

van de Rakt, Jan and Mccarthy-Grunwald, Steven ORCID: <https://orcid.org/0000-0003-4873-5068> (2015) Diagonals part two: assessment and trunk rules. Italian Journal of Sports Rehabilitation and Posturology, 2 (3). pp. 262-298.

Downloaded from: <http://insight.cumbria.ac.uk/id/eprint/2665/>

Usage of any items from the University of Cumbria's institutional repository 'Insight' must conform to the following fair usage guidelines.

Any item and its associated metadata held in the University of Cumbria's institutional repository Insight (unless stated otherwise on the metadata record) may be copied, displayed or performed, and stored in line with the JISC fair dealing guidelines (available [here](#)) for educational and not-for-profit activities

provided that

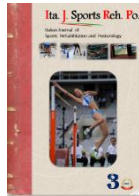
- the authors, title and full bibliographic details of the item are cited clearly when any part of the work is referred to verbally or in the written form
 - a hyperlink/URL to the original Insight record of that item is included in any citations of the work
- the content is not changed in any way
- all files required for usage of the item are kept together with the main item file.

You may not

- sell any part of an item
- refer to any part of an item without citation
- amend any item or contextualise it in a way that will impugn the creator's reputation
- remove or alter the copyright statement on an item.

The full policy can be found [here](#).

Alternatively contact the University of Cumbria Repository Editor by emailing insight@cumbria.ac.uk.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

262

Ita.J.Sports.Reh.Po.

Italian Journal of
Sports Rehabilitation and Posturology

Diagonals Part 2 : Assessment and Trunk Rules.

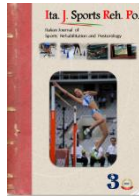
Authors: Jan Van de Rakt¹, Steve McCarthy-Grunwald².

¹ *Physical Therapist NDT teacher IBITA, Course Leader and teacher on the Dutch Institute for Allied Health Sciences Nursing Home "Waelwick" in Ewijk The Netherlands*

² *MSc BSc RMN Lecturer in Mental Health Nursing with Dementia Specialty. University of Cumbria, Bowerham Road, Lancaster, LA1 3JD England*

Abstract.

Part two describes the assessment process of the diagonals, including the front, back and homolateral structures. We discuss various positions for assessment including patients laying down on their back and side, sitting and standing. We also look at the use of the balance reaction test Statiek to assess the capability of both the diagonals and homolateral structures. This provides a greater understanding of what the diagonals can do, and what would be considered normal or abnormal as assessing both gives the examiner a greater appreciation of what to expect. We can use this practice to increase our awareness of what to observe and feel for, identifying some tips of where to place your hands to enable you to both apply pressure and feel for the amount of resistance the patient can apply in response. Subtle differences can be observed in patients depending on various individual characteristics they may have such as different leg lengths when comparing the left and right sides, or if somebody has a recognized problems within the structure and function of their backs. We begin to describe "trunk rules" as everyone should has the same reaction response when performing movements but these can present differently depending on the individuals level of mobility and selectivity. This article starts to briefly consider body scheme which is the perception of the body and its influence on the reaction of muscle patterns This perception can alter the overall function of the diagonals. In part three Pathology we will go more into developing the understanding of the impact that perception plays in the control and movement of diagonals. In the final section we move on to describing the trunk rules, discussing how both diagonals and the homolateral structures work in collaboration to help control and enable a greater range of movements of the trunk, and how this supports the keypoints of the great joints, identifying which movements are enabled and which are restricted.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

Assessment

When assessing the function of the front and back diagonals, we are required to know what the normal reactions are expected to look like, therefore allowing the practitioner to be able to compare the results of the assessment to determine any abnormalities which may be present. Additionally we also need to observe the cohesiveness of the keypoints at either end of the diagonals (the shoulders and hips). Here we tend to see the most significant damage with patients who have had a stroke, due to this area being a junction where both the front and back diagonals converge creating a homolateral structure with an increased rotational component to its movement. We take the assessment further by examine the interactions between the front and back diagonals, focusing on how they assist each other to maximize the overall performance within these homolateral structures. Finally we need to identify the amount of power within the diagonals, comparing this with the expected normal functional power. One way to achieve this is by examining both the patient alongside a colleague with no limitations in power until you become a more confident and competent practitioner.

Here we start with a chronological summary of first impressions for an assessment of somebody with normal function.

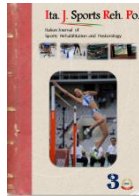
1. Primarily we want to identify the tone of the abdominal muscles by inspecting and palpating the umbilicus area. This provides a good indication of the cohesion and muscular tone between the m. rectus abdomen and the front diagonals. For the examination the patient needs to be in a supine position on the couch which allows the examiner to undertake the assessment by trying to insert his fingertips just under the ribcage and compare each side for variation. A normal result would show little to no difference between each side with only a small portion of the fingertips being able to fit under the ribcage. Next we require the patient to raise their head whilst we assess if we can maintain the fingertips position just under the ribcage. What we would expect to see is an increase in muscular tone resulting in the fingertips being pushed away.

2. Following this we need to examine the reaction of the body when force is applied to the patient's arm. What we would expect to see is a corresponding reaction in the opposite leg (due to the response of the front diagonal). Slightly before this movement we would also expect to see an initial response reaction occur in the leg on the same side as the arm (due to the initial reaction of the back diagonal). This provides evidence of the interconnections of both the front and back diagonals in the homolateral structures.

With these two simple assessments we have been able to examine two key elements of this system in action;

- A. The cohesion of the front diagonal to the opposite leg and
- B. the stabilization of the other leg.

Getting the patient to perform the arm exercise helps the practitioner to assess the stabilization reaction in the body. Whilst the force is applied to the patient's arm and they resist, then practitioner can take the opportunity to inspect and palpate for a reaction in the buttock muscle



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

which results in a push of the heel into the couch. Only the push of the heel into the couch is normal, plantar flexion of the foot is a pathologic reaction.

3. The reaction on resistance of the arm is small comparing with moving and resistance against an leg. Lifting one leg gives in the other leg see a slight endorotation of the other leg even before it begins to lift off the couch. Alternatively we can ask the patient to position their legs as wide apart as is comfortable and then repeat this assessment. What you will notice is even before the leg can become stable, it will need to re-orientate its position back towards the midline of the body before the process of lifting can be achieved. This identifies the link between power, perception and the ability to achieve stability in movement.

When we consider the cohesion in movement of the second leg following the lifting phase of the first leg there are two distinct elements we see.

A. The cohesion of the front diagonal to the opposite arm can present as both a little protraction and a little retraction depending on the patient's level of function. The presence of retraction is a sign that the lifting of the leg is restricted in some way proving difficult for the patient to perform.

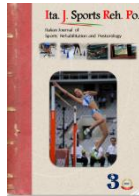
B. We can also observe how well the stabilization movement of the leg is achieved. This is performed as before by palpation of the buttock muscle, along with observing for a pushing movement of the heel into the surface of the couch.

Let us now deconstruct these assessments in more detail.

1. Single Arm Resistance in a Supine Position.

Description of the Technique:

Arm: The patient's arm is positioned in a 90 degree ante flexion (see photo 1) whilst they are encouraged to building up a level of resistance within the pattern of the front diagonals. To achieve movement the amount of force applied to the arm by the practitioner needs to be matched and exceeded by the patient's front diagonals. To be able to perform this assessment correctly it is useful to have a second person providing the resistance which then helps to free up the examiner to be able to observe what is happening in the opposite leg by palpating the buttock muscle whilst noting both heel and forefoot movements as identified previously. Remember movement of the forefoot by normal resistance is not normal.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

265

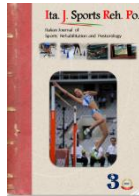


Photo 1. Test for cohesion of the frontal diagonal for the right arm & left leg and the back diagonal for the right leg & left arm

What we would expect to see is limited application of force would result in minimal amount of resistance and consequently there will be no reaction, but as the amount of force is increased we can then start to observe the following;

1. The heel of the right leg (Photo 1) will start to push down into the surface of the couch along with a reaction of the buttock muscle to try and maintain stability. While it is still possible for the patient to produce a counter resistance to the pulling movement, in this case the left leg will react by increasing its flexion and endorotation. This is a positive response which indicates a normal reaction. When the force of the pulling movement is significant enough that the patient feels unable to maintain their balance, we will then expect to see the right leg begin to work harder pushing into the surface of the couch, whilst the left leg starts to provide additional support to maintain balance by acting as to stabilize the body position by replicating the same movement as the first leg by also starting to push into the surface of the couch. At the same time the leg itself will begin to move in exorotation which is also a positive reaction signifying a normal response to the test.
2. Alternative observations include, the left arm moving into retraction and retroflexion with the patient grasping the edge of the couch to provide this additional stability. This is still recognized as a positive normal reaction when the pulling movement remains at its maximum. In some circumstances when the force is great enough the head may be observed to extend to assist in gaining stability to maintain balance.

J. Van de Rakt - Italian Journal of Sports Rehabilitation and Posturology 2015 ; 2; 2 ; 262 -298
doi: 10.17385/ItaJSRP.015.3002 - ISSN 2385-1988 [online] - IBSN 007-111-19-55



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

When there is no evidence of exorotation of the legs or an positive plantar flexion in the ankles this is a negative outcome indicating an abnormal reaction suggesting poor control and reduced cohesion of the back diagonals!!

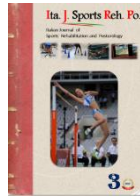
266



Photo 2: Testing the diagonals with the legs. *In this case the right leg which in this position the test involves the front diagonal from the right leg to the left shoulder being tested along with the back diagonal running from the left leg over to the right shoulder.*

Stabilization is always the primary reaction being observed, additional to this we would also want to start seeing reactions in the left leg “before” the commencement of the lifting phase as described above. In photo 2, we can see the right leg is bent at a 90 degree angle at the hip and the knee. Depending on the patient’s level of flexibility, the practitioner does not have to adopt this position as a similar reaction can be observed with a straight leg that is fully extended providing an alternative examination. Observe from the picture the positive reaction to the force being applied from the stabilized leg. Initially when we commence lifting the right leg, we will expect to see a slight endorotation of the hip. Immediately following this small amount of movement we begin to see a counter reaction start to maintain stability in the body.

As before when you place the patient’s legs as far apart as is comfortable, this changes the Centre of balance. Consequently to regain stability the patient’s left leg will start repositioning



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

itself to a more central position under his body. That is a positive result and helps us to interpret the patient's level of proprioception.

267

1. Single Leg Resistance in a Supine Position.

Description of the Technique:

1. Primarily we start to pull the leg outwards whilst inspecting and palpating for any noticeable reactions to the movement. We would expect these reactions to be quicker than with the arm because the legs weigh heavier and provide more stability for the body. As previously identified it is beneficial to get a second person to perform the pulling action, enabling the examiner to palpate for the left buttock muscle movement and observe the heel and forefoot pushing movement. The practitioner should also observe for reactions with the arms and head. Again when the pulling movement is only slight, we tend to observe the left shoulder position to be in protraction, whilst the right shoulder position is retracted. A typical response could involve the right hand repositioning to the edge of the couch seeking to gain stability.

2. When the pulling movement is increased significantly, the stability of the body becomes compromised as before resulting in the following response:

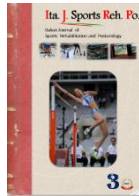
A. The pushing movement of the left leg is increased and the m. gluteus maximus begins to work hard to maintain stability in the body. The examiner can observe and palpate the buttock muscle altering position increasing exorotation (which in itself is an action of the buttock muscle).

