International Journal of Sport Studies for Health, 2024, VOL. 7, NO. 1, 27-35

International Journal of Sport Studies for Health

Journal Homepage

We Should Not Keep Drawing-In the Abdominal Wall During the Core Training

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A r t i c l e I n f o

Article type:
Review Article

How to cite this article:
Aragón Salamanca, J. C. (2024). We Should Not Keep Drawing-In the Abdominal Wall During the Core Training. *International Journal of Sport Studies for Health, 7*(1), 27-35.
http://dx.doi.org/10.61838/kman.intjssh.7.1.4

A B S T R A C T

Objective: The goal of this article is to compile relevant literature that proposes that perhaps the abdominal drawing-in maneuver (ADIM), also known as the "abdominal hollowing maneuver" (AHM), should not be applied as a general rule during the core training.

Methods and Materials: Based on current evidence, this paper evaluates whether general use of this ADIM is beneficial for the core training. In this regard, we have searched for related scientific evidence in PubMed and Google Scholar. The keywords used were: abdominal hollowing maneuver, abdominal drawing-in maneuver, lumbo-pelvic stability, core stability.

Results: The literature shows us that the application of ADIM during core strengthening exercises does not meet the requirements for isolated TrA-specific retraining, can increase Inter-Rectus Distance, may be incompatible with postural stability goals, and could interfere the Rectus Abdominis input impairing the lumbo-pelvic stability during high-load exercises.

Conclusion: It can be concluded that if the goal is to train core stability and strength with high-load scenarios we should not use the ADIM.

Keywords: *Core training, abdominal drawing-in maneuver, low load tasks, high load tasks.*

1. Introduction

In 1996 the impaired function of Transversus Abdominis (TrA) was related with insufficient muscular stabilization of the lumbar spine (1). A specific retraining of the TrA muscle was then indicated for lumbopelvic stabilization through its voluntary contraction by the abdominal hollowing maneuver (2). On the other hand, 10 years later it was suggested that the body appear to select an appropriate natural muscular activation pattern to

Article history:
Received 07 November 2023
Revised 25 November 2023
Accepted 09 December 2023
Published online 01 January 2024

sufficiently maintain spine stability and, conscious activation of individual muscles around this natural level may decrease its stability (3). In 2010, in a controversial and important review article about the myth of core stability it was proposed that people who have been trained to use complex abdominal hollowing and bracing maneuvers should be discouraged from using them (4). Nowadays, many trainers and some schools of a technique as preeminent as the Pilates Method keep cueing to draw the abdominal wall in during its practice, which is why we firmly believe that it is important to bring this topic to the attention of the physical activity community. The goal of this article is to compile relevant literature that proposes that perhaps the abdominal drawing-in maneuver (ADIM), also known as the "abdominal hollowing maneuver" (AHM), should not be applied as a general rule during the core training. Throughout this article we will use AHM and ADIM indistinctly when referring to the action of drawing-in or hollowing the abdominal wall.

2. Materials and Methods

In order to achieve and justify this methodological and cognitive change within the fitness and physical activity community we have based our argument on the question of why we draw the abdominal wall in during the core training. The two main reasons found in the literature that explain why the ADIM is used during core training are, because we want to do a selective activation of the Transversus Abdominis (TrA) (5, 6) and because we want to improve the lumbo-pelvic stability (7, 8) Based in these two lines of reasoning we have searched for related scientific evidence in PubMed and Google Scholar. The keywords used were: abdominal hollowing maneuver, abdominal drawing-in maneuver, lumbo-pelvic stability, core stability.

3. Results

We discuss each of the lines of thought in tun and present the result of each literature consulted.

3.1 ADIM to do a selective activation of the TrA muscle during the core training.

It has been pointed out that the TrA, a local muscle of the core region, has an important role in the prevention and rehabilitation of low back pain (9). As a local muscle, the TrA has been characterized by his tonic activity, slow-twitch (type I) fibers with low threshold activation, and appear to be biased for low-load activities (6-10) and its retraining should be done in a specific and isolated way from the global core muscles to retrieve its low threshold tonic recruitment for low-load tasks (11). The TrA is known as the "corset muscle", hence the most common cue to achieve its activation is to "draw the abdominal wall in," (6).

