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Original Article

"Centering": a fundamental instrument for teaching balance in competitive adolescents

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Abstract
For many years, there has been a debate regarding the role of intra-abdominal pressure (IAP) in supporting the vertebral column, particularly in the lumbar region. The role of IAP is particularly evident during physical activities that require complex movements and rapid jumps (Paoli et al., 2010). The hypothesis that IAP relieves the compressive load on the lumbar vertebrae by better distributing the force vectors during physical activities was first proposed in 1923 by Keith and subsequently discussed by Bartelink (Bartelink, 1957). This hypothesis was later confirmed by Morris et al. in 1961 using a mechanical model. The authors demonstrated that a voluntary increase in IAP alleviates lumbar compression, both directly and indirectly, by inducing spinal extension, causing flattening in the cup-shaped form of the thoracic diaphragm muscle (Morris et al., 1961). Other authors have confirmed the important role of IAP in coordinating the activity of trunk muscles (Stokes et al., 2010; Madle et al., 2022), and its indirect contribution to respiration has been expanded upon and studied (Hodges, 2000). These aspects are crucial for achieving good performance in sports involving acceleration and jumping (Gennaro et al., 2019; Bitnar et al., 2015; Hwang et al., 2021). Therefore, it is possible to activate the components of the trunk stabilization system using its muscles by increasing IAP, which is associated with voluntary use of the thoracic diaphragm muscles (Stokes et al., 2011). Performance improvement has also been demonstrated using "Centering" (Debernardi, 2008). "Centering" (CENT) is the proportional utilization of IAP depending on forces experienced due to the acceleration during sports movements. CENT improves the execution of technical gestures and their learning (Fogliata et al., 2022). Owing to the importance of CENT in the stabilization and protection system, the aim of this study was to verify the possible effects of CENT on balance and stabilization dynamics (Malwanage et al., 2022) and to study possible differences in balance between adolescents with and without CENT. Furthermore, the Stork test was employed to identify possible changes in balance parameters in adolescents with and without CENT (Condon, 2014).
Kay Words: **Balancing, Centering, Adolescents Sport.**

Introduction

The optimal stabilization of the spine is a complex process that relies on the synergistic interaction of various key components - the diaphragm, pelvic floor, and abdominal muscles. This interconnected system contributes significantly to the regulation of intra-abdominal pressure (IAP), a pivotal aspect of core stability (Hodges et al., 2013). Notably, IAP offers robust support to the ventral spinal column mitigates compressive loads on the vertebrae (Allard-Latour et al., 2022), and harmonizes with the paraspinal muscles and lumbar spine in safeguarding spinal stability (Cholewicki et al., 1999; Lee et al., 2008).

The concept of Centering (CENT), wherein diaphragm activation is deliberate, proportional, and precedes sporting movements (Hrysomallis, 2017; Zemková, 2016; Granacher et al, 2013) is of particular importance to athletes. Mastering such a system of voluntary activation can enhance sports performance and reduce the risk of injury (Hagins and Lamberg, 2011; Hodge, 2000; Kobesova et al., 2015; Saeterbakken et al., 2021). Furthermore, evidence suggests that CENT can potentially ameliorate back pain issues (Hlaing et al., 2021; Tsai et al., 2020).

CENT also serves as a valuable tool for optimizing models and experimental methodology of visceral mass movements (Lopez et al., 2022). Its integration with the locomotor-respiratory movement during trotting and galloping in quadrupeds stabilizes their gaits and enhances their movement quality (Bramble and Carrie, 1983; Simon and Chabris, 1999). Similarly, in humans, CENT's role extends to running (McDermot et al., 2003) and walking (Rassler and Khol, 1996), fostering improvements in gait quality. (Ledin et al, 2007; Zehr, 2018).
However, the literature thus far has not fully explored the potential impact of CENT on general balance. Balance, given its intrinsic relationship with the nervous system, is an essential skill that should be learned and/or solicited during the appropriate growth phase, such as adolescence (Gudrun, 2000; Dalton, 1991). Several scholars argue against focusing on muscle strengthening sessions for young athletes. Instead, they emphasize the value of training fundamental motor skills in synchronization with the athletes' central nervous system (Caira and Sergi, 2012; Daverio, 2022).

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This study aims to shed light on potential differences in adolescent balancing ability, comparing CENT-trained and naive adolescents. Specifically, we aim to evaluate the impact of CENT on technical-sports support and balance training. If a positive correlation between these variables is confirmed, we propose using CENT as an innovative approach for teaching training exercises that are yet to be thoroughly investigated.

In additionally, the literature highlights a growing recognition of the importance of CENT in physical education, as well as in competitive sports. Researchers have examined the benefits of CENT in teaching fundamental motor skills, with a particular focus on balance and movement control (Brown & Pfeiffer, 2018). Their work suggests that CENT training could represent an effective preventive strategy against injuries, as well as enhancing the effectiveness of motor learning in young people. From a preventive perspective, the practice of CENT in physical education could help reduce the risk of long-term injuries in adolescents, as well as improve their overall motor competence (Williams & Johnson, 2019). This emphasizes the importance of these fundamental motor skills for the development of good sports technique, as well as for promoting a safer and more controlled approach to movement during adolescence.