B. At the same time the arms will both move into retraction with the shoulder in retro flexion, along with flexion in the elbows and occasionally depending on the amount of force being exerted, the head may also move into extension and lateroflexion (see Photo 2) to enable the upper trunk to become more stabilized in an attempt to provide resistance to counteract the force being exerted.

3. The next test requires the patient to be back in the first position (laying supine on the couch) so we can test the strength of both the front and back diagonals (front right leg, left shoulder and the back left leg and right shoulder). With a second person assisting in the examination, they are required to pull the lifting leg downwards. While the leg is pulled the examiner inspects and palpates for the reaction. Pulling downwards on the right leg would result in a counter reaction by both the front and back diagonals. Therefore if we feel no resistance as an outcome we can deduce two possible outcomes from the assessment.

1. The front diagonal has reduced muscular power, or

2. The back diagonal has reduced muscle power to enable stability to be achieved. In some cases both of these could be observed requiring further tests by the examiner to provide the evidence required to confirm this.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

268

Testing the front diagonals.

For this assessment we need to ascertain the degree of tone in the front diagonal. We achieve this by palpation trying to evoke a response.

The palpation response is performed with the patient in a supine position, whilst the evoking response is achieved in a sitting position.

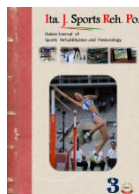
Palpation starts with the examiners fingertips positioned under the ribcage then carefully move the hands to try and move under the ribs to feel for resistance. When the resistance is high we asked the patient to lift their head so we can feel how fast our fingers are push away from the ribcage.



Photo 3. *Passive testing the tone of the abdomen muscle, both left and right.*

If there is no tone in the stomach muscles, this results in the individual being unable to lift their head up whilst in a supine position. Evoking a reaction of the front diagonals is also possible by the examiner sitting on the edge of the couch and push the patient backwards by the shoulders, The feet must be free. In response to this force of this push movement the front diagonals should become activated resulting in both legs raising up from the couch. Flexion of the hips/ knees is a clear sign that the front diagonal are intact. Furthermore, the degree of unity with which both the legs raise at the same time is important when assessing normal function as we would expect to see both legs raise at the same time as a normal response.

Now we have explored the capability of both diagonals whilst the patient is in a supine position this information can provide extremely important guidance when supporting patients who have severe degrees of stroke. (This will be discussed in more detail in Part Three of this series when we look at Pathology and Stroke).

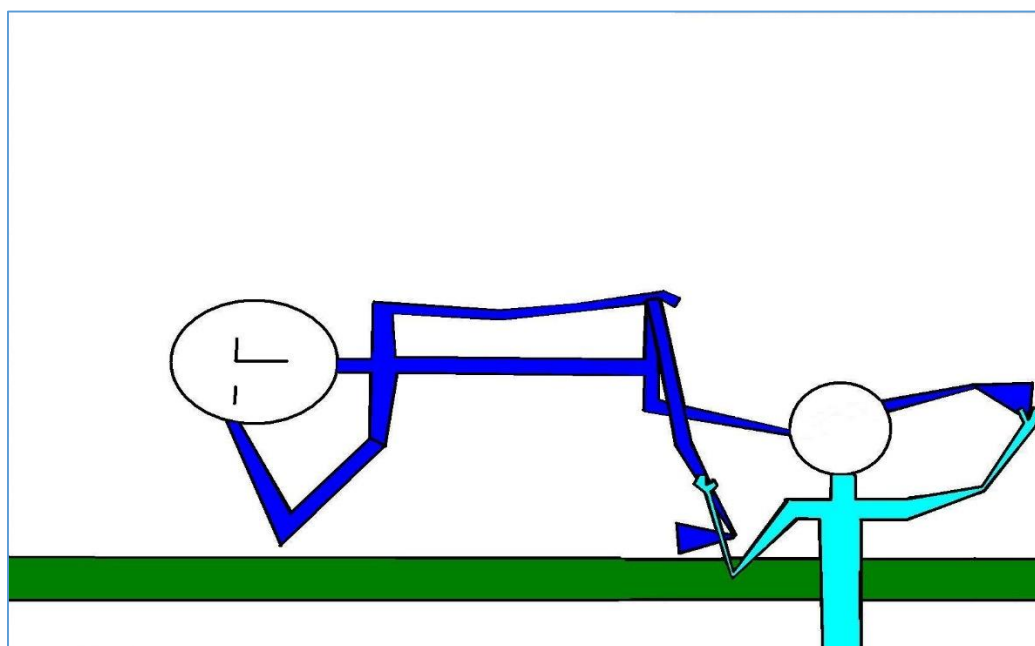


Now we move on to explore both diagonals when we start to examine the homolateral structure.

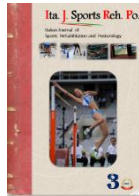
Testing the homolateral in lateral position

269

When investigating the homolateral muscle pattern we require the patient to lie down in a lateral position (on their side) with the weakest of the two sides on the couch. The lower leg is positioned as straight as possible whilst the patient is requested to raise the upper leg. Once the leg has been lifted it will then need to move forward, so we can start to identify any counter movements. Examiners need to observe the lower leg, main trunk and arm on the upper side for movements which are providing a level of counter movement to gain stability in the body. Generally we would expect to see backwards movement in both the arm and the upper trunk, whilst the upper leg move to the front and the lower leg push in the couch and try to brace the movement with the forefoot and try to turn the foot back. Once this element has been completed we then ask the patient to move the leg in the opposite direction –backwards- so we can observe further corrections in the leg, trunk and shoulders from an alternate perspective. Now the movement of the upper arm /trunk is to the front and the lower leg turns back on the heel and the person will try to rotate the foot in the direction of the forefoot. To get an idea how strong the patient is within the homolateral structures, we repeat the same movements whilst applying a force against the upper leg then getting the patient to move so we can assess the amount of resistance they can generate. And you can started with only give resistance on the upper leg and feel the resistance without movement to the front or to the back. When the force is good you will feel that the lower hip comes loose of the couch.



Picture 1. Patient lies in a lateral position with the therapist placing one hand on the foot of the lower leg closest to the couch, so they can feel what happens with the foot, whilst the other hand applies resistance against the upper leg.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

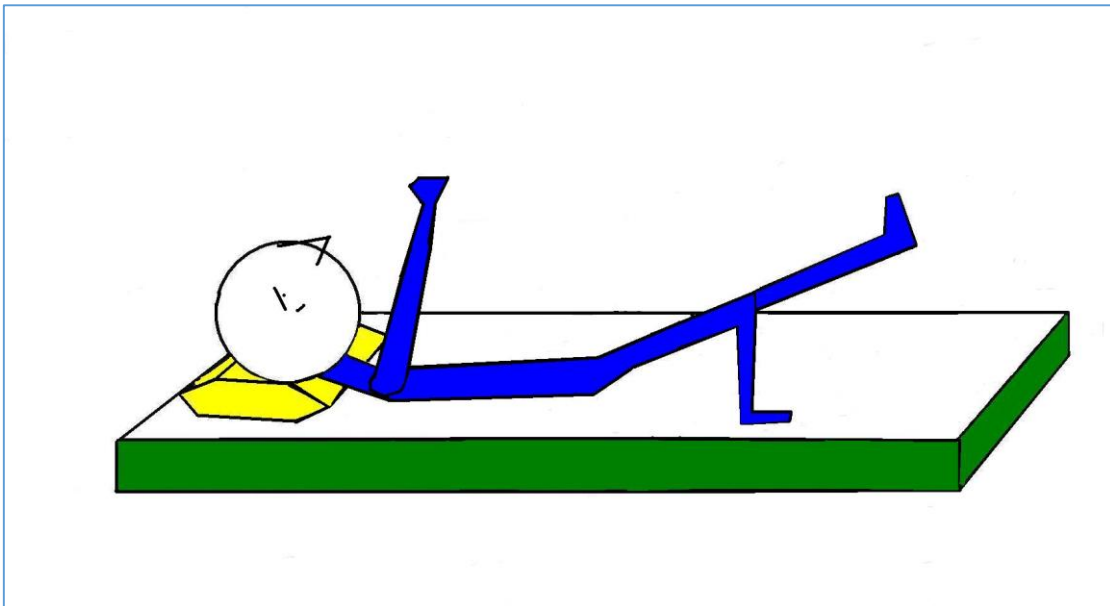
ISSN 2385-1988 [online] - IBSN 007-111-19-55

270

This assessment can be difficult to perform, with a potential result of reducing the amounts of resistance being applied. One way to improve your skills of performing this technique is to experiment on yourself, experiencing the kinds of movement resistance which could be considered within normal range. What we are aiming to achieve is to feel for a degree of clear resistance where we would see the hip of the lower leg (trochanter major area) start to lift up from the couch. The m.gluteus medius must be fully functional to enable the patient to perform this, therefore observing this movement would be considered a normal muscle power response.

Tentacle Test

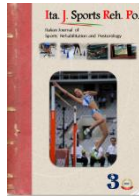
The final test performed with the patient on the couch helps to provide information about the strength of the back diagonals along with the coordination of the trunk, especially the hip muscles. What we want to assess is whether they are capable of holding a firm position as part of the diagonals, whilst the keypoints of the hips and the area of connection between the front, back and homolateral structures remain stabilized.



Picture 2 : Tentacle Test. *This assessment is performed in a supine position with both arms raised into the air simultaneously, without resistance is one of the most difficult tentacle exercises performed. Resistance is the most difficult form and is a very heavy exercise. Often is raising arms not possible that means that when they are not be use , the normal function of especially the hip is not normal.*

The assessment looks at the patient with respect of:

1. The ability to lift both buttocks off the couch
2. The ability to then hold that position whilst shifting their weight onto one leg and then lift the other leg into the air without collapsing from that position.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

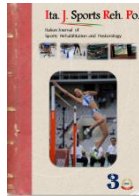
When the patient has demonstrated they can maintain this position, the examiner can look to increase the difficulty by applying resistance against the leg which is raised into the air, whilst observing and palpating for resistance.

As previous tests to gain experience you can practice this either on yourself or with a person who has normal function to enable a better understanding of what would usually be expected. With these three tests completed we can gather a lot of important information about the performance of the diagonals when the patient is lying down. From here we need to move on looking at the patients abilities related to balance whilst in a sitting and standing position.

Assessment of balance in a sitting and standing position with respect to the diagonals.

When the patient is sitting up on the couch this offers a good opportunity for the examiner to assess the front diagonals. Be aware of the need for the feet not to be touching the floor, but allows to swing freely over the side of the couch. Once the patient is comfortable the examiner firstly provide resistance by gently pushing against the shoulder whilst observing for movements in both legs. When the front diagonal are fully functioning, both legs will start to lift up into the air whilst the hips are in flexion with additional exorotation and abduction movement (Referred to as trunk rules). To be classed as a normal response the movement should be both equal with a quick response reactions. To increase the difficulty the examiner can apply resistance to both legs, here we would expect to feel a degree of resistance with the patient trunk exerting force back onto the examiners hand creating a firm trunk muscles behind the area of support helping to maintain stability. When standing we look at postural characteristics - The Statiek Test-enabling the examiner to investigate the functionality of the diagonals when the patient is in a standing position. This is also a good test to measure the patients balance capability. In 'Diagonals' part one, we discussed aspects related to the balance reaction. This reaction involves a complete response of the body and is dependent on the level of force being exerted determining if balance is difficult to maintain or not for the individual. When we receive a push from behind, for us to maintain balance we require the body to react. We require our body to maintain a firm position whilst shifting our weight to one foot, so that the other foot is free to move forward to provide a stable base and performing a 'brake reaction' to prevent falling.