The basic strategies for the isolated TrA muscle training are performed in static positions, with low load for a low threshold recruitment of the tonic fibers, plus an isometric contraction through an abdominal drawing-in action, and a neutral lumbo-pelvic alinement (11, 12) (Figure I-A).

Most of the core exercises used in the fitness and sport training environment are mainly high-load and/or fast dynamic tasks. According to Mottram and Comerford criteria, low-load tasks are described as "normal postural control and non-fatiguing functional movements", at low speed with the dominance of recruitment of the local muscles, while high-load tasks are developed with high-load resistance or high speed that generate muscle fatigue and promote co-activation of the local and global muscles (13), examples of low-load and high-load tasks which require pelvic stability are represented in figure II. In the same paper, Mottram and Comerford differentiate the term "motor control stability," where this isolated TrA muscle retraining is included, and "stability and core strengthening," referring to the high-load stability tasks. Therefore, most of the core exercises used in the fitness and sport training environment or the Pilates method do not meet the requirements for a controlled isolated activation of the TrA muscle; in fact, most of these exercises better match the concept of core strengthening. Therefore, performing ADIM during these kinds of core exercises become not very effective for the purpose of TrA muscle isolation.

A

B

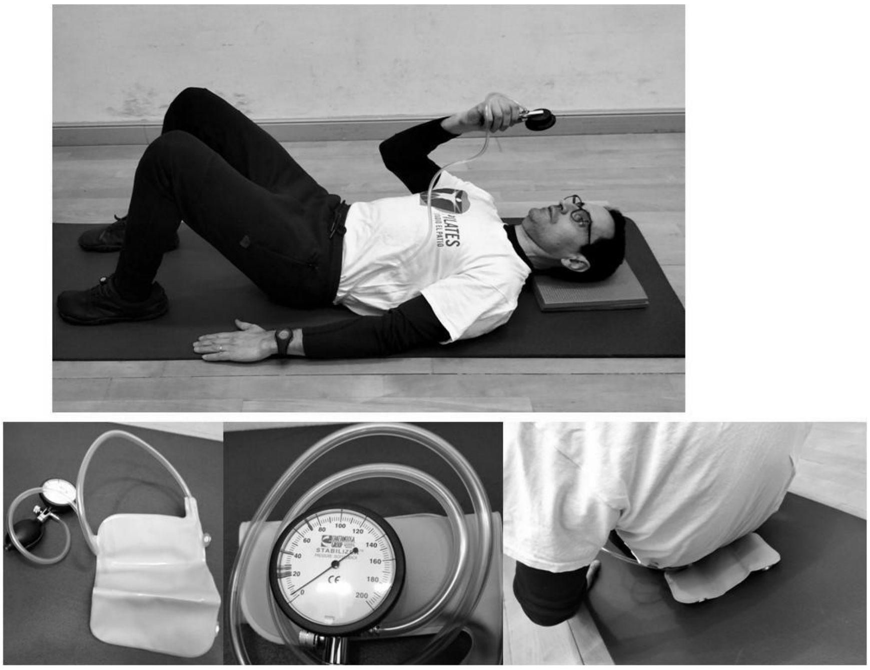

Figure 1. TrA muscle retraining in supine by means of a controlled drawing the abdominal wall while using a Stabilizer Pressure Biofeedback. B: A Stabilizer Pressure Biofeedback with an air pressure gauge to detect unwanted lumbo-pelvic motion.

