Journal of Bodywork & Movement Therapies 24 (2020) 82–87

Contents lists available at ScienceDirect

Journal of Bodywork & Movement Therapies

journal homepage: www.elsevier.com/jbmt

Original Research

Exploring treatment of medial tibial stress syndrome via posture and the MyoKinesthetic system

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ARTICLE INFO

Article history:
Received 1 June 2019
Accepted 2 June 2019

ABSTRACT

Introduction: A standard treatment protocol for medial tibial stress syndrome (MTSS) has not been identified. Clinical practice focuses on local evaluation and treatment neglecting a global approach. The MyoKinesthetic™ (MYK) System includes a full-body postural assessment to identify compensatory patterns that may lead to MTSS. The purpose of this study was to assess the effects of the MYK System in treating patients diagnosed with MTSS.
Method: A multi-site exploratory study was used to assess the effects of the MYK System on perceived pain and disability in patients diagnosed with MTSS. Eighteen physically active patients (6 female, 12 male), ages 18–25 years (19.89 ± 1.32) were treated with the MYK System.
Results: Paired T-tests were utilized to assess change. The change in patient reported pain was statistically significant ($t_{(17)} = 10.48$, $p < .001$, Cohen's $d = 2.48$) and represented an average decrease of 96% in patient reported pain. The change in disablement was statistically significant ($t_{(17)} = 7.39$, $p < .001$, Cohen's $d = 1.74$) and represented an average decrease of 88.2% in patient reported disablement.
Discussion: Participants treated with the MYK System experienced significant improvements and appear to surpass traditional interventions without the need of rest.
Conclusion: Implementation of the MYK System to treat MTSS led to significant decreases in patient reported pain and dysfunction. A full-scale clinical investigation of the MYK System is warranted to determine its effects compared to traditional treatment options.

1. Introduction

Medial Tibial Stress Syndrome (MTSS) is a common manifestation of leg pain, accounting for 5% of all injuries in the physically active, (Brewer and Gregory, 2012; Burrus et al., 2015) and between 16 and 50% in select populations (e.g., runners) (Craig, 2008; Yates and White, 2004). Originally, the theoretical etiology of MTSS was inflammation of the periosteum due to tension at the tibialis posterior causing tearing of the muscle fibers and/or periosteum at the muscle-bone interface (Beck and Ostering, 1994; Beck, 1998). The attachment of the tibialis posterior, however, does not appear to be medial enough to support this theory. Instead, researchers suggest the soleus is a more likely cause of inflammation due to its medial attachment (Burrus et al., 2015; Yates and White, 2004; Beck and Ostering, 1994; Gallo et al., 2012; Yuksel et al., 2011) An updated theoretical etiology of MTSS is that in the presence of excessive pronation, a facilitated soleus leads to muscular fatigue and can result in pain of the triceps surae group (Beck and Ostering, 1994; Beck, 1998; Gallo et al., 2012; Yuksel et al., 2011; Reinking et al., 2007; Bennett et al., 2001; Michael and Holder, 1985; Starkey and Brown, 2015).

Currently a consensus of effective treatment options for MTSS does not exist. Traditionally recommended treatments for MTSS include rest, ice, stretching, strengthening exercises, and orthotics, but none have been found to be effective as signs and symptoms typically return with the reintroduction of activity (Greibert, 2014; Moen et al., 2012A; Loudon and Dolphino, 2010). A potential factor in treatment ineffectiveness is a focus on the location of pain (Winters et al., 2014; Moen et al., 2012B; Cook, 2010). A suggested approach to treatment is to view the body as a whole, emphasizing

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https://doi.org/10.1016/j.jbmt.2019.06.004
1360-8592/

the need for a global assessment opposed to focusing on the local area of pain (Cook, 2010; Herzia, 1991; Horak, 1991).