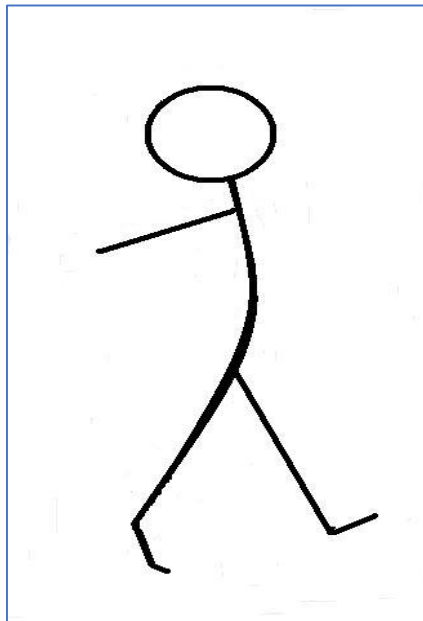
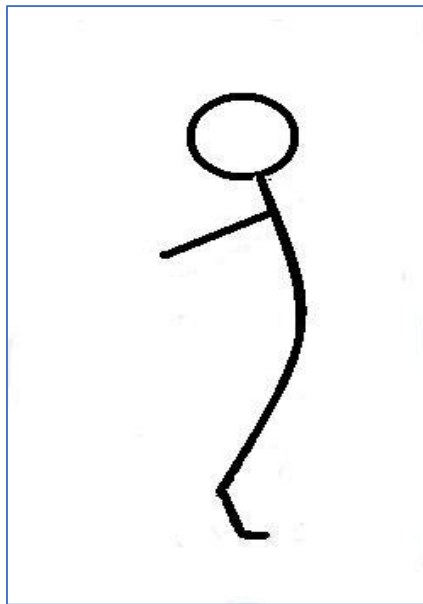
A push from behind must result in a "brake-reaction" to enable the transfer of weight and repositioning of the foot to create a stable base. Trunk position is extremely important when we look at maintaining balance control. As discussed previously trunk movement is not only important in helping to 'brake the fall', trunk movements determinate the movement of the leg that becomes free. An movement of the trunk backward gives an leg movement to the front and that is require now. An wrong trunk movement can be the differences between falling and not falling!! The examination therefore needs to include the trunk where the examiner observes and palpates looking to identify the functional capability and the range of movements for the diagonals with the patient. When a patient is pushed from behind we expect to see an initial change in stability resulting in loss of balance. In response there is always a pattern of movements which are followed a 'brake reaction' aimed at repositioning the legs to create a stable base and reduce momentum to prevent falling and maintain balance.



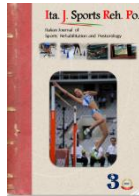
J. Van de Rakt , S. McCarthy-Grunwald
Diagonals Part Two : Assessment and Trunk Rules
Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002
ISSN 2385-1988 [online] - IBSN 007-111-19-55

At the same time there is also a need for the trunk to move in the opposite direction to create space and increase range of movements in the great joints otherwise the leg needed to brake the fall will be unable to move into the correct position reducing the patient's ability to restore balance.

272



Picture 3 and 4. The “brake reaction” includes a push from behind, followed by a shift of weight and finished with the step forward.



J. Van de Rakt , S. McCarthy-Grunwald

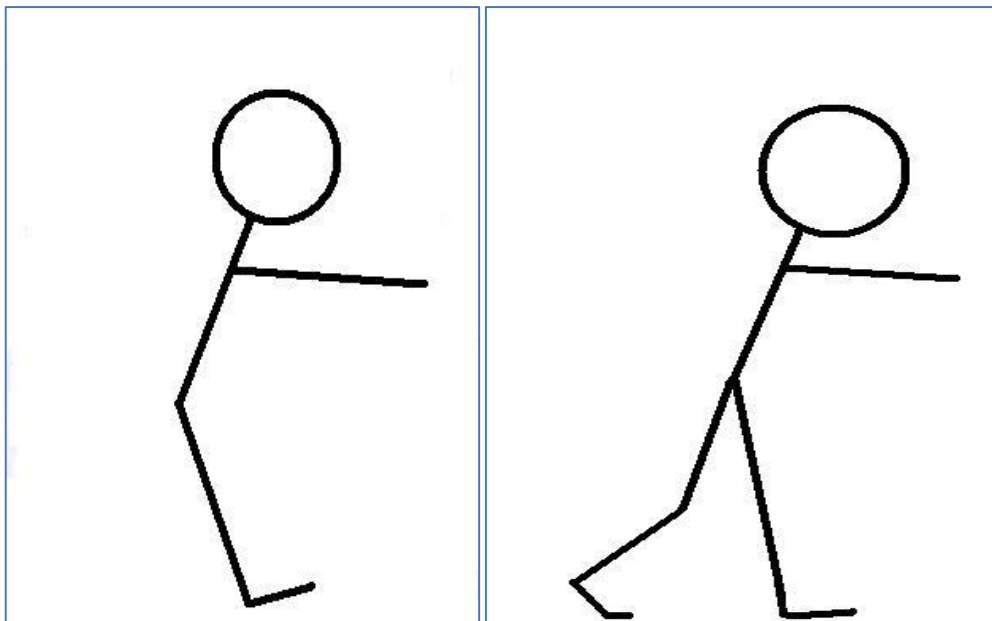
Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

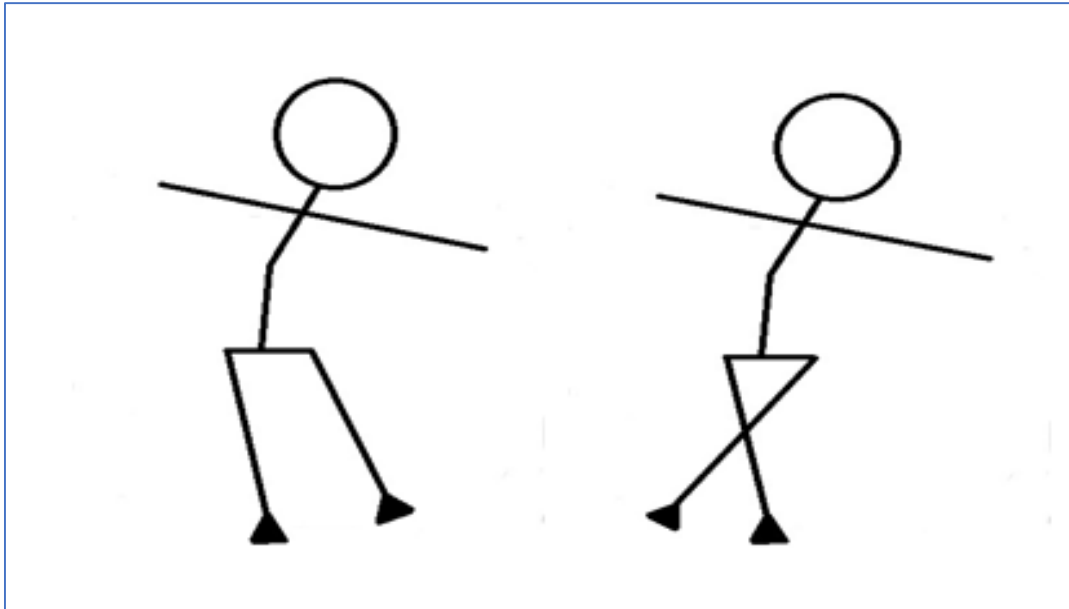
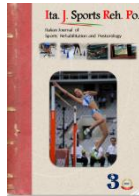
ISSN 2385-1988 [online] - IBSN 007-111-19-55

273

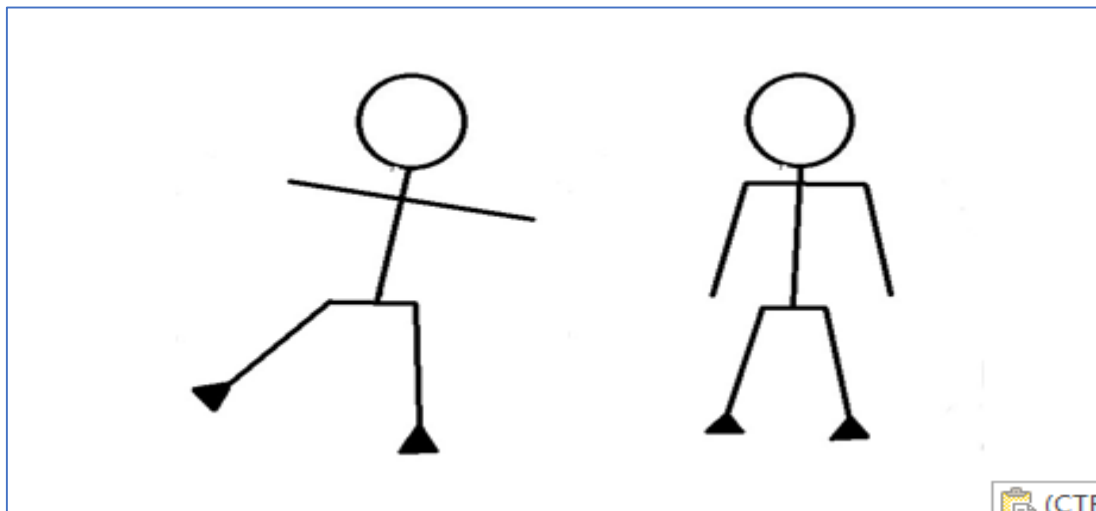
Alternatively if a patient is pushed backwards, this will result in the trunk needing to move forwards creating space and increasing range of movement for one leg to step backwards. This follows the initial “brake reaction” and transfer of weight onto one leg. Trunk move forwards gives an leg movement to the back. Older people have often an bended trunk and that makes not only the brace incomplete by an push from behind, but also the leg movement very difficult. That leg won't to go to the back. Another aspect is when a patient is pushed from the side, will result in the leg furthest from the side being pushed, must make an trunk elongation. This response acts as a brake reaction transferring the weight onto this leg so the opposite leg closest to the side being pushed being able to move position crossing over the standing leg placing the foot on the opposite side to regain balance (See the pictures).



Pictures 5 and 6: *The brake reaction, the shift of weight and the foot placing backwards after being pushed from the front.*

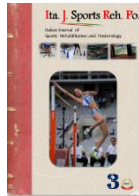


Picture 7: Demonstrates a lateral position reaction and subsequent movement of the trunk, where in **Picture 8;** the 'break reaction' of the fall is performed but balance remains unstable due to the legs being crossed. Below identifies the need for a further step to be taken uncrossing the legs and taking a wide step sideways to create a stable base.



Picture 9 and 10. Now the balance reaction is complete. In picture 8 there is still great instability with balance which is regained by placing the crossing leg on the ground to brake the fall then kicking the other leg outwards. This results in the wider stance and reestablishment of balance and stability

In 'Diagonals' part one, we have already explored our back diagonals discussing how they are both strong and have a quick reaction speed. The importance of the back diagonals being the strongest link in our body is related to the need to provide stability in movement along with the



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

275

importance of having a quick reaction due to a lack of other sensory warning (e.g. no eyes to be able to see behind) This helps us to prepare to counteract against a push from behind, by producing a quick reaction to the stimulus which is crucial in helping to prevent falls.

Conversely the front diagonals are weaker due to the availability of the sensory organs (the eyes and ears) we are able to interpret the potential of a collision before we are pushed, therefore enabling us to react faster to prevent falling.

