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The Effects of Structural Integration on the Mini- Balance Evaluation Systems Test: A Case Report

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Abstract

Background: The loss of balance, which can lead to fall-related injuries is a serious health risk to elderly people. Multiple biological systems need to be addressed to improve balance deficits. Conventional treatment involves balance and strength exercises, however comprehensive manual therapy has the potential to address balance deficits in unique ways. The Rolf Method of Structural Integration is manual manipulation focused on the continuity of fascia throughout the body. Because fascia has a functional relationship with muscles and the autonomic nervous system, deficits in proprioception, sensorimotor function, and posture may all be addressed with the Rolf Method of Structural Integration.

Purpose: To examine the effects of the 10-session series of the Rolf Method of Structural Integration on a valid and reliable measure of functional balance, the Mini-BESTest.

Method: A 78-year-old woman with concerns about her balance received the 10-session format of the RMSI, each lasting approximately 75 minutes, over 11 weeks. The Mini BESTest was administered before session 1, and two days following the final session #10.

Results: The Mini-BESTest total score improved 9 points from 13/28 pre-intervention to 22/28 post-intervention. Most notable were the improvements in the categories of sensory orientation and rapid postural adjustments to recover balance. The intervention did not affect strength deficits affecting balance.

Conclusion: This case report demonstrated the Rolf Method of Structural Integration had a positive effect on balance as it related to proprioception and sensorimotor function for a relatively healthy older woman. These findings support research showing the influence of fascia manipulation on autonomic nervous system controls. It also demonstrates that Structural Integration has the potential to be an effective tool in fall prevention. Future research is needed to discover if other populations suffering from balance challenges would benefit from this approach.

Keywords: case report, Structural Integration, fall prevention, proprioceptive rehabilitation, Balance Evaluation Systems Test

Introduction

Falls are the leading cause of injury-related deaths among people 65-years and older.[19] The loss of balance, which leads to falls has different causes, and many interventions have been identified to improve balance in the elderly. The rehabilitative intervention depends upon which biological systems are impaired. The United States Preventative Task force recommended exercise to prevent falls among people 65 years and older as well as populations of people at higher risk of falls.[22] The Center for Disease Control and Prevention recommends a multifaceted approach to fall prevention, which may include balance and strength exercises, gait training, medications, nutritional supplements, orthopedic supports, and environmental alterations.[12]

The Rolf Method of Structural Integration (RMSI) is a form of manual therapy and sensorimotor education which aims to improve whole-body biomechanical function rather than focusing on symptoms of dysfunction.[4] The agency of RMSI and other variations of Structural Integration (SI) is not clearly understood. Studies have demonstrated the ability of SI to improve function through an increased joint range of motion[5] and increased tissue extensibility.[23] Other studies have reported changes in pelvic position and increase parasympathetic activity[2], and improved gait quality in children with cerebral palsy.[9]

To date, RMSI has not been applied as a therapy for fall prevention among the elderly in the research, yet based on the purported merits, it may be an effective intervention to improve balance. This case reports the effect of a 10-session series of the RMSI based on the Mini-BESTest, a valid and reliable measure of functional balance.

Timeline

2020-09-28	Informed consent signed. Posture photos. Mini-BESTest (Total Score: 13/28) Rolf Session # 1: 1. Free breathing, teach diaphragmatic breathing. 2. Reduce myofascial restrictions in superficial fascia to create adaptability in subsequent sessions.
2020-10-01	Rolf Session # 2: 1. Reduce myofascial restrictions in structures of legs and feet 2. Establish sense of support from the feet 3. Movement cues for MTP joints, ankle, knee, and hip hinging in supine, prone, seated, standing and walking.
2020-10-06	Rolf Session #3. 1. Reduce myofascial restrictions along sides of body 2. Establish client's sense of front and back of body in space. 3. Particular attention to the Quadratus Lumborum.

