an active rest and maintenance.

4. Impact of core training on table tennis players

4.1. The objective was to improve technical stability and the quality of stroke

Studies have shown that core strength training has a significant impact on the ball speed related to basic table tennis skills. In one of these studies, twelve high-level table tennis players of Southeast University were involved. They were chosen randomly as an experimental group that would receive core strength training in the course of six weeks, and as a control group that would receive conventional physical conditioning in the course of six weeks. The findings showed that forehand ball speed in the experimental group increased from 10.00 ± 1.78 m/s to 14.32 ± 2.54 m/s, while the control group improved from 10.83 ± 0.91 m/s to 12.98 ± 1.79 m/s ($p < 0.05$). For backhand speed, the experimental group's figures rose from 11.00 ± 1.78 m/s to 12.05 ± 2.83 m/s, compared to the control group's increase from 11.83 ± 0.91 m/s to 12.88 ± 1.96 m/s ($p < 0.05$). These findings indicate that core strength training is more effective in increasing the ball speed than the conventional conditioning methods [4]. The reason behind this is that a stronger core will offer a more reliable anchor of limb movement thus making the force transmission more effective. Another research confirmed that core stability training yielded far superior outcomes compared with general physical training in improving the technical skill of adolescent table tennis trainees in skills like the forehand attack, backhand block, and a combination exercise like alternate attacking [5]. This supports the fact that the increase in core strength directly correlates with increased technical execution that is more stable and accurate.

4.2. Enhancement of coordination and balance

Players need to repeatedly make sudden shifts in direction and massive swinging movements and these exert severe stress upon the ability of the body to perform dynamic equilibrium. The core muscles maintain stability of the spine and pelvis and thus make the upper and lower body to work

in a balanced manner. As core strength is enhanced, the rate at which the center of gravity moves over to the other side of the body also rises and this is the foundation of rhythm in looping strokes. Experimental evidence indicates that core stability training (i.e. the use of suspension systems) can considerably enhance the capacity of a player to stand on a single leg (a major gauge of balance). Such physical quality improvements are directly translated in the capabilities of the player to maneuver and stay in control within the court [6].

4.3. Prevention of injury and extending the athletic lifespan

The lower back is a frequent injury among table tennis players because of the twisting movements involved in the sport. The multifidus and transverse abdominis are deep core muscles that, in collaboration with other small stabilizers, promote the integrity of the spine. An effective way of reducing the risk of lumbar spine injuries is to strengthen these muscle groups which enhance lumbar stability. In addition, sufficient core strength prevents the inefficient distribution of energy during movement, which could otherwise cause uneven distribution of forces and increased likelihood of lower limb joint injury during rapid, agile movements. Within the framework of training elite athletes, the evidence of practical implementation of the concept of integrated rehabilitation and conditioning has demonstrated the effectiveness of systematic core strength training in the treatment of the risk of sporting injuries. A single clinical trial involved sixty male university students with non-specific chronic lower back pain. They were randomly allocated to either a core stability training group (experimental) or a traditional lumbar strength training group (control) where they had an eight-week intervention. The results showed that the VAS pain score of the experimental group reduced to $1.11 \pm .81$ after the intervention, whereas the VAS pain score of the control group reduced to 2.11 ± 1.52 ($p=0.000$). Also, the experimental group scored significantly lower on the symptom score of pain (1.26 ± 1.10) compared to the control group (1.63 ± 1.89 , $p=0.011$). The rate of recovery was 66.67 in the experimental group, which is significantly higher than the 20% in the control group ($p=0.000$). Moreover, the integrated electromyography (iEMG) of the rectus abdominis, erector spinae and multifidus muscles indicated significant reduction in the experimental group ($p<0.05$) which revealed better muscle performance. It was concluded that core stability training provides better therapeutic effects than conventional back exercises in adolescents with chronic non-specific lower back pain and this effect is largely attributable to better muscular performance [7].