In comparison the homolateral structures are far more complicated than the previous two. Firstly a brace stance is required which is created from the homolateral structure itself and initially starts in the trunk region. As identified previously the trunk itself has to elongate and become an extension of the bracing leg to enable an increased range of movements, otherwise the opposite leg cannot cross over to prevent us falling. This movement itself requires both the trunk and foot to make an inversion movement due to a slight time delay. This provides the patient with the opportunity to brake the fall by crossing the legs over. The movement in crossing the legs requires more front diagonal action if the leg crosses over the front, whilst crossing the legs behind calls more on the back diagonal. Once the legs are crossed, the body is able to brake the fall but remains un-balanced and then requires the trunk and the standing leg to move into a more shortened position which allows for repositioning of this standing leg. This is achieved by kicking the leg out sideways so they are now uncrossed and around shoulder width apart laterally to create a stable base. This requires coordination and interchangeable selectivity between all three areas the front and back diagonals and the homolateral structures.

A robust examination therefore must include an examination these specific elements answering the following questions:

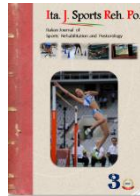
1. Is the reaction time both quick and equal on both sides?
2. Is the reaction time quick in both the legs and in the trunk?
3. Is the level of resistance adequate and complete to maintain balance?
4. When increasing the pressure of resistance does the reaction remain adequate?
5. Is the power of the muscles in the foot enough to support this? (We have already identified the power of the trunk muscles previously).

“Statiek” assessment.

Starting position: Get the patient to stand in front of the couch at a distance of approximately 20-30 cm away from the edge. Ensure the couch is at a safe height for the patient to brace against if required. Then sit yourself in front of the patient. So you can start the examination but maintain a level of safety against patient’s falling.

Start by asking the patient to resist the pressure when applied against their hip, indicating for them to “not allow you to push them backwards”.

The first tests are performed at hip height and inform us of the reaction of the lower aspects of the trunk and its capability to maintain balance.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

1. Apply pressure on the front of the hip joint pushing backwards in the direction of the couch. Start with very little pressure and release quickly before performing it again. We can see from this, if the patient comprehends the exercise and prepares the body to resist the pressure that is being applied. Often the examiner tries to prepare the patient by simulating the process of applying the pressure but stop at the last moment. This enables us to see that the body itself responds by moving forward and this helps to confirm the patient has understood the exercise. Following these initial tests we start to assess for;

A. Any variation between the left and right side of the body. Having identified the reaction that the patient has, we can now feel difference between the two legs. Even by “normal” people there often an light difference between left and right. Some factors are a difference between the lengths of each leg, a problem with mobility in the hip, knee or foot or it can be, a light loss of perception in one foot.

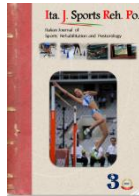
B. The next phase is to steadily increase the amount of pressure as much as the patient can tolerate before experiencing a loss of balance. This informs the examiner as to what amount of resistance the patient can produce in response to the pressure being applied. To develop personal skills it is worth experimenting with different individuals to provide a range of experiences.

C. Observe that the movement is correct to what would be expected. When pushing someone backwards then we expect to see both feet start lifting off the floor, with the person rocking backwards onto their heels. At the same time the knees are in extension and the hip and trunk must flex.

D. The next step is to apply force that the person can resist but. When performing this it is Important that the patient remains in a midstance position and not on the edge of their supporting area. Minimal movement of the feet and no movement of the hip is the usual expectation. Then apply pressure to the patient increasing intensity up to a point where the patient is unable to tolerate more without losing balance and being pushed backwards. Once this is achieved quickly release the pressure so the brace movement can be observed when the patient repositions themselves to prevent themselves falling over. We would expect to observe the patient shifting their weight to one foot and steps forward. Therefore- the brace movement - that the examiner want to see is the patient standing forward onto their toes and a backward movement of both the hips and the trunk.

With pressure being applied to the front of the hips we would assess the following:

1.The power, the speed and the movement to counter that pressure being applied to the hips. Additionally when we increase the pressure as high as possible with the patient in a midstance position then we hope to observe if the capability to brace effectively is enough to enable a shift of weight to one leg and provide room to take a step forwards before balance is lost.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

2.The movement of the feet in dorsal flexion must have the same amount of power. The power must be sufficient enough that when the feet are fixed, the person can lean slightly backwards onto their heels and still maintain balance.

3.The power that we need in the plantair flexors are ; we are able to push up with one leg from heel to forefoot that amount of force must be there and that must be easy and without problems 10 times repeated.

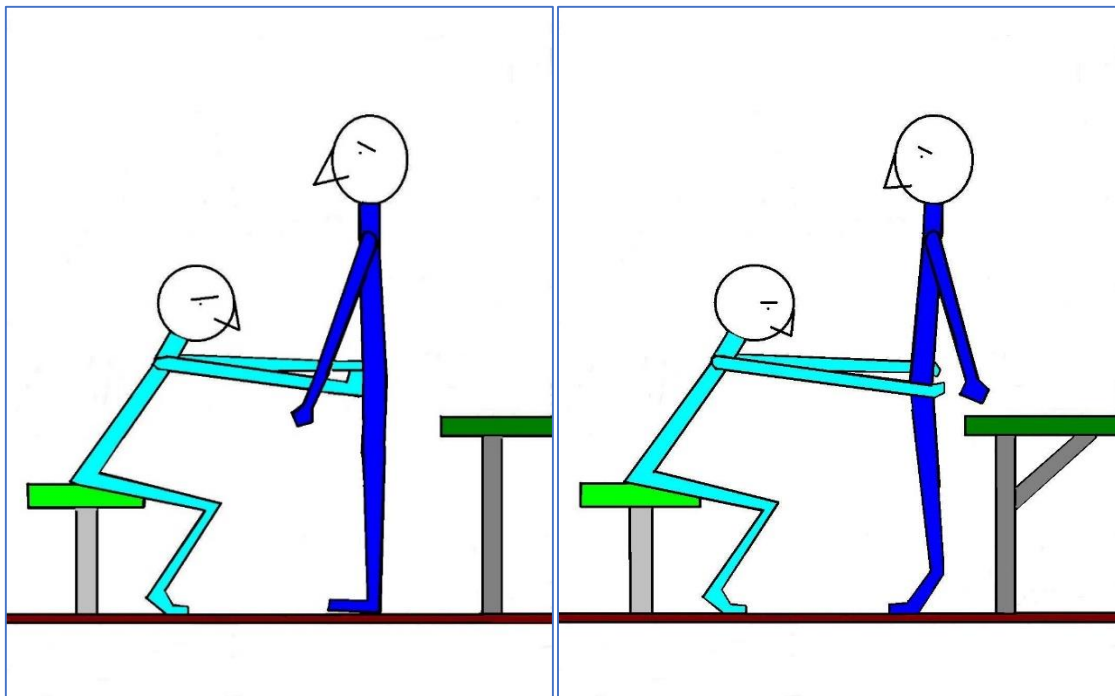


Figure 11 and 12. Notices where the examiner is placing their hands. It is extremely important, that you place your hands in such a way, that the patient cannot “hang” onto them.

We also look at the patient’s movement when resisting against the pressure being applied by the examiner when the midstance position is exceeded. We do this to observe not only the movement but also the individual power of the patient. When we examined the brace possibility you need to ensure the patient starts in midstance. We can use this exercise in a standing position easily to test the range of the patient’s individual capabilities.

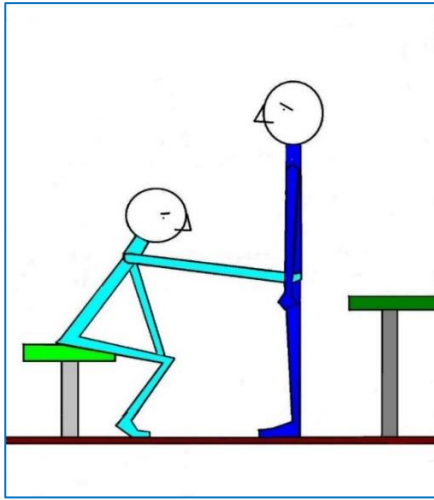
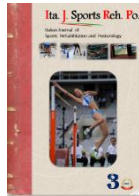


Figure 13. Sideways movement

Notice how this can be done easily with one hand.

When we use two hand on both side the reaction is often different.

The expected normal reaction is a reaction in the leg where we apply the pressure.

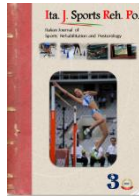
Sideways pressure requires a reaction in that leg where we apply the pressure. If the patient cannot do this, then the reaction will come from the other leg but has its own set of potential concerns. If after several repetitions there is still no reaction in that leg, we can deduce that the likely cause is reduced power in the abductor muscle.

Therefore when we test the other side we need to be careful as we have already identified a limitation of power in the leg being examined which has resulted in a poor reaction. Many patients who use a rollator (walking aid) will create an homolateral structure that ask very few of the abductors of the hip. As a consequence hey are more likely to have problems with this test.

Summary of the test:

- With gentle pressure you are observing for a quick reaction that is equal to the pressure being applied. You would expect to see a change when repeated that by the second or third time that the body reacts before you make contact.
- Then increase the pressure and observe that the reactions remain consistent. With pressure from the front, you would expect to see bending in the trunk/hip and dorsal flexion of the feet, whereas pressure from the back you would expect to see extension of the trunk/hips and plantair extension in the ankle. Any pressure from the side we would expect firstly to see an elongation of the trunk/hip on the side that the pressure is applied, with barely any movement in the foot.
- When in midstance we begin to increase the pressure to a point where the patient can only just maintain their balance in midstance so we can assess the amount of power they can tolerate, then the examiner quickly release the pressure to assess the body's response to the changing condition.

1. Pressure at the front will usually result in a brace reaction backwards (with extension of the trunk/hip and plantair extension of the ankle) along with transfer of weight placing one foot to the front



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

2. “Pressure” (which is a pulling movement) on the back will result in a reaction of the body falling backwards (With both trunk/hip in flexion and feet in dorsal flexion) along with a transfer of weight placing one foot to the back.

3. Pressure to the side with a reaction of the same leg will result in a reverse action when the pressure is suddenly removed. Changes in the trunk/hip area occur with them becoming elongated while the head moving to the opposite side and there is an eversion movement in the foot.

Additionally the patient steps either in front or behind the other leg so the legs cross over, which creates a brace to stop falling but has limited stability. This is then followed by the standing leg being lifted and moved laterally to create a wider stance to achieve a stable base preventing falling. These reactions give use an overall picture of the equilibrium of the body along with providing valuable information about the integrity of the touch receptors of the legs, especially in the soles of the feet. Examiners also need to look at testing the functional state of the trunk and hip muscles. The importance of the diagonals within maintaining balance can never be fully test as we are unable to identify the exact trunk reactions when balance is lost, along with the difficulty examining both trunk/hip power accurately.

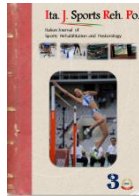
Trunk reactions are crucial to maintaining balance by using the diagonals as either an agonist or antagonist for movements forward and backwards and at times together with the homolateral muscle for keeping balanced during a sideways movement.

In an assessment we start by repeating the same examination techniques as previously described for the hips and the shoulders. Originally, Gerard Worm who developed this process of assessment included the same resistance assessment with the patients head. This additional observation was thought to provide a more complete picture of function, although if testing the trunk identifies an impairment in the muscle performance then further testing of the patients head would offer no more information of any value to inform the assessment process.

As a practitioner there is another test that I often do which involves getting the patient to stand on one leg (One Leg Standing) – which provides us with information on the development of the “scheme” of the body.

For example: A patient who walks with a rollator frame can become more reliant on the walking aid to maintain their balance resulting in a decrease of weight bearing on the feet and legs, this results in a change in that body scheme perception. This phenomenon we see by patient with neurological disease especially Dementia and that explain that this people are not capable to lie straight in bed and also don’t correct the attitude.