2020-10-13	Rolf Session #4 1. Reduce restriction along the inner leg and thigh 2. Reduce myofascial restrictions in the pelvic floor 3. Establish connection in movement between pelvic floor and inner line of the lower extremities in sidelying, standing and walking.
2020-10-20	Rolf Session #5 1. Reduce myofascial restrictions in rectus abdominus and iliopsoas. Also quadricepts 2. Movement coaching to differentiate abdominal wall from iliopsoas in supine, seated, standing and walking. 3. Differentiate pelvis from thighs.
2020-10-27	Rolf Session #6. 1. Reduce myofascial restrictions that interfere with sacral mechanics. 2. Reduce myofascial restrictions along posterior aspects of body.
2020-11-03	Rolf Session #7. 1. Reduce myofascial restrictions to head posture in the neck 2. Reduce myofascial restrictions of jaw and cranium 3. Find efficient head postures in supine, sitting, standing, and walking.
2020-11-10	Rolf Session #8. 1. Revisit restrictions in lower extremity and pelvis that were creating anterior shift in pelvis during standing. 2. Reinforce connection of pelvis to feet and to shoulder girdle and head.
2020-12-04	Rolf Session #9. 1. Bring pelvis and rib cage in alignment through more release of tight anterior neck and chest muscles. 2. Differentiate shoulder and arm motion from pelvis or head.
2020-12-08	Session #10. 1. Reinforce a connection of regional interdependence through global stabilization tasks. For example: Perterbations "don't let me move you." 2. Myofascial work while client elongates opposite ends, i.e., head/heels or finger tips and back.
2020-12-10	Post series Mini-BESTest. (Score total: 22/28)

Narrative

Client Information:

A 78-year old woman was recruited to participate in this prospective case report during a tune-up session to address tightness and mild tingling in her right foot. While performing a functional assessment prior to the treatment, she demonstrated some teetering during walking, and postural swaying while standing and turning her head side to side. Though she did not lose balance, she expressed concern that she felt "wobbly". This admission, and the fact that the client was otherwise in good health, made her an appropriate subject. She was enthusiastic to participate when asked.

The subject had no self-reported cardiovascular disease. She had not fallen in recent memory. The client had not experienced dizziness or vertigo. Her vision was good to the point she only needed glasses for reading. She presented with osteoarthritis in both knees and complains of pain with knee bending and functional activities such as walking up and downstairs. She has a bunion and cross-over toe on her right foot.(10) She described her activity level as low. Walking is her only form of exercise, which may be done up to 3 miles once or twice a week. She suffered foot and ankle fractures after being struck by a car in 2011 at the age of 69. The medial malleolus of her left ankle, both medial and lateral malleolus on her right ankle, as well as the fifth distal metatarsal, were sites of fracture. Her right ankle has a screw fixating the distal fibula fracture, and a screw stabilizing a medial malleolus fracture. Following a course of physical therapy, a final follow-up X-rays in 2011 showed normal healing of the fractures and no disruption to her mortise joints by any of the surgical screws. She reports occasional mild numbness and tingling in the fourth and fifth toes on the right foot.

Clinical Findings from the initial assessment:

Objective Observation of Static posture:

Front view:

- Right side bend of neck and occiput tilts left on neck.
- Right shoulder lower than left.
- Right ilium and right lower rib cage are closer together.
- Columns of legs seem centered in weight distribution through to the heels.
- Front of Mortise joints and knee caps ankles at the same horizontal level.
- Right foot Cross-over toe of 2^{nd} toe over 1^{st}

Side view:

- Overextension at lumbar/thoracic junction,
- Pelvic girdle is shifted anteriorly such that more weight seems to be in the toes.
- Anterior head carriage.

Posterior view:

- Left foot pronation.

Gait Assessment:

- Walks on the outside of her feet with hip adduction in the mid-stance phase.
- Looks down at the floor to find balance.
- Avoids ankle plantar flexion in the right foot more than left. Right foot cross-over toe affects the function of her foot as a base of support and in gait.[10]
- Trendelenburg Gait: Unsupported ilium drops in gait.[13,25]
- Confirmed with positive Trendelenburg Test (Single Leg Balance).[13,25]

Breathing Pattern:

Apical

Outcome measure:

The Mini-BESTest is an abbreviated version of the Balance Evaluation Systems Test (BESTest). The BESTest is an assessment of balance suitable for those with and without balance disorders. It is a 36-items examination, divided into six sections each of which is designed to identify underlying biological impairments affecting balance. The six sections are 1.biomechanical; 2. Stability Limits and Verticality; 3. Anticipatory Postural Adjustments; 4. Postural Responses; 5. Sensory Orientation; and 6. Stability in Gait.[8]

The BESTest was developed to aid physical therapists in the development of accurate treatment protocols for their patients. It has been vetted by a number of credible research studies to have excellent reliability and good validity.[3,21,24] The Mini-BESTest is a 14 item examination, which allows for a more convenient, time-efficient clinical use of the test. The Mini-BESTest has been found to have higher reliability and accuracy in the classification of balance deficits than other balance tests including the full version of the BESTest.[21,24] In addition to clinical use, the resources are made available to human movement researchers.[27]