Therefore, CENT could not only improve sports performance and reduce the risk of injuries, but also significantly contribute to general physical education, enhancing motor skill and balance in adolescents (Phillips et al., 2020). In this context, CENT training could represent an innovative and promising teaching strategy for physical education.

Materials and methods

The authors chose to use the Stork Test to assess the relationship between CENT and skills. All the underage participants provided their informed consent through the signature of their parents or legal guardians.
The total subjects tested were 82, female athletes, practicing a competitive sport, aged between 15 and 17 years (average 16.5 years). (Ntozis et al., 2021; American College of Sports Medicine, 2021). The 82 subjects were divided as above into: group 1 SICENT and group 2 NOCENT.

Each group consisted of 41 subjects of comparable age (group 1 mean age = 16.50; group 2 mean age = 16.50). Centering ability of all participating subjects, belonging to group 1, SICENT, was previosly tested. All participants had the right lower limb dominant, according to the Edinburgh Handedness Inventory. (Clark et al., 2010; 2015; Barrera et al., 2022)

Furthermore, the subjects underwent anamnesis and morphological analysis. (Paillard, 2017; Myer et al., 2005; Leon and Corrales, 2016) All participants were symmetrical at the level of the circumference between the right and left thigh and leg. No subject had suffered joint trauma to the lower limbs in the six months preceding the Test. All subjects reported, previous traumas (beyond the established six months) were discarded unless there was an assessment of suitability and symmetry by a physiotherapist. All the participating subjects underwent a control and explanation training on visual fixation maintain.

All subjects were tested on a flat Linoleum surface in the same space position. All subjects kept head oriented along the sagittal axis, standing against a wall with demarcation point perpendicular to their faces.
Each subject was asked to maintain the Stork Test position: standing on one leg, the opposite leg flexed so as its foot sole was resting on opposite knee inside face.

The hands had to be at the hips and the gaze had to focus on the fixation point, graduated according to the height. Once in position, the subject was asked to detach from floor the heel of the pivot foot and to maintain the position for as long as possible without swaying with the torso.

There were always at least two examiners present: one of them was responsible for checking the correctness of the execution and used a stopwatch to control the principal, the other one was responsible for the quality control of the CENT (in the SICENT group) and used a stopwatch to control the principal.

All subjects were allowed to perform preliminary tests to gain familiarity with the task (max 3). Performance was then measured with experimenters stopwatches (controls), as well as by a third pressure stopwatch (Kalenji kick and run Base model) positioned under the heel of the subjects.

All data was collected in the 2022/2023 competitive season between August and September, before the start of the sports season.

Results

In the analysis phase, the data were read through the following indicators:
1) Average time: average of time spent in balance by performing the test on the left and right lower limbs.
2) Imbalance: difference in time detected by performing the test on the left and right lower limbs.

The collected data show that the average time spent in balance is comparable between the two groups: SICENT group = 4.3 seconds vs NOCENT group 4.4 seconds, thus showing a decidedly limited gap.

The data relating to the imbalance show a distribution tending towards a Normal curve with values included in a range of 9 seconds and most of the cases concentrated in the midpoint with a value of 0, i.e. where the time difference in balance on the left leg and the right is null.

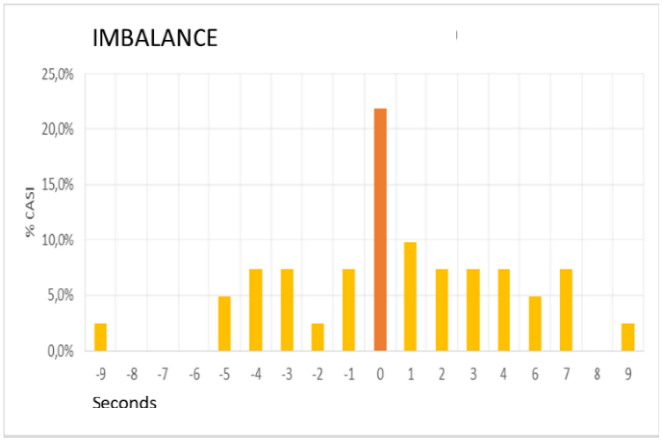

Fig. 1- Comparison between right and left balance time

From the analysis of the data it emerges that the use of Centering leads to greater stability between the time in balance recorded by performing the exercise on the left leg and that tested on the right leg.
The SICENT group showed a range of imbalance between the left leg and right leg three times smaller than that recorded in the NOCENT group, going from 9 seconds to 3 seconds