In the next part of this article we are going to discuss the “statiek” test conducted on the shoulders and the one leg standing test.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

Statiek test. With pressure application to shoulder.

In the description of the balance reaction we indicated that the trunk had a very important part to play. By falling backwards or forwards, the trunk reaction was seen to be equally as quick to respond as the reactions of the feet. When we look at a sideways movement then trunk reaction becomes even more important as the response time needs to occur before the feet start to react.

Examine on hip height is important in identifying any bilateral deviations which could affect balance. When we assess only on hip height than we can ignore the trunk. Generally the difference between the assessment at hip height or shoulder height is not that much but when we consider the individual pathology of these great joints then the difference suddenly varies greatly. This difference can lead to an understanding on why certain individuals have a greater risk of falls.

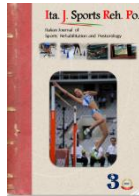
These further investigations include:

A. The difference between left and right. Having previously identified the power that this patient has within the diagonals and homolateral areas, along with palpating for anomalies in the physical structures this can help to inform the examiners understanding of potential deficits which can affect control and balance. For instance, there can be differences between the length of each leg, a problem with the mobility of joints including the hip, knee or foot, or alternatively there could be a loss of proprioception in one foot. And people with back pain have also an altering perception in the back proprioception and that can change the balance reaction. When a test can be developed to test the power of the trunk area, this will help to identify if the diagonals themselves are incomplete which may be the reason for the changes being seen.

B. When we have assessed the initial power, we then increase the pressure as much as the patient can tolerate, this helps the examiner to develop an understanding of what counter resistance the patient can produce in response. For experience it is worth repeating this test with several different individuals to form a comparison of differing responses. When performing this on the trunk, we need to observe the patient to ensure they can fix their body position firmly from the shoulders to their feet.

C. Observe the patient to ensure that movement is within normal limits. For instance; when you push someone backwards, the examiner observes for both feet starting to come off the floor, and the person ends up standing back on their heels, whilst the knees are in extension and the hips are flexed. When pulling the patient forwards the examiner observes an extension of the trunk/hip and at the same time rolling forward on their feet ending up standing on their toes. When pushing the patient to one side we would initially see an elongation of the trunk and then a reaction of the foot becoming inverted.

D. We also need to know how strong this entire system is. Standing on the toes: ask the patient to stand on one leg and push themselves up until they are standing on the forefoot. A



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

281

normal response would be easy for the patient to perform, and we would expect the trunk to remain in the correct position.

Standing on the heel: Next the examiner whilst in a seated position places their feet gently on the patients feet and feels for resistance from the patient. A normal reaction would be for the patient to easily generate enough resistance to move.

Standing on the lateral side of the foot: This movement needs to be unrestricted and easy to perform for the patient to move to a medial position and back again when standing on one leg. These tests are such that they may gain support at certain points.

E. Next the examiner applies force to an amount that the person can tolerate without the need to correct their position. It is Important that the patient being tested stands in midstance, and the feet remain in the same place, with little to no movement in the hips. Start increasing the pressure as much as possible without pushing the patient backwards, then quickly release the pressure. What we would expect to observe is the patient bracing to prevent themselves falling forwards, by transferring their weight and stepping forward onto one foot to break the fall.

Some key questions to consider at this point in the assessment are:

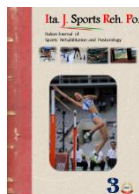
Testing this way is the only good measurement to identify the patient's ability to remain stable and maintain their balance. And the difference between test and exercises is very small.

The Task Specific Resistance Training is one of the basic exercises that everyone can participate in, especially when we consider falls reduction. Prevention itself is very difficult to achieve and can be considered a utopia!!! This will be discussed in more detail in part 3 "pathology"!

Statiek Test Shoulder level from the front.

We have already identified that the front diagonals are the weakest part of this structure within our body. Therefore exerting a lot of pressure here will force the patient to adjust their position taking a small step backwards creating a brace which prevents the examiner being able to fully assess the completeness of the front diagonals. Examiners must ensure therefore that once the pressure is applied to the shoulders they observe for a dorsal flexion of both feet occurs whilst there is no changes in position with the trunk which results with the step backwards. This test requires the whole body to produce the power to remain firm (like a wooden board), to resist the amount of pressure being applied at the shoulders. This level of firmness needs to be equal or almost equal on both sides to prevent twisting and a resulting loss of balance in turn.

You can test the strength of the dorsal flexion of the feet by placing your feet gently onto the patient's feet and then feel the amount of pressure they can exert when being pushed backwards and thus the strength of these muscles. Ideally you would expect the patient strength to be such that it is difficult to prevent their feet moving yours.



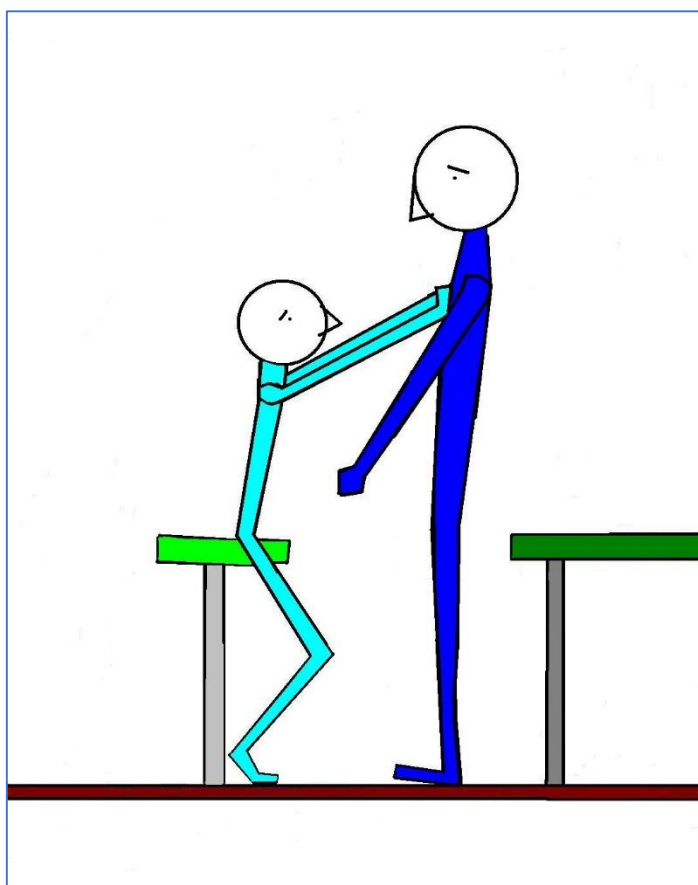
J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

282



Picture 14

Statiek Test shoulder level at the front.

The examiner first ask the patient to resist a small amount of pressure that is placed on the shoulders and is repeated several times.

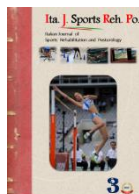
Observe that the patient has the ability to resist against the pressure correctly.

Than we can increase the pressure and assess the completeness of the front diagonals.

This assessment helps the examiner to understand the “brake movement” of the front diagonals observing for the resistance being of sufficient strength to allow time to transfer weight onto one foot and then enable the other to step backwards to create a brace (step strategy).

You can also use the pressure exerted to evoke a balance reaction with the patient stepping forwards, allowing the examiner to assess the completeness of the back diagonals. It is important that this is done whilst the patient is in a midstance position, which enables the patient to build up the level of resistance necessary to remain stable without having to transfer weight towards the back of their feet or step backwards. When performing this assessment it is important to apply the maximum amount of pressure which can be tolerated and resisted by the patient before releasing all the pressure as quickly as possible and observing the body’s reaction.

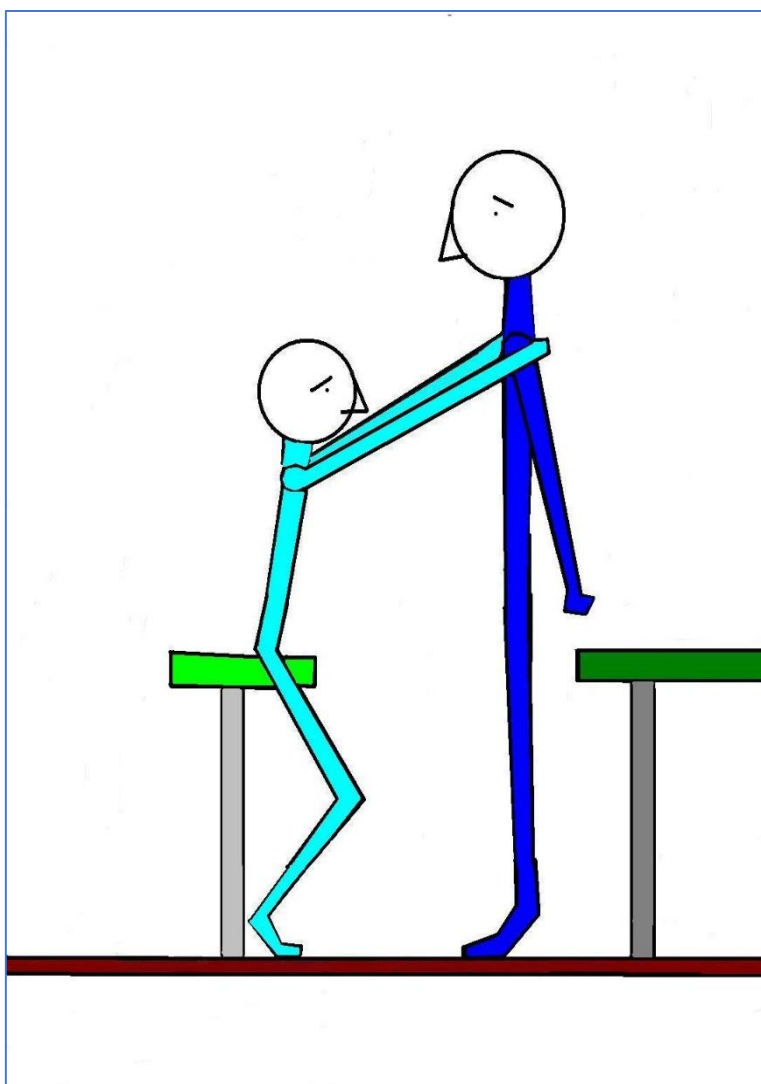
The brake movement occurs with weight shifting to one leg followed by the opposite leg moving forwards to create a brace. It is important for the examiner to step back to allow a safe distance for the patient to step into. Note as the patient is experiencing a sudden loss of balance when the pressure is removed quickly, a natural reflex in the body is triggered and they may reach out to try and support themselves preventing falling. If the examiner remains too close then the



patient may use them to do this which does not allow the brake movement reaction to be observed fully.

Statiek Test from the back at shoulder level.

283



Picture 15.

Statiek test from behind.

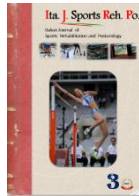
The examiner asks the patient to resist as they pull forwards on their shoulders.

You should experience a significant increase in the amount of resistance from the patient compared with the assessment from the front.

Start with a small amount of pressure pulling forwards and feel for the patient exerting a level of resistance with minimal effort to maintain a firm stance.