Method:

Each RMSI session covered a scripted territory prescribed in Dr. Ida Rolf's basic 10 session series. The series distinctly follows a course of work, progressing from superficial to deep myofascial structures, and from the ground up over ten sessions. Each session lasted approximately one hour and fifteen minutes, and consisted of manual manipulation, and guided movement. The guided movement lasted up to 10 minutes of any session and was employed to reinforce the client's sense of how to use body segments to support her posture, and move efficiently. The first session began with the pre-intervention Mini-BESTest. Sessions 1 and 2 were conducted on Tuesday and Thursday of the first week, all other sessions were conducted once a week. There was a two-week break between sessions 8 and 9 due to scheduling issues. The final week consisted of the 10th and final session on a Tuesday, and the post-series Mini-BESTest was administered Thursday. The practitioner read verbatim from a test form script provided by the creator of the Mini-BESTest.[27] The Mini-BESTest was filmed and analyzed by the practitioner after the fact to ensure accuracy of scoring. No exercise homework was given between sessions.

Practitioner Information:

The practitioner received his basic training at the Rolf Institute of Structural Integration in 2006. He holds both a B.A. in Kinesiology completed in 1996 and an M.S. in Kinesiology completed in 2020. Previous to his Structural Integration training, the practitioner had been a Certified Massage Therapist since 1998.

Result:

There was a significant improvement in the Mini-BESTest test after the intervention. The total score improved by nine points, from 13 of 28 points to 22 of 28. The first of four subsections, anticipatory postural adjustments, increased by one point. Subsection, reactive postural control improved from 0/6 to 4/6, showing the subject was able to recover balance with fewer steps. The sensory orientation tests category improved 2 points from 4/6 to 6/6, and the dynamic gait subsection also improved 2 points from 6/10 to 8/10.

Discussion

The Mini-BESTest outcome provided detail about the degree that various biological systems were affected by the RMSI series. Though the subsections are the convergence of more than one aspect of balance, each of the four categories provides a particular focus.[3]

The first section measured the subject's ability to anticipate postural adjustments. This subscore increased the least post-intervention because the client was lacking the strength needed to accomplish the tasks of rising onto toes and standing on one leg.[3] Corrective exercise would improve performance of these tasks,[25] although home exercises were outside the scope of the RMSI intervention. The second section shed light on the subject's ability to recover equilibrium with a fast step in the direction required to bring her feet under her center of mass.[3] Improvements in these tasks signify an improvement in proprioceptive feedback and rapid motor response.[3] The third section, sensory orientation, tested the client's vestibular system as well as sensory integration when standing on varied surfaces with her eyes open and closed.[3] Again, there was an improvement in these tasks post-intervention, particularly in standing with feet together and eyes closed on a foam surface. The subject was unable to balance for more than one second before the RMSI series, and post-intervention was able to balance more than 30 seconds. This improvement is likely due in part to the emphasis the Rolf Method puts on improving the client's sense of herself in space. Calm awareness and confidence are brought to posture and movement during each session. The client is taught to appreciate and perceive the relationship between movement and posture and emotional states that support or detract from her balance and function. This enhancement in self-awareness in turn affects the frame of reference the vestibular system has for spatial orientation.[28] In the last subcategory, dynamic balance during gait, improvements were recorded in the walking over obstacle task and walking to a pivot turn task. There was no improvement in a task that required attention split between walking and a cognitive task, nor walking with a head turn. This subsection tested sensorimotor programs related to posture and gait as the client managed walking with various challenges.[3]

These improvements in score may be due to a recalibration of sensory organs found within the fascia. The nervous system receives the greatest amount of sensory information from myofascial tissue,[15] therefore manipulation of this tissue can alter sensory feedback. Histological findings have discovered contractile cells, free nerve endings, and mechanoreceptors within the fascia, most abundantly in the superficial fascia.[16,18,20] Aponeurotic fascia, such as the thoracolumbar fascia and fascia lata, function to transmit tension between adjacent joints, and between synergistic muscle groups, which creates an anatomical continuity.[18] Furthermore, these mechanoreceptors in these fascial sheets can perceive the stretch of underlying muscles via myotendinous junctions.[15,18] At a more local level, mechanoreceptors in epimysial fascia associate with individual muscle fibers are stimulated to correspond with the particular muscular contraction.[18,26] A distal muscle perceives the state of contraction of a proximal muscle through fascial connections. Furthermore, the transmission of stretched fascia can stimulate muscle spindle cells, thus influencing muscle contraction.[18] The neurological communication through connective tissue may be how a global approach to manual therapy such as RMSI could have significant effects.