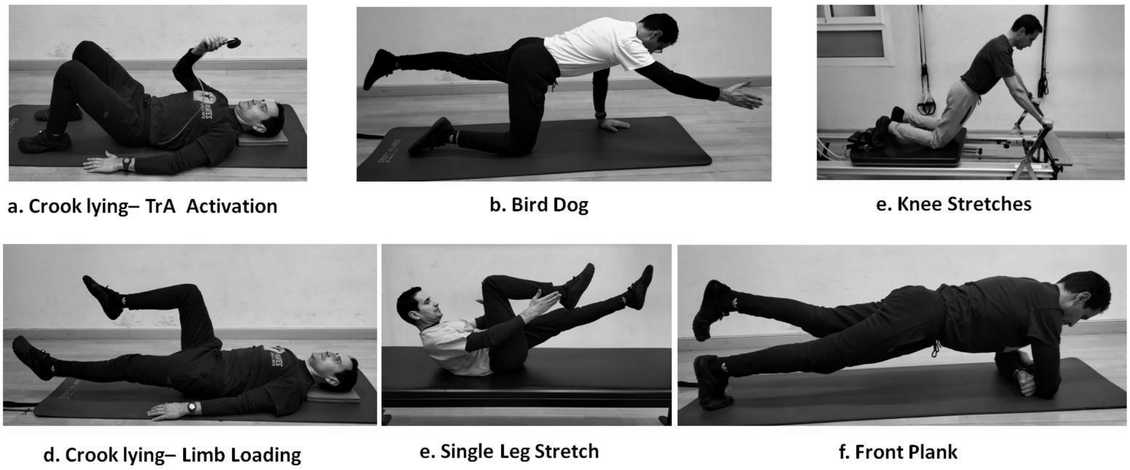

Figure 2. Examples of low-load tasks (a, b, c) and high-load tasks (d, e, f) according to Mottram and Comerford criteria (13).

The teaching process for the correct execution of the ADIM for an isolated activation of the TrA muscle seems to be one of the main limitations of the low-back stability programs because it becomes very difficult and time demanding (14). In order to get a strictly controlled isolated contraction of the TrA it is very common to require the use ultra sound imaging or a stabilizer pressure biofeedback unit (15) (Figure I-B). The application of the ADIM with no feedback or without good control elicits the activation of global muscles of the core (16), which would impair the selective retraining on the TrA (17). It has been suggested that a not-well-tuned activation of the global muscles, which may suppose an inappropriate spine stabilization, could confuse the nervous system stability perception and, consequently, the local muscle activation may not be started (17). Bergmark also points out that voluntary contraction of the global muscles could prevent early activation of the local muscles (18). Therefore, the application of the ADIM without a controlled and screened muscle contraction compromises the implementation of an effective isolated activation of the TrA muscle, which could impair the optimal spine stabilization.

Another effect of the contraction of the TrA muscle is related to the Inter-Rectus Distance (IRD). It has been pointed out that the contraction of the TrA, the Pelvic Floor Muscles, or a combination of both contractions, increased the IRD in post-partum women with diastasis rectus abdominis (DRA) (19).The activation of the TrA before a curl-up results in a relatively wider IRD than during an automatic curl-up (with no pre-activation of the TrA) in women with DRA (20). The execution of a curl-up or abdominal-crunch without any conscious maneuver for the activation of the TrA muscle decreases the IRD in postpartum women (21). It has been proposed that the AHM may not be beneficial for subjects with severe abdominal DRA, hernia repair, or severe uncorrected abdominal hernia (9). All these give us another important reason to raise the topic of avoiding the ADIM as a general application tool during the core training.

Compressive forces in the intervertebral disc have been associated with low back pain (22). It is also recognized that the compressive forces of the lumbar spine are increased during the abdominal muscle contraction (23). If we interpret that during a regular core-exercise or a regular daily activity the abdominal muscle should be activated, as a natural effect of the task requirements, and if we impose an extra level of contraction through conscious activation of any specific core muscle, we might be putting an extra level of compression in the spine. According to Lederman, this continuous activation of the core muscles can potentially jeopardize the structures of the spine (4).

The foundation base of cueing a voluntary contraction of the abdominal wall for postural stability control seems to go against the fundamentals of Neuroanatomy. Neuroanatomy tells us that the neuromotor system has two descending motor tracts. These are traveling pathways for the motor signals from the brain to the lower motor neurons (24). The motor tracts are split in Pyramidal and Extrapyramidal tracts. The Pyramidal tracts give motor signals for the conscious control of the muscles of the body. The Extrapyramidal tracts carry motor signals for the unconscious, reflexive, or responsive control of musculature, for example muscle tone, balance, or posture (24). The abdominal girdle has 75% of type I slow-twitch tonic motor fibers with a main nonconscious postural role that, if they are trained with phasic conscious exercises, could lead to a muscle tone dysfunction (25). It seems that in no-gravity conditions, the local muscles with an attributed postural role lose their tone (26), and one of the components of the stiffness and muscle tone is modulated by feedback from the muscle spindle (27). So, if the lack of the gravity stimulation causes the local muscles to lose their tone, the tone of the local muscles should be a natural reactive response to the force of gravity. Interference with this natural reaction in healthy people with a conscious activation of specific muscles may impairs the stability strategies of the nervous system. Again, we should rethink the use of the ADIM while performing core stability and postural control training.