At this point strength is not so important, more looking at the reaction from the entire back diagonals

When the examiner feels confident that the back diagonals are complete they can proceed further with this assessment. There may be several occasions when the back diagonals are not complete, here it is important that the examiner repeats the pull test several times to ensure that this is the case, and gain an understanding to what degree it is compromised. Very often we will see a flexion of the trunk and the hips that remains consistent with every attempt. The resulting outcome from this suggest the patient lacks the level of muscular integrity to produce firm back diagonals (like a wooden board) to maintain the body position. Patient's exhibiting



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

these concerns usually have difficulty with any exercises that involve using the gluteus maximus muscles. In this assessment we can often identify a failure of the extensors of the hip that have not been previously diagnosed. Some examiners have suggested that this assessment can be performed when the patient is in a supine position on the couch, by lifting the patient's heels upwards as far as possible. The difficulty with performing the assessment this way is the examiner cannot observe for the balance reaction because the support area is only in the shoulders and the head. It is extremely important that the examiner can identify that the back diagonals function is complete, because any flexion of the trunk and hips will force the free leg to go back rather than the required step forwards to prevent falling.

Following this test the examiner looks at evoking a complete balance reaction by pulling with as much force as possible whilst the patient is in a midstance position. Then as before release the pressure as quickly as possible, observing for the transfer of weight and the stepping movement to create a brace. Note it is important to allow enough space from the couch behind the patient so they can step into it enabling the examiner to fully assess all three movements (the brake, shift and step strategy).

Statiek Test from the side at shoulder level.

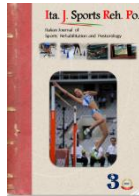
In this assessment the examiner is looking for a response only from the side of the body where the pressure is apply. This side must react creating a firm and stable body position just like the previous 'wooden board' analogy.

Examiners will often observe the opposite side reacting when pressure is applied. This usually indicates that the patient has a reduced function in the homolateral structure and does have an incomplete brake movement. With this in mind it is important to test for the amount of pressure required first on both sides of the body before the examiner tests for the brace, shift and steps reactions.

Note for patients to maintain balance and prevent falling a lot of trunk movement is involved with the following sequence of movements being observed.

1. Legs crossing over each other
2. Placing the foot of the crossing leg on the floor
3. Uncrossing the legs using the opposite leg and
4. Stepping out to the side in a wide stance to create a stable base.

If examiners feel unsure that this movement is possible for patients, then it is worth asking a colleague to provide support if required to help prevent the patient falling over.



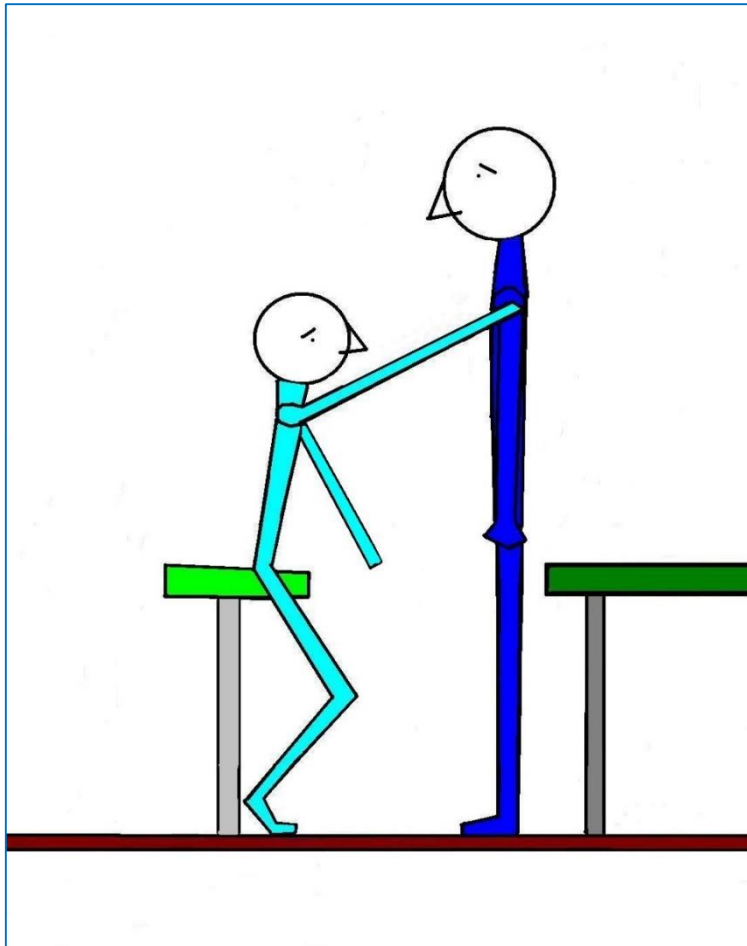
J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

285



Picture 16

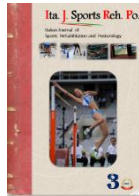
This test is performed with one hand. The pressure must be felt only on one side otherwise the patient will use the opposite hand to remain stable resulting in a poor assessment of their balance ability.

We start with gentle pressure whilst asking the patient to offer a level of resistance as quickly as possible.

It's useful to repeat this several times as patient may respond to late and must "learn" how to react.

With the patient in a midstance position the examiner firstly applies pressure pushing against their shoulder increasing the amount of pressure to a point where the patient can still produce resistance to main balance. Then as before the examiner releasing the pressure as quickly as possible expecting to observe the patient falling sideways and working to regain balance.

The pressure sideways on the shoulder absorbs high amounts of power that gives an trunk-shortening. After release of the pressure that shortening must be change in an elongated Movement from head down to the foot, resulting in an inversion movement. Other options are often seen by the sideways balance reactions. Such as: - the opposite side of the trunk shortening more to allow a steps out to the side where the pressure is being applied, - alternatively the person jumps sideways to try and regain balance. But try to investigate that this is an alternative and not an compensation.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

Note older people has often difficulty with this movement and pressure sideways gives often not the result we want to see. And the test with high pressure and release is too dangerous to perform, than the one leg standing test gives the opportunity to see what is wrong. The patient needs to adopt this position – one leg standing - for a period of time of 30 seconds with their eyes closed using proprioception to maintain stability for this to identify how intact the function is. When performing the sideways Statiek test with high pressure and quick release and the one leg standing by patients that have poor balance, it is worth considering using a pool for safety and perform this test in water.

One leg standing test

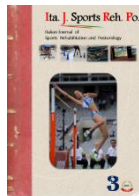
For the one leg standing test there are a series of outcome measurements the examiner can use:

1. Not possible
2. Possible with support
3. Less than 15 sec.
4. More than 30 sec with the eyes closed.

One common concern patients express when performing this test is a fear of falling due to the difficulty with balancing on one leg. Consequently they feel more secure having the chair closer but this provides issues for the assessment due to the reduction of space being available for the trunk to move sideways slightly so that the patient can leg can lift up. Exploring these concerns with the patient can help to indicate to the examiner the depth of perception of their body scheme. Furthermore patients who use rollator frames for support when walking will begin to experience this change in perception due to the muscles in the homolateral areas losing the ability to perform a quick response, resulting in reduced muscle strength and the degree of coordination within the great joints and diagonals.

As a result of these concerns it may be inappropriate to undertake the one leg standing test with an chair, as an alternative enable the patient to lean with their hip against a couch before raising the leg, to provide more security. Consequently the arms are hanging loose resulting in the trunk becoming elongated and the foot, they standing up, will move from medial to lateral position and back, searching for the best position.

The pelvis itself should remain in a horizontal position with no downward movements being observed. If we see this type of movement then this identifies the possibility that a part of the homolateral structure is not strong enough to support the body weight. (Trendelenburg). Resulting in an increased risk of falling due to a poor stability and balance reactions.



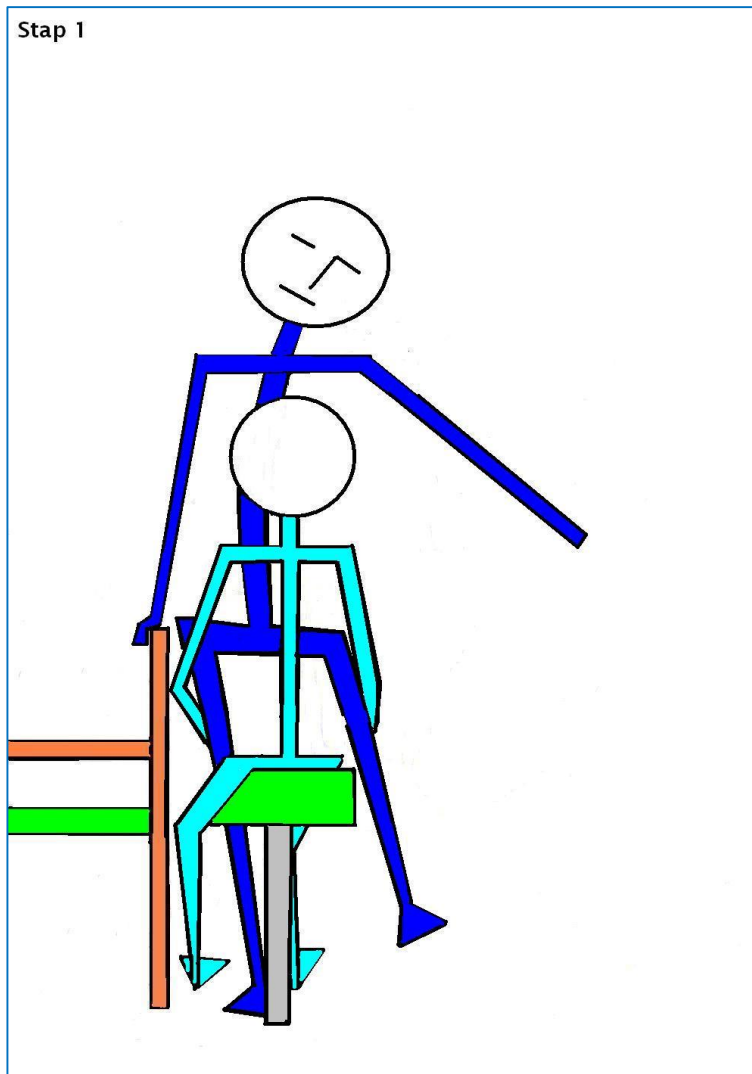
J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

287



Picture 17

How to perform a one leg standing test.

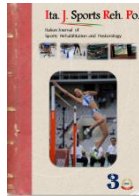
Initially to get into the correct position the patient can use the back of the chair for stability whilst the examiner supports them and helps to lift the leg.

Once this position is achieved then the patient is asked to remove the hand from the back of the chair and stand their eyes closed for a period of time in excess of 30 seconds if possible.

Throughout the individual assessments examiners identify which parts of the diagonals and homolateral structures remain in good condition and which areas require retraining. Therefore once examiners have explored the diagonals capability they need to move focus towards identifying the best way for patients to restore function.

In Diagonals part one, we identified how areas of the same diagonal structure provides support for each other maximizing its overall performance. Using this knowledge along with the outcome of the assessments helps examiners to develop a treatment plan.

When a crucial structure within the diagonal is not functioning correctly, the overall integrity, structure and function of the diagonals changes. Diagonals part one identified the angle of the back diagonals needs to be a 45 degree angle to maximize it functional capacity. When the buttock muscles strength is reduced creating limited ability to perform as expected, this angle needs to increase to achieve the right conditions to optimize performance when moving.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

288

Due to the greater angle, the muscles on the inside of the legs replace the function of the buttock muscles resulting in the thigh muscles being pulled toward adduction and endorotation affecting the overall performance of the legs.

If the patient presents with these functional changes, for safety the examination can be performed as previously described in a supine position which will still allow the examiner to observe the patient's functional ability for both sitting or standing.

In Diagonals part three we will start to discuss how medical conditions such as stroke and neurodegenerative change can affect patient's ability along with considering treatment plans for using the diagonals to help restore some of the functional capacity.

Trunk Rules.