These findings lend to the conception that the RMSI series may have removed distortions in the fascia, which had the effect of improving the communication between sensory organs in fascia and muscle and also force transmission through segments of the body. As a result, there may have been some improvement in the transmission of force through kinetic chains, proprioceptive feedback, spatial awareness, and neuromuscular coordination. This is what the fascial researcher Robert Schleip termed "sensory refinement".[15]

There is some research to corroborate the far-reaching role of fascia in muscle function, proprioception, and transmission of tension.[6,7,11,20] Most notably, a study of thirty-three healthy men recorded electrical and mechanical vibration response of muscles remote to a muscle being massaged. Electromyogram/mechanomyogram (EMG/MMG) hybrid probes detected signals from the middle deltoid and tensor fascia lata (TFL) before and after manual therapy to the brachioradialis and peroneal muscles, respectively. EMG amplitude increased in the TFL only, and MMG increased in TFL and deltoid[7] showing continuity between remote structures via fascia. Another study found proprioceptive acuity in the ankle joint measured by dual inclinometer was significantly greater in a massage-treated gastrocnemius with exercise-induced muscle damage as compared to a control.[17]

Client Perspective

Through the course of the series intervention, the client reported her surprise when she tripped over an obstacle in a parking lot and caught her balance. She experienced less knee pain going up and downstairs, particularly following the 5th session, which included the myofascial release of the quadriceps. She also was pleased with a newfound ability to sit cross-legged in the car, representative of improved hip and lower extremity flexibility gained during the RMSI series.

Limitations

The outcome measure of this study offers insights to help physical therapists treat patients with balance disorders, however, it does not preclude the need for further diagnosis to determine the most accurate cause of balance loss. The change in objective measure reported herein could be further analyzed by other tests to clarify the nature of the constraints of the subject. Secondly, the validity of the outcome measure could be strengthened by having a formally trained physical therapist administer the Mini-BESTest. Research has demonstrated that inexperienced raters, without physical therapy experience were able to learn and score the BESTest with good accuracy, however, a therapist with expertise in the nuances of testing may have provided more accuracy.[3] Last, each SI practitioner brings different levels of experience and education to the process, which could make the reproduction of the results difficult. Additionally, more research is needed to observe whether several subjects experience a similar level of improvement before broader conclusions can be drawn about the efficacy of RMSI as a therapy to prevent falls among elderly people.

Conclusion

This case report provided an evidence-based description of the RMSI on balance. The RMSI had a significant effect on the Mini-BESTest, a reliable and valid measure of system-specific balance deficits. [21] The results support research evidence that suggests skilled manual manipulation focused on the fascial system throughout the whole body can improve body alignment, proprioceptive function, and motor coordination. The Rolf Method intervention had a positive effect on each sub-section of the Mini-BESTest, though did not have an effect on strength deficits. Therefore, RMSI is most useful when considered as part of a broad approach to therapy in order to provide patients comprehensive and effective treatment for fall prevention.

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Attachments

MiniBESTest Table 1

MiniBESTest Items by Category			
	Pre-Rolf Series 9/28/2020	Post-Rolf Series 12/10/2020	
ANTICIPATORY	Subscore: 3/6	Subscore: 4/6	1 point increase
1. Sit to Stand	2=Normal	2=Normal	
2. Rise to Toes	0=Severe	1=Moderate	
3. Stand on 1 Leg	1=Moderate	1=Moderate	
REACTIVE POSTURAL CONTROL	Subscore: 0/6	Subscore: 4/6	4 point increase
4. Compensatory Stepping Correction - Forward	0=Severe	2=Normal	
5. Compensatory Stepping Correction - Backward	1=Moderate	1=Moderate	
6. Compensatory Stepping Correction - Lateral	1=Moderate	1=Moderate	
SENSORY ORIENTATION	Subscore: 4/6	Subscore: 6/6	2 point increase
7. Stance (feet together); Eyes Open, Firm Surface	2=Normal	2=Normal	
8. Stance (feet together); Eyes Closed, Foam Surface	0=Severe	2=Normal	
9. Incline - Eyes Closed	2=Normal	2=Normal	
DYNAMIC GAIT	Subscore: 6/10	Subscore: 8/10	2 point increase
10. Change in Gait Speed	2=Normal	2=Normal	
11. Walk with Head Turns - Horizontal	1=Moderate	1=Moderate	
12. Walk with Pivot Turns	1=Moderate	2=Normal	
13. Step Over Obstacles	1=Moderate	2=Normal	
14. Timed up & Go with Dual Task	1=Moderate	1=Moderate	
	TUG 13s. ; Dual Task TUG 16s.	TUG 11s. ; Dual Task TUG 15s.	
TOTAL SCORE	**13 of 28**	**22 of 28**	