3.2 *ADIM to improve the lumbo-pelvic stability during the core training.*

Lumbo-pelvic stability (LPS) and core stability (CS) have been two popular and frequent topics in the scientific literature, related to low-back pain (28-30) and sport performance (7, 12). Two of the best-known strategies for LPS and CS are AHM, a local approach, and the “Abdominal Bracing Maneuver” (ABM), a global approach, leading to a well-known controversy as to which of these is better for LPS or CS (7).

As we have seen, the ADIM or AHM aim is to get a specific activation of the TrA muscle. The TrA is considered a local muscle with an essential lumbar postural role by controlling Intra Abdominal Pressure (IAP) but with limited capacity to control the orientation of the lumbar spine (18, 31). Local muscles of the core are essential for the stability of the lumbo-pelvic region but not enough for its orientation control, while Rectus Abdominis (RA), as a muscle part of the global system, is critical for the direction control of the spine and transfer of loads from thorax to pelvis (18). The RA muscle has the capacity for pelvic orientation control when the thorax is a fixed point (32, 33). RA is the most important abdominal muscle in order to correct the lumbar lordosis through the control of the anterior pelvic tilt thanks to its large lever arm (34). RA also participates in the elevation of the IAP (35), which has been described as a spinal unloading (36) and extension mechanism (17). The Internal Oblique (IO) is considered another local muscle of the core area, and is associated with the TrA in the maneuver of drawing the abdominal wall in (37). The electromyographic (EMG) analysis during a “Bird Dog” position, a low load task according to Mottram and Comerford criteria (13), shows that the activity level, represented as a percentage of the maximal voluntary contraction (MVC), of the local IO muscle (18%MVC) is much higher than that of the global RA (4,9%MVC) or External Oblique (EO) (16,6%MVC) muscle (38). This tells us that in a low-load task with a major postural control component the local muscle input is the main source of stability. However, during a high-load task like a "Plank" and a supine "Double Leg Raise", the RA activation (58,99-65,82%MVC) is higher than that of the IO (52,89-52,97%MVC) (39). Furthermore, during an unstable "Plank" position, on a TRX, the RA activation (88,3 %MVC) was even higher than for the EO (83,3%MVC) (40), giving an idea of the important input of the RA global muscle during these high-load core stability exercises. The anatomy analysis of the horizontal orientation of the muscle fibers of the TrA and the vertical orientation of RA muscle fibers show a mostly perpendicular relationship between both muscles (32, 34). This perpendicular relationship could put both muscles in a sort of competitive situation because when the TrA contracts, pulling from the connective tissues of the RA sheath, it stretches the RA fibers (20), compromising its concentric contraction direction (Figure III). Besides, the EMG analysis of the core muscles showed that AHM decreases the RA activation and increases that of the TrA (16, 41, 42): when one decreases the other one increases, which may give us another indication of this competition (Table I). Therefore, the excessive activation of the TrA or the IO during the ADIM could compromise the RA input to control pelvic anterior tilt and hyper-lordosis during high-load tasks, as could occur in many core training exercises.

Table 1. ADIM decreases the RA activation and increases the local muscle activation during different tasks.

	Supine Task %MVIC (16)		Curl-up Task %MVIC (41)		Sitting Task %MVC (42)	
	RA	TrA	RA	TrA	RA	IO
Without ADIM	19,7	56,9	49,3	38,4	9	20
With ADIM	9,5	76,5	26,2	56,5	6	21

MVIC: Maximal voluntary isometric contraction. MVC: Maximal voluntary contraction. ADIM: Abdominal Drawing-in Maneuver.RA: RectusAbdominis. TrA: TransversusAbdominis. IO: Internal Oblique.