Trunk movement enables the great joints themselves to increase their range of movements when in different positions. This is predominately due to the influence of the diagonals on the trunk itself. When the selectivity and the mobility of the joint is normal, individuals are capable of performing several movements in all directions forwards, backwards and to the side. Some structural limitations within the great joints therefore restrict certain positions from being achieved resulting in the need for trunk rules becoming dominant in dictating the function.

Trunk rules are the work of two N.D.T. Bobath senior teachers out the U.S: Kathy Levit and Susan Ryerson. Their findings have been published in an excellent book entitled: "Functional Movement Re-education".

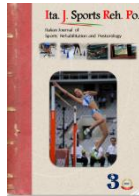
The structural connection between the upper trunk and the lower trunk is the spinal column which helps with some of the movement. The rest will be undertaken by muscle patterns especially the back and front diagonals in collaboration with the homolateral structures. The cooperation between this structures makes movement possible because when one muscle is active the other is never passive but moves together to be ready when the movement stops. (agonist – antagonist)

This active movement of the trunk maximizes the range of movements in the great joints (In Diagonals part one this is referred to as keypoints), along with helping to identify the borders where these movements end.

Upper trunk

1. Bending forwards (Upper Trunk Forward)

Exploring these movements in more detail, when patients sit up on the couch and bend forward from the head to look down at the floor without allowing any movement from the pelvis we should observe a flexion movement in the cervical and thoracic spine. As a consequence the shoulder girdle area undergoes the following movements:



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

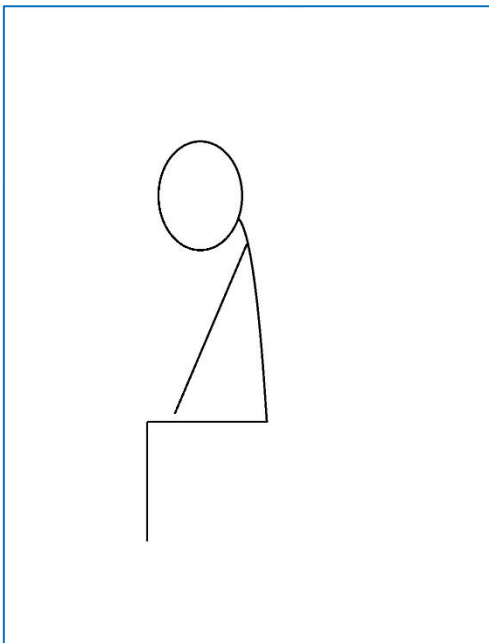
289

- Protraction of the shoulder blade (protraction is combination of laterorotation, abduction and elevation)
- Anteflexion, endorotation and adduction movements enabled in the glenohumeral joint.
- Extension within the elbow joint.
- There will also be a reaction of the lower trunk, although it is important for examiners to ensure there is limited movement only.

We- normal people-, can alter this movement, but when we move so far as possible an upper trunk forward movement, we feel that we cannot move so far as when the trunk is in mid position. Try to exorotated the shoulder with the upper trunk total bend and hold that position and move to mid position of the trunk, you will feel that more exorotation is possible.(Picture 18 see below.)

2. Bending backwards (Upper Trunk Backward)

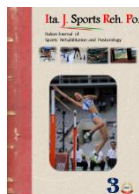
A normal person or a patient sits on the couch and extends backwards starting from the head, movement is “only” observed in the upper trunk. This position is very difficult to maintain for extended periods of time because the upper portion of the back diagonal are now work concentrically. In pathology we see some patients with an upper trunk backward sitting for an long period. This has massive implications to their quality of live, especially with the limitations to swallowing (we will discuss this more in Part 3 Pathology).



Picture 18 Upper Trunk Forward

Movement start in the upper trunk and is an eccentric contraction of the back diagonals.

During the concentric contraction of the front diagonals we can observe movement in the legs and not just in the upper trunk “alone”.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

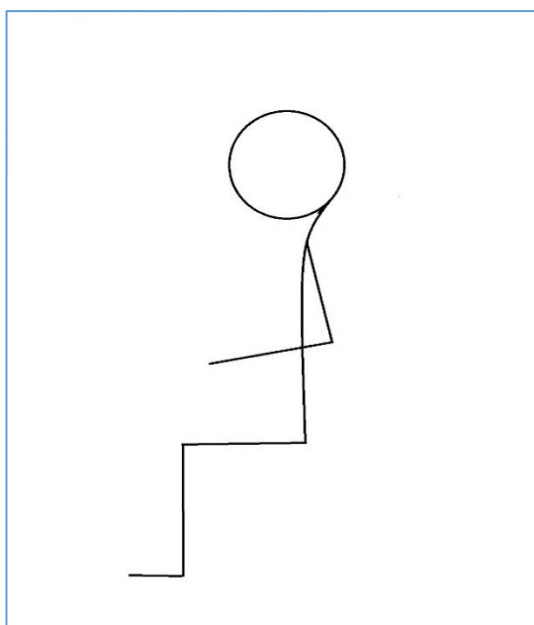
ISSN 2385-1988 [online] - IBSN 007-111-19-55

290

With extension in both the thoracic and cervical spine the following reactions can be observed in the shoulder girdle:

1. Retraction of the shoulder blade (retraction is a combination of movements from mediorotation, adduction and depression).
2. Retroflexion and exorotation in the glenohumeral joint.
3. Flexion in the elbow joint.
4. A concentric movement usually starts in the upper trunk with limited movement initially in the lower trunk. When the lower trunk takes part on this movement , it is than no upper trunk movement any more.

This is an difficult movement for normal people because an bending to the side without rotation is an movement with little benefit. But rotation makes the movement far more difficult therefore only bending sideway. The movement is starting from the upper trunk and there must little or no movement in the lower trunk. That means that the trunk on one side is start with a short active shortening.



Picture 19

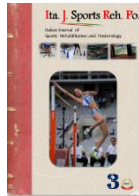
Concentric contraction of the back diagonals starts in the upper trunk.

Back diagonals are stronger and less flexible than the front diagonals resulting in a quicker reaction response being observed in shoulders and arms.

Relaxation of the upper trunk backward gives often a upper trunk forward

3. Bending to the side starting from the upper trunk (Upper Trunk Sideway)

An concentric movement of the upper part on that side from the front and back diagonal. But after this brief moment, this movement will be done by eccentric activity of the muscle on the



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

291

other side and then mostly the back muscle. The muscle of the diagonal on the other side keep this movement in street side way.

Movement in the trunk with the spine becoming both shortened and elongated at the same time results in the following movements in the shoulder joints:

1. *Short side:* here we see the shoulder blade moves into retraction (adduction, mediorotation and depression).
2. Retroflexion and exorotation movement in the glenohumeral joint.
3. Flexion in the elbow flexion.
4. *Long side,* Here the shoulder blade move into protraction (abduction, laterorotation and elevation), generally with more abduction than laterorotation.
5. Anteflexion in the glenohumeral joint, (note: any other movements are not so obvious because the joint remains parallel with the trunk and the shoulder blade makes less laterorotation.
6. More extension than flexion in the elbow joint.

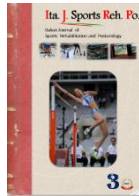
When the patient performs this movement with an increased weight resistance we observe significant changes in the muscle activity.

For example: When carrying a tray full of drinks, the natural position is to tuck the elbows into the sides for stability. This results in a slight upper trunk movement sideways, the short side now makes use of the retraction of the shoulder blad and the exorotation of the glenohumeral joint. This trunk movement makes it possible to the tray “easy”.

Lower trunk.

These movements emanate from our support area, therefore any movement needs to be executed immediately so stability is maintained. Any movement is required to be both small and more controlled to maintain balance throughout and is now the starting point of the movement compared to the upper trunk which is the complete opposite.

When patients start movements in the upper trunk, which results in a significant reaction in the lower trunk, there is usually a deficit present. This could be due to the person fatigue or the lower trunk having a reduced capability to support this movement. One example of this is seen with patients walking with rollator frames

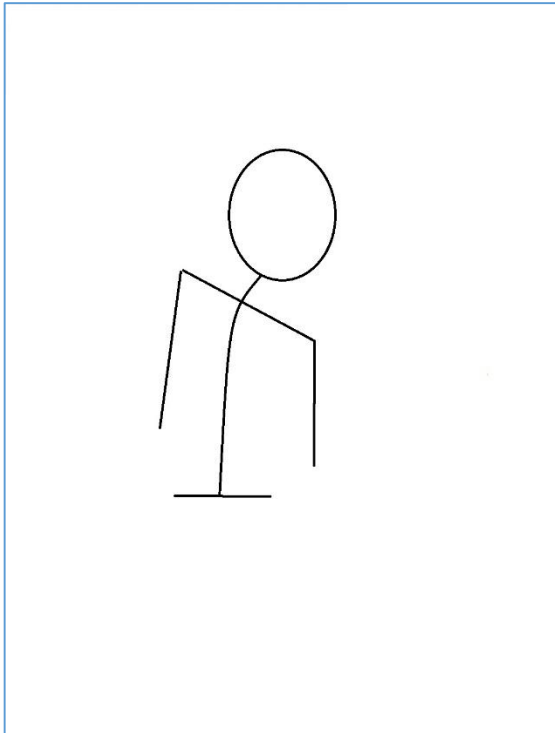


J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55



Picture 20

Bending sideways.

The upper trunk starts with a concentric movement of both diagonals. As it progresses both diagonals of the elongated side becomes dominated by an eccentric contraction although this is mostly situated in the back diagonals.

The change from concentric to eccentric from agonist short side to agonist long side is created by the influence of gravity.

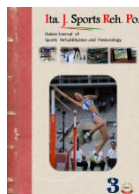
Due the position adopted to hold the frame increasing pressures from the arms, this results in the upper trunk being required to enable lower trunk movements. Similarly if we were to help someone stand up, a pulling force is exerted on the upper trunk whereas standing up independently is predominantly a lower trunk action. We should give support on the lower trunk.

1. Bending forwards (Lower Trunk forward).

Standing up requires the lower trunk to move forward. Consider when we standing up without using our hands we make an initial movement with the trunk forwards until the head passes the hips, then the knees bend allowing the feet to move backwards.

When we reach the point of being able to stand up we then observe the following sequence of reactions in the great joints.

- Extension in the trunk with the pelvis “tilted” forwards.
- Flexion in the hips with a small amount of abduction and exorotation.
- Flexion in the knees flexion.
- Dorsal flexion in the feet.
- Retraction in the shoulder blades (adduction, mediorotation and depression).
- Retroflexion and exorotation in the glenohumeral joint.
- Flexion in the elbow.
- You can also see the lower trunk moving forwards whilst the upper trunk moves backwards.

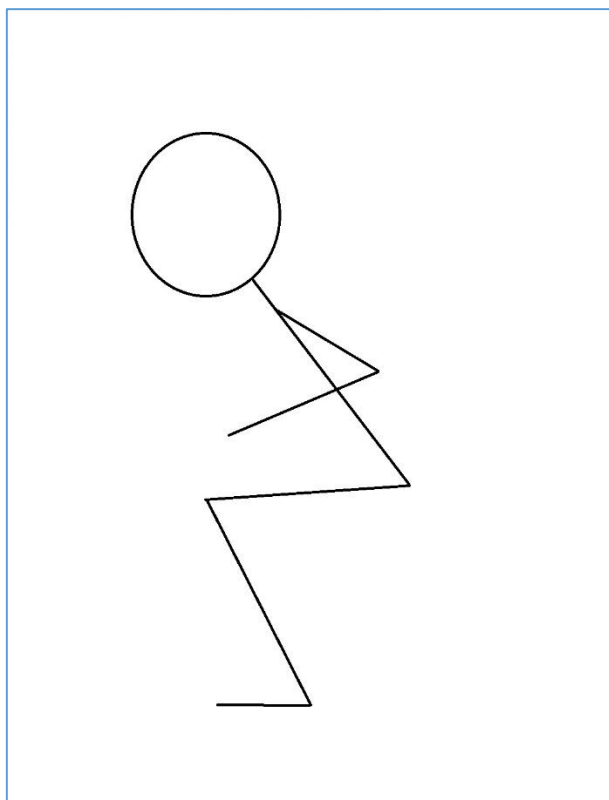


J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55



Picture 21

Lower Trunk Forward.