Mini BESTest Score Table

ROLF METHOD INTERVENTION NARRATIVE

Sereis Session and Date of:	Session Objectives (Rolf Institue curriculum, 2006)	Clinical Findings	Movement Cues
9/28/2020 MiniBESTest & Rolf Session # 1	1.Horizontalize pelvis 2.Improve vital capacity 3. Vertically align body regions AIM: Lengthen front body KEY: Superficial fascia	Score: 13 points of 28 points -Apical breathing pattern -stands with ant. pelvic shift and -walks on outside of feet	"Fill sides of lower rib cage and belly with your breath."
10/1/2020 Rolf Session #2	1.Ground the system 2. Balance the foundation 3. Free fibula AIM: Lengthen the back KEY: Erector Spinae	Gait=glutius medius weakness & she avoids rolling through 1stMTP R>L to avoid crossover toe -Knee bend=quad dominance	Tripod of feet for support:1st &5th MTP's with heel. "Feel equal weight front back and sides and between feet"
10/6/2020 Rolf Session #3	1. Establish lateral midline 2. Integrate front and back 3. Free 12th rib AIM: Lengthen sides KEY: Quadratus Lumborum	Tissue around fibulas very congested, Tight QL and Serratus Posterior Superior	Standing sideways on slanted surface while reach through floor with foot and out of hip upwards.
10/13/2020 Rolf Session #4	1. Establish an internal line 2. Organize the pelvic floor 3. Awaken core AIM: Lenghten internal line KEY: Adductors	Gait seemed to have less opposite ilium from during mid stance	-Standing sideways on slant board, "reach big toe through floor to create lift through LE and hip"
10/20/2020 Rolf Session #5	1. Define functional relationship between abdominal wall and hip flexors AIM: Iliopsoas & Rectus Abdominis KEY: Rectus Abdominis	Posture=less craning of subocciptals -Able to breath diaphrgmatically when cued. -"My knees don't hurt going down the stairs."	1.Supine, hold lumbar and pelvis in neutral, let therapist move hip. 2.Hip hinge from stand to sit with dowel on back as reference for neutral spine position
10/27/2020 Rolf Session #6	1. Free the sacrum 2. Establish breathing pelvis	Supine Straight leg raise approx. 80 degrees hip flexion. Seated roll down=flatness at lumbodorsal region	"Walk heel to toe with weighted tailbone."
11/3/2020 Rolf Session #7	1. Create horizontal head 2. Establish breathing cranium 3.Put head on top of neck	"Tripped over curb last week & caught myself from falling." -Anterior head carriage	"Let eyes rest in sockets." "Tuck chin to lengthen back of neck." Standing shift pelvis back and forward, head stays in same place."
11/10/2020 Rolf Session #8 (Lower)	1. Organize horizontal hinges 2. integrate blocks 3. Create stable base.	"Can cross legs sitting in car." Still tends to thrust shoulders back and lift chest to stand tall.	1.Supine core bracing, while allowing therapist to move LE passively. 2.Contralateral movement in gait.
Rolf Session #9 (Upper)	1. Create lift from from above 2. Initiate appendicular movement from lumbodorsal hinge	She is able to differentiate shoulders from torso. Work to tissues of anterior neck and chest for head posture.	Seated neck rotation with axial elongation, progress to standing and walking
12/8/2020 Rolf Session #10	1. Horizontalize all hinges 2. Create functional whole 3. Provide dynamic stability 4. Encourage autonomy	Quads, psoas, adductors manipulation while client does standing knee bends to reinforce pelvic neutral.	Manual Perturbation to challenge standing posture, "Don't let me move you."
12/8/2020 MiniBESTest Test		Score: 22 points of 28 points	

Narrative Table Case Report