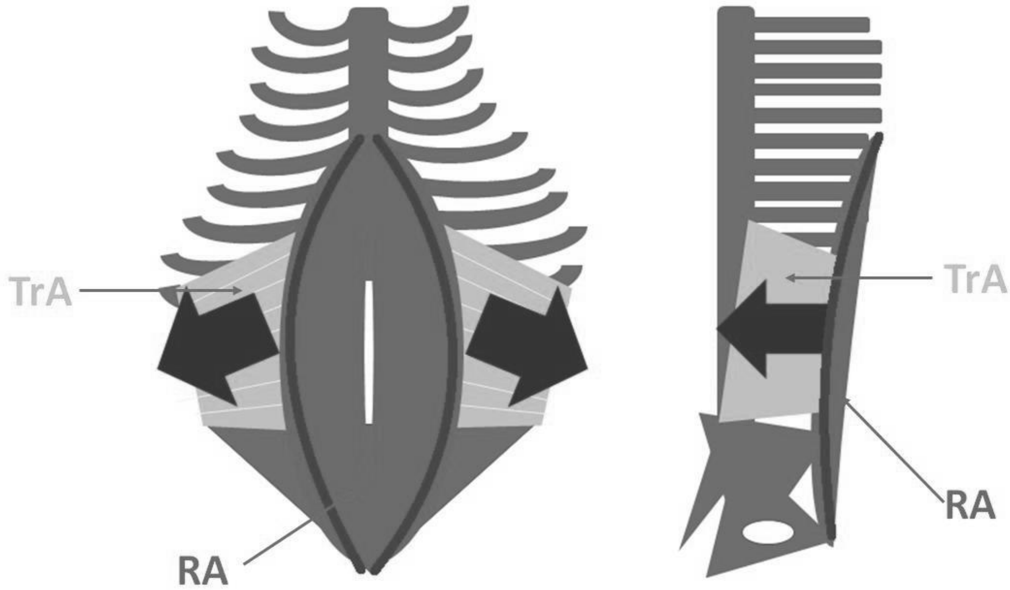

Figure 3. The concentric contraction of the TrA fibers pull from the RA, stretching its muscle fibers. TrA: Transversus Abdominis. RA: Rectus Abdominis.

There are anatomical reasons to believe that the RA has a key role to make compatible breathing with pelvic stability, especially during high-load tasks. The upper attachments of the RA are on the anterior arcs and cartilages of the 5º, 6º and 7º ribs and the xiphoid process, and the EO attachments cover the front and lateral side of the last seven ribs (34). Thus, the RA muscle insertions leave all the lower ribs free, offering a double advantage: it can maintain its contraction status for pelvic stability and, at the same time, let the lower ribs open for inhalation. On the other hand, the EO muscle will require an eccentric elongation of its fibers to allow movement of the lower ribs for inhalation, perhaps compromising the pelvis stability (Figure IV). In fact, the intensity of muscle activation of the EO muscle is around 10% lower than that of RA during the inhalation phase in four different postures: supine, tripod position, 4-point kneeling, and standing (43), perhaps allowing lower-rib expansion while the RA maintains greater activation to control the pelvis. Many of the core training exercises test LPS by challenging pelvic orientation control with high loads. Consequently, the excessive activation of the TrA muscle during the ADIM could compromise the pelvic orientation control input of the RA. For all these reasons, we suggest that the ADIM could impair the LPS during the high load core exercises.