The extension in the trunk gives the reaction in the shoulder that means that arm get easier to the back than to the front.

The movement of an trunk in extension over the hip will give this effects on the legs (flexion hip, knee and feet). A movement from the upper trunk in flexion over the hip gives a latter reaction in the legs.

That is one of the reasons why older people have difficulty standing up with support of the arms, because the trunk movement is not far enough to the front.

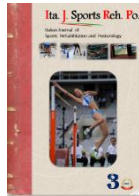
In this position the back diagonals are more active due to extension of the spine which is a concentric movement. Similarly there are concentric movements in the front diagonals due to observed movements of the legs with the hips in flexion. Collaboration of both diagonals simultaneously helps to place the pelvis in best position enabling the hipflexors to work. All this makes standing up a high selectivity movement which is necessary because it is one of the heaviest and most difficult Activity of Daily Living (A.D.L.s) we perform.

2. Bending Backwards (Lower Trunk Backward)

This movement is best observed when a patient lays down in a supine position from sitting. This movement is an eccentric movement of the front diagonals and therefore we see a reduction of flexion in the hips.

The reaction in the greats joint include:

1. Flexion in the trunk with the pelvis "tilted" backwards.
2. Extension in the hips with some adduction and endorotation.
3. Extension in the knees.
4. Plantair extension in the feet.
5. Protraction in the shoulder blades (abduction, laterorotation and elevation).
6. Anteflexion, endorotation and some adduction in the glenohumeral joint.
7. The elbow becomes extended.



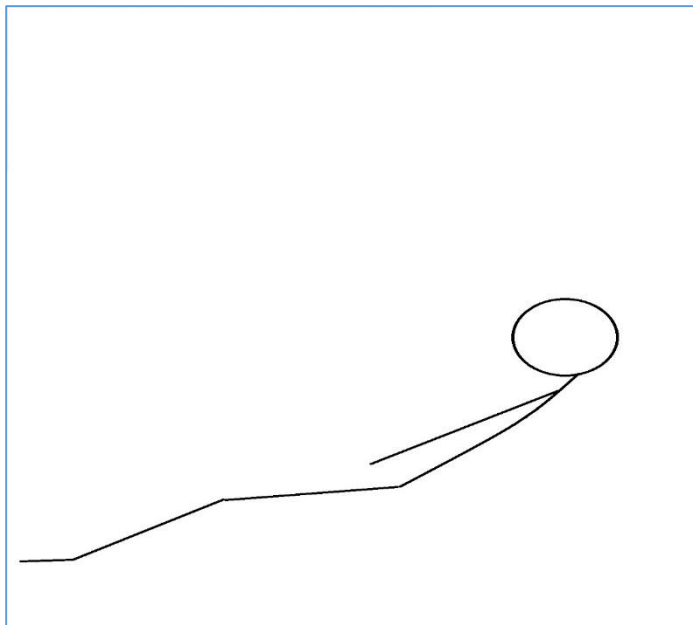
J. Van de Rakt , S. McCarthy-Grunwald
Diagonals Part Two : Assessment and Trunk Rules
Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002
ISSN 2385-1988 [online] - IBSN 007-111-19-55

8. You can also observe that movements in the lower trunk backward results in the upper trunk moving forward.

294

Many patients all over the world are sitting in this position and often is this position fixed by moving the legs in an extension. More extension means that the pelvis will capsized further back and that the thorcal spine “collaps” to the front and that this “collaps” must be counter by the cervical spine through massive extension.

This massive extension restricts the muscle at the front of neck resulting in difficulties in both swallowing and speech



Picture 22

Lower trunk backward.

We all adopt this position after a busy day working where we are exhausted.

We tend to sit with a firm tilted pelvis backwards which makes it easier to lift your feet in extension on a foot stool.

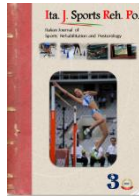
Remember this is not a concentric action of the front diagonals because by an concentric movement the hip would flex.

3. Bending Sideways (Lower Trunk Sideway).

This is a difficult movement because it requires the cooperation of all diagonals coming together as part of the homolateral structure. Therefore weakness in any part can compromise the integrity in the other structures.

This movement requires concentric actions everywhere but at differing levels of involvement. For instance, an Upper Trunk Sideways movement starts with an action on the short side with a concentric contraction, but then changes into an eccentric action afterwards.

When our support area becomes smaller such as movements in the lower trunk area, we require more power to perform the movement and maintain stability. This is achieved by using concentric contraction. When we try to rotate, there is a higher demand on the process of selectivity to maintain a firm structure and stability.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

For more information with respect of muscle action, it is well worth reading the work of renowned writers such as Joan Mohr, Pat Davies or Kathy Levitt and Susan Ryerson.

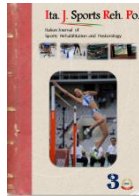
Reaction in the great joint include:

The trunk is elongate towards the side where the person is resting on whilst the opposite side becomes shortened.

1. *Elongated Side:* Protraction of the shoulder blades, with more abduction than laterorotation which allows the glenohumeral joint more freedom of movement.
2. Anteflexion of the glenohumeral joint initially, with endorotation and adduction only towards the end phase of the sideways movement. This enables the individual to maintain this position, and retain balance. to hold this position, a balance position. But that is an movement far too far, to understand the trunk rules !!
3. Extension in the elbows.
4. *Shortened Side:* Retraction of the shoulder blades.
5. Retroflexion and exorotation of the glenohumeral joints.
6. Flexion in the elbows.
7. *Elongated Side:* Exorotation in the hips with a 90 degree flexion. This exorotation is extremely important to enables us to control the power, balance and movement requiring the action of the m.gluteus max. If we move too far forward the legs will begin to flex, if we move is too far backwards the leg will extend as sign that sideways resulting in the same lack of stability.
8. The knee become bent.
9. *Shortened Side:* Endorotation in the hips where the back moves into extension while the front becomes more flexed. When a balance reaction is required we then see abduction movements in addition, but that is not the goal, because balance reaction need very high level of selectivity and we want to know what is happening by sideways movement of the trunk in the great joints.

Control of a small support area allows us to observe the amount of cooperation between the diagonals and homolateral areas.

Picture 23 demonstrates a fixation point for the whole body from the right hip. There needs to be a degree of control within the movement producing both an exo and endorotation. This means that to stabilize the hip there will be a continuous change from agonist to antagonist



J. Van de Rakt , S. McCarthy-Grunwald

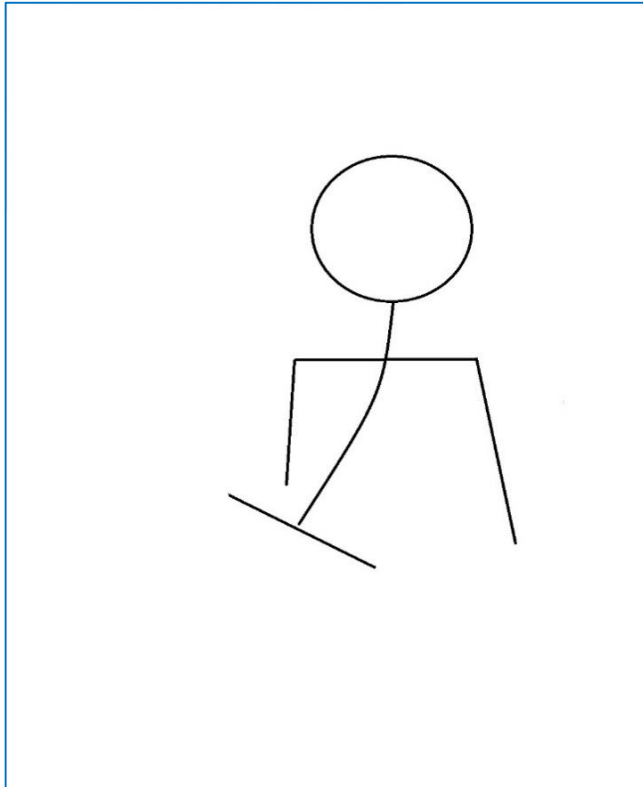
Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

together with the M.Gluteus medius ,max, the adductor muscles and the small muscle of the hip.

296



Picture 23

Lower Trunk Sideway.

Creating such a small support area makes this movement more difficult due to requiring an immediate balance reaction to maintain stability.

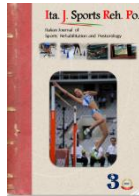
With support of the arms the movement start in the upper trunk and not in the lower trunk.

We make this movement all the time when we are preparing to stand from a seated position by either lifting our weight or shuffling on our buttocks to reposition ourselves to the front of the chair in preparation for standing.

We have discussed previously how both diagonals go from the right hip to the left shoulder. The front and back diagonals need to work in collaboration performing concentric movements similar to the muscles around the hip. This requires both diagonals to provide fixed points simultaneously with which to allow concentric movements as required.

Therefore the lower left areas of the front and back diagonals provide a fixed point for the right front and back diagonals, while on the opposite side the lower right areas of the front and back diagonals provide a fixed point for the left front and back diagonals. Once this is in place the lower left areas of the front and back diagonals can start to lift the left buttock, then in combination with the upper area of the right leg the diagonals produce an active shortening of the spine.

The base (right buttock) must be active so that the left buttock can also lift. The shortening process of the spine enables movement of the shoulder blades and a corresponding reaction in the left arm, on the side that is moving slightly reducing some of the back diagonal action as a consequence.



J. Van de Rakt , S. McCarthy-Grunwald

Diagonals Part Two : Assessment and Trunk Rules

Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002

ISSN 2385-1988 [online] - IBSN 007-111-19-55

297

The increase of tone in the front and back diagonals in the lower left area provides a reaction in the upper left area of both diagonals, resulting in the right side experiencing more action in the front diagonal and therefore the observed reaction of the shoulder blades in turn.

Combining the front and back diagonals play are an enormous part of the movements in the homolateral structures, producing increased visibility of the reactions in the great joints despite minimal changes in muscle tone.

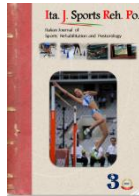
The diagonals truly at their best!!

End of part two.

Rectification notes for Diagonals Part One: Following discussions with a dear colleague from the Donders Institute in Nijmegen, there is now an alternative interpretation of the description for the innervation of the trunk compared with the one published in Diagonals part one. The alternative view involves a double innervation from one hemisphere is only good at the axial part of the spine and the four big joints the “keypoints” of the diagonals. This innervation is mostly towards the back and not so obvious at the front. This helps to explain why the back muscle recovery is quicker than the front muscles. For this insight we would like to offer our appreciation in helping to strengthen this series of publications.

Part Three

In Part three we will start discussing Pathology with a focus toward individuals who have experienced a stroke.



J. Van de Rakt , S. McCarthy-Grunwald
Diagonals Part Two : Assessment and Trunk Rules
Ita J Sports Reh Po 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002
ISSN 2385-1988 [online] - IBSN 007-111-19-55

298