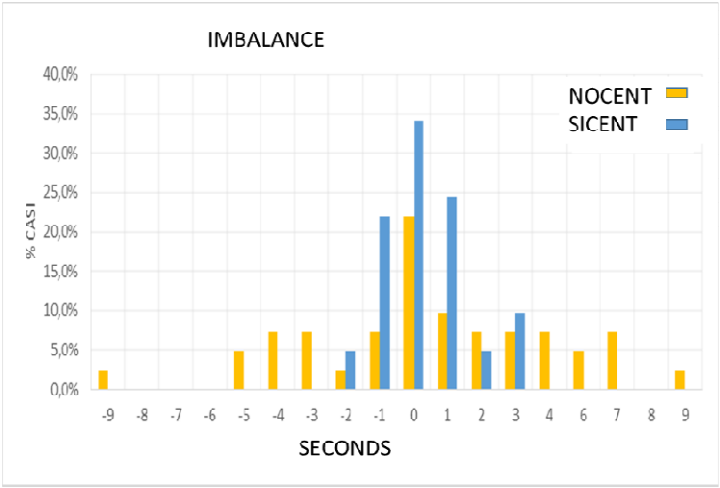

Fig. 2- Comparison between Group1 and Group2 right and left leg balance time
80% of the SICENT group demonstrated a maximum imbalance of 1 sec versus 39% recorded in the NOCENT group;

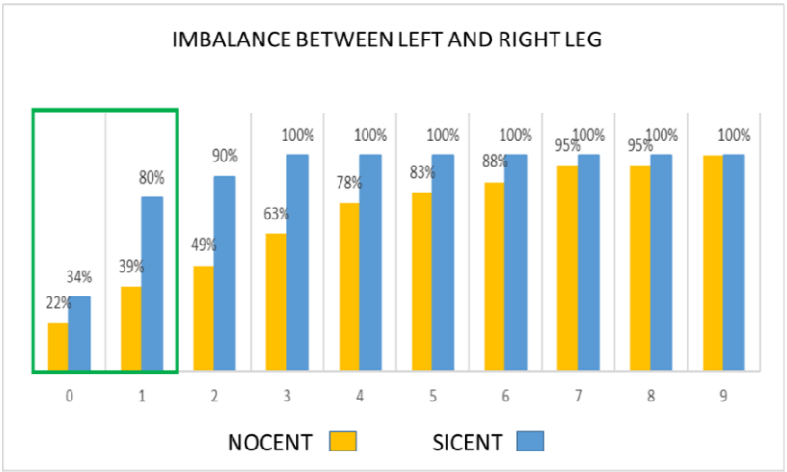

Fig.3- Statistic distribution of imbalance

A logistic regression was also performed which highlighted a T-Value of -8.62 (negative as the values in the SICERT group are reduced compared to those recorded in the NOCERT group) with significance "<0.0001".

Discussion

In the light of the results obtained, it can be seen that, although Centering does not seem to have an effect on the increase in balance times, there is a substantial improvement in the motor balance between the two limbs. This datum, whose experimentation should be expanded, indicates a possible benefit in the use of Centering in all those sports in which the athlete is subjected to an imbalance. Maintaining a balance between the limbs could not only improve performance but also decrease the risk of injury.

Conclusion

Based on the outcomes from a myriad of studies, it seems clear that the pedagogical introduction of centering techniques can lead to significant enhancement in limbic motor balance (Bitnar et al., 2015). However, much of the existing research has primarily been focused on assessing the effectiveness of centering techniques in improving balance times, while the exploration of long-term impacts of centering instruction on motor balance remains somewhat limited (Condon and cremin 2014).

Nonetheless, a handful of hypotheses have emerged suggesting the potential long-term benefits of centering instruction in the realm of injury prevention in athletics (Dalton, 1991). Centering, in particular, is conjectured to bolster the balance between bilateral limbs, thus mitigating imbalances that could lead to injuries (Lee, 2005). Furthermore, the associated gains in stability and motor coordination could improve athletes' performance by augmenting their capacity to execute precise and intricate movements (Kobesova et al., 2015).

In addition, the concept of centering can also contribute to the stability of the trunk, thereby enhancing lumbar spinal stability (Cholewicki et al., 1999). The importance of trunk stability in preventing sports-related injuries, particularly in the lower back, has been well-documented (Morris et al., 1961). Hence, the centering technique, by improving trunk stability, can potentially reduce the risk of sports-related injuries.

Also, teaching centering techniques can lead to better breathing coordination, which can improve athletic performance (Bramble and Carrier, 1983; McDermott et all., 2003). Proper breathing and respiratory coordination have been found to have significant impacts on running efficiency and overall sports performance.

In conclusion, the instruction of centering techniques stands as a promising strategy for augmenting motor balance in athletes and mitigating the risk of sports injuries (Daverio, 2022). However, more extensive research is required to investigate the long-term effects of centering instruction on stability and motor coordination, and whether these effects culminate in improved sports performance and a decreased propensity for injury

Conflicts of interest. None of the authors has a conflict of interest.

The authors' contributions were as follows:

Arianna Fogliata - Conceptualization of the paradigm, data collection supervision, and manuscript writing.

Roberto Borghini - Data collection and analysis, revision of the English language.

Antinea Ambretti - Scientific coordination of the work and revision of the manuscript.

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