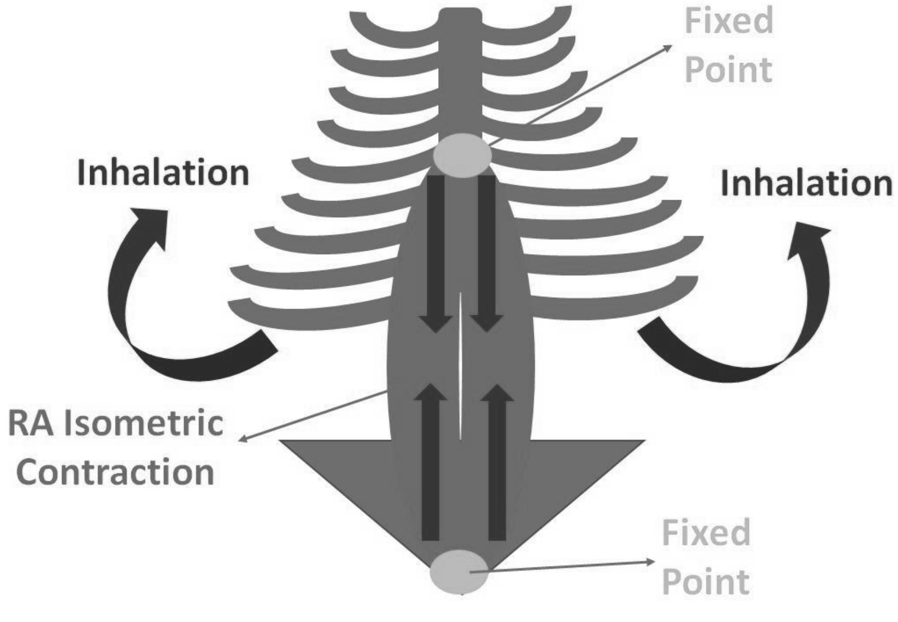

Figure 4. The upper attachments of the RA muscle allow the opening of the lower ribs during the inhalation phase keeping the pelvis stable in the sagittal plane, through an isometric contraction, against anterior pelvic tilt forces. RA: Rectus Abdominis.

Several studies have compared the effectiveness of the AHM and ABM for the control of the pelvic rotation. Two studies evaluated the effectiveness of these two maneuvers stabilizing the spine during a “Sitting Task” against a sudden perturbation. The first study concluded that the AHM was less effective controlling the spine motion after the perturbation (42). The second study suggested that the AHM was better for pelvic stability and the ABM was better at stabilizing the upper thorax (44). A sudden perturbation could be considered a high load task because of the need for a fast reaction (12, 13), which could explain the reason why AHM was less effective at stabilizing the spine in the first study and the thorax in the second. We would also like to point out four additional studies because they evaluated typical Pilate’s scenarios, where the Pilates Method highly recommends the use of ADIM. The first one compared the movement of the spine during a “Prone Hip Extension” using AHM and ABM (8). The results of this study showed that AHM was slightly less effective at controlling the spine motion and slightly more effective at controlling the pelvis motion, with very close values. In our opinion the AHM was able to obtain good stability performance from the pelvis during this study because we cannot consider this prone hip extension to be a high load task; in fact, Mottram and Comerford considered it a low-load task (13). In the second piece of work, Lee evaluated the correlation of the IO/RA ratio with LPS during a Pilates machine exercise: “Knee Stretches”. It has been pointed out that to improve proximal stability the activation of the global muscles should decrease while activation of the local muscles increases (45), so the ratio of the local muscles activity to that of the global muscles should be high (5, 37). In the Lee study concludes that when the IO muscle is more activated than the RA muscle, the pelvis is more stable (46). In this study Lee used a 75% Reformer spring and performs the Knee Stretches exercise with the knees resting on the carriage, which makes this exercise a low-load task (13). This could explain why, in this study, there was a correlation between the IO/RA ratio and the pelvis stability. The third work evaluated the capacity of the AHM and ABM for controlling the pelvic rotation during an active leg raise. This study concludes that the AHM was less effective in the pelvic rotation control (47). The fourth study compared also the effectiveness of AHM and ABM in the pelvic rotation control during another Pilates exercise, "The Leg Pull Front" (Figure V), concluding that the AHM was less effective at controlling the pelvic rotation even though this maneuver obtained a higher EMG activation level of the TrA and IO than the ABM (48). The "Leg Pull Front" is a high-load core exercise; in our opinion, in this type of task, the global muscle is the main source of stability. Therefore, a decrease of the global muscle activation by AHM impairs the pelvic stability. We would like to highlight the important contribution of studies that assess not only the EMG activity of the muscles but also the quality of movement by measuring the displacement of the pelvis and spine. The EMG information alone does not tell us the direction of contraction of the muscle fibers, concentric or eccentric; therefore we cannot know the level of quality of the movement. Jung and Oh's study (48) shows no correlation between muscle activity level and pelvic stability, which tells us that the EMG information may be important but does not describe the whole picture. All these studies raise the need to revisit and discuss the efficacy of the ADIM for lumbo-pelvic stability during core training. In our opinion, during high-load tasks the ADIM compromise the LPS.