5. Training effects in athletes experiments and case studies

5.1. Experimental studies of teenage athletes

Wang Siyuan organized a twelve-week experimental study to test the effects of core stability training to table tennis performance by using forty-two adolescent trainees who engage in table tennis. Experimental group underwent training on core stability whereas the control group underwent a normal physical conditioning program. The findings showed that the experimental group recorded a much higher improvement as compared to the control group in various measures. These were core endurance (one-minute curl-up $P=0.043$; trunk extensor endurance $P=0.035$), balance capacity (single-leg stance on dominant side $P=0.008$), agility (T-test run $P=0.021$), and levels of technical skills (forehand attack $P=0.004$; backhand block $P=0.009$; alternate attack These were statistically significant differences [3]. Moreover, the experimental group scored much higher on psychological questionnaires in comparison with the control group ($P=0.025$). Based on this evidence, it can be

inferred that the effect of core stability training on the functional core capacity, coordination, agility and technical proficiency of young table tennis players is markedly positive. It also seems to have a positive effect on psychological condition, and its overall training effect is better than that of general physical conditioning. There is also other research that indicates that core training has the ability to improve the physical qualities of teen athletes [8].

5.2. Practice case study of a high-performance athlete

Core strength training is now a major part of major competition preparation at the elite level. Look at the case of the Chinese female table tennis player Chen Meng in the run-up to 2024 Olympic Games in Paris. During six months, her rehabilitation and physical training plan was directed by the innovative principle of the combination of rehabilitation and physical conditioning [9]. In this process, there was the use of sophisticated sports rehabilitation evaluation methods and a scientific physical training model that profoundly combined the approach to rehabilitation and the requirements of her event. Certain interventions involved specific training of core rotational power, development of aerobic metabolic capacity, and development of joint range of motion. The results indicated that there was a marked increase in rotational explosiveness of Chen Meng, as well as the successful management of her risk of sports injury. This gave her a strong physical base upon which she was able to maintain a high degree of competitive form in the high intensity multi-rally exchanges of Olympic competition. The given case demonstrates that individual core training, which is developed based on personal traits of an athlete, is an extremely important supportive factor of the work of the leading athletes.

6. Conclusion

The benefits of core strength training on table tennis players are numerous. To begin with, it is capable of enhancing technical stability significantly. It enhances speed and precision of forehand and backhand strokes by enhancing trunk control. Second, core training improves general body balance and coordination, which enable athletes to be in an optimal position to perform quick actions and thus be more agile. Third, having a strong core muscles is an efficient way of preventing sport injury, especially lowering the risk of lumbar spine, and lower extremity joint problems. Lastly, the experience of junior players and high-level players in general has shown that the core strength training is a necessary route of increasing the level of performance in table tennis, being systematic and scientifically directed. At the present, though, the integration of core training that is specialized in table tennis is usually stifled by archaic training philosophies and practices. The importance of the core region is not always considered important and a well-developed and comprehensive training system is missing.

Following the above analysis, it is possible to recommend a number of optimizations to core strength training in table tennis. The training content design must be in a logical order in which stable environment is followed by unstable environment and then stable holds are followed by dynamic movements in a rational order of the four stages of basic stability, dynamic stability, rotational power and functional integration. The training must be based on the age and the level of skills of the athlete: the younger players should be focused on the fundamental stability and proper form, and the experienced players should be focused on the rotational explosiveness and sport-specific integration. Regarding the connection of training with particular skills, core work is not to be conducted separately but, instead, to be closely interlaced with technical table tennis exercises.

Coaches must begin to understand better the role of the core in the kinetic chain of stroke production and design training processes should be more specific.

In summary, sport-specific core strength training for table tennis is a scientific and systematic undertaking. When applied judiciously, it can lead to comprehensive gains in technical stability, force production efficiency, and injury mitigation. Future research could further investigate the differential effects of various training methodologies on distinct playing styles and explore optimal strategies for integrating core training with other facets of physical conditioning. Like the holding resistance exercises, core control exercises at the time of movement, etc. Simultaneously, create a system of scientific monitoring and evaluation, periodically test the core endurance, ability to balance and special skills, and reasonably regulate the load. Moreover, there is a need to revise training ideas and refer to the newest models like "integrated rehabilitation and physical fitness" in order to integrate the core training with rehabilitation and technology organically.

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