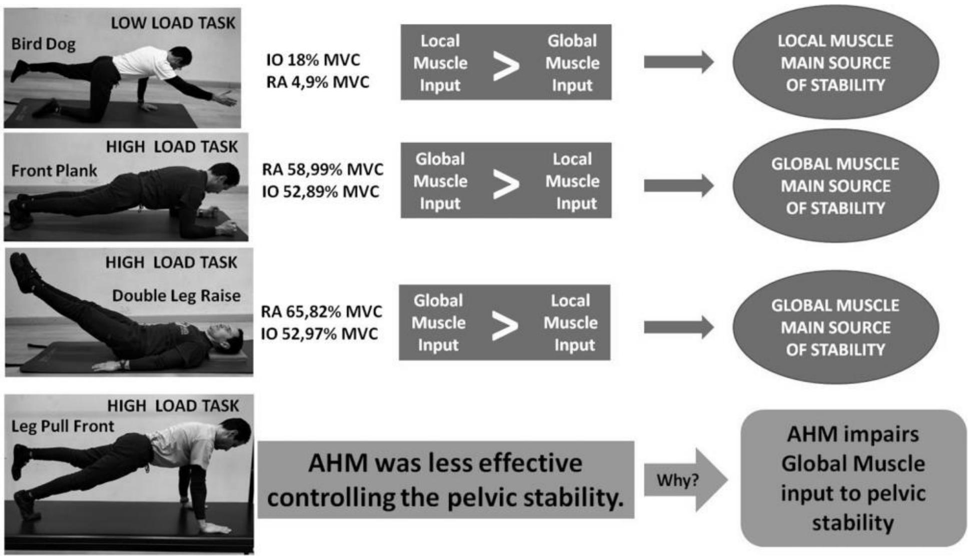

Figure 5. During low-load tasks local muscle input is greater than global muscle input , EMG data from Biscarini et al. (38). During high-load tasks global muscle input is greater than local muscle input, EMG data from Park & Park (39). During a Leg Pull Front, a high-load Pilates exercise, the AHM was less effective at controlling the pelvic rotation (48), perhaps because the drawing-in maneuver impaired global muscle input, the main source of stability. IO: Internal Oblique. RA: Rectus Abdominis. MVC: Maximal Voluntary Contraction. AHM: Abdominal Hollowing Maneuver.

4. Conclusion

In order to provide a new perspective on whether the ADIM should be a rule applied during the core training we have reviewed recent literature. Our main conclusions are:

Concerning the use of the ADIM to perform a selective activation of the TrA muscle, our opinion is that, although ADIM can increase TrA activation, most of the core training exercises do not meet the requirements for isolated TrA-specific retraining. The application of ADIM during the core exercises, without quality control of the TrA activation, could impair spinal stabilization strategies. Enhanced activation of the TrA during ADIM increases the IRD under DRA conditions. The continuous conscious activation of the core muscles can potentially jeopardize the structures of the spine. Neuroanatomy concepts contradict the use of a conscious muscle activation technique, such as ADIM, to enhance the postural stability tonic role of the TrA muscle.

With regard to the use of the ADIM to improve LPS, we conclude that during high-load core tasks excessive activation of TrA muscle due to the ADIM, an essential but ineffective local muscle for pelvic orientation control, may interfere with RA muscle input for pelvic directional control, the most important abdominal muscle in order to control anterior pelvic tilt.

There is evidence suggesting that, in specific situations of low-back pain or first stages of the rehab process, the TrA muscle may need an isolated retraining strategy; in these situations, a controlled and monitored ADIM could be used. However, we also agree with the idea that the brain thinks about movement or the goal of the movement but not the contraction of individual muscle, therefore, at some point, during the motor reeducation program, we should stop using conscious muscle activation. The literature consulted leads to the conclusion that if the goal is to train core stability and strength with high-load scenarios we should not use the ADIM.

Acknowledgements

None.

Conflict of Interest

The author declared no conflict of interest.

Author Contributions

Not applicable.

Data Availability Statement

Data are available for research purposes upon reasonable request to the corresponding author.

Ethical Considerations

Not applicable.

Funding

This research received no external funding.

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