The MyoKinesthetic™ System (MYK) is a global assessment and treatment model used to evaluate and treat postural imbalances to restore normal allostatic loads within the neuromuscular system (Brody et al., 2015A; Uriarte, 2010). The system includes a unique postural examination designed to detect compensations or dysfunctions within the nervous system that present as static postural abnormalities, which may result in pathology (Brody et al., 2015A). The clinician observes and performs the patient postural assessment in the standing, seated, and prone positions. Using the postural chart (Table 1) clinicians connect postural abnormalities to specific nerve root pathways; the pathway containing the highest number of imbalances is identified as the driver of pain and dysfunction. A dichotomous key is utilized if two or more nerve roots present with equal dysfunction. The clinician prescribes a treatment corresponding to the patient's classification determined by the postural assessment (Brody et al., 2015A; Uriarte, 2010).

MyoKinesthetic™ System treatments include active and passive movement by the patient, and simultaneous tactile stimulation by the clinician, of each muscle innervated by the nerve root that was identified as dysfunctional via the postural assessment. Tactile stimulation is performed with deep or soft pressure along the muscles of the nerve root and is dependent on the patient's pain tolerance. The repetitive active and passive movements allow the clinician to freely move from one body area to the next until all muscles along the nerve root myotome have been stimulated (Brody et al., 2015A). By stimulating all of the muscles innervated by a nerve root, clinicians activate mechanoreceptors along that specific pathway (Uriarte, 2010). The simultaneous movement and tactile feedback is used to stimulate several ascending sensory tracts and improve communication between the central nervous system (CNS) and the muscles innervated by the corresponding nerve root; spinothalamic tracts are stimulated by touch (Giesler et al., 1991) and spinocerebellar tracts are stimulated by movement (Bosco et al., 2006). Movement repetitions help stimulate mechanoreceptors by sending signals back to the CNS to re-establish allostatic communication (Brody et al., 2015A; Uriarte, 2010). As communication (i.e., efferent and afferent) normalizes, kinetic chain function is able to restore allostasis by eliminating compensatory patterns that may predispose the body to injury and pain (Uriarte, 2010). Treatments can be performed daily or by the specific guidelines within the MYK System.

Although MYK lacks substantial published evidence, the MYK System has been purported to be a useful treatment approach for various conditions. The two publications in existence to date introduce MYK as a manual therapy, provide an explanation of its theoretical framework (Brody et al., 2015A), and present a case study highlighting positive patient reported outcomes in patients with chronic back pain (Brody et al., 2015B). With the purported versatility of the MYK System (Brody et al., 2015B) a pilot study was undertaken with the purpose of assessing the effects of MYK as a treatment for MTSS.

The purpose of this multisite cohort pilot study was to assess the

Table 1
Posture chart.

HEAD			**LUMBAR SPINE**		
Extension	–	(C1–C3)	(L1-L5)	–	Flexed
Flexion	–	(Cl-T1)	(L1-L2)	–	Extended
Rotation	–	(Cl-T1)	(L1,L2)	–	Lateral Flexion
Lateral flexion	–	(Cl–Tl)	(L1-L5)	–	Rotation
SCAPULA			**HIP**		
Elevated	–	(C3,4)	(L5,S1)	–	Flexed/Ant rot
Depressed	–	(C3–C5)	(Ll,2,3,4,5)	–	Extended/Post
Protracted(AB)	–	(C3–C5)	(L2,L3)	–	Abducted/down
Retracted (ADD)	–	(C5–C8)	(L4,L5)	–	Adducted/upslip
Upward rotated	–	(C3–C8)	(L2,3,4,5,S1)	–	lateral Rotated
Downward rotated	–	(C3–C7)	(L5,S1)	–	Medial Rotated
SHOULDER			**KNEE**		
Flexed	–	(C5–C8)	(L3,L4)	–	Flexed
Extended	–	(C5–C8)	(SI)	–	Extended
Depressed(AB)	–	(C5–C8)	(L2,L3,S1)	–	Externally Rot
Elevated (ADD)	–	(C5–C6)	(SI)	–	Internally Rot
Medial rotated	–	(C5–C6)			
Lateral rotated	–	(C5–C8)			
ELBOW			**ANKLE**		
Flexed	–	(C7–C8)	(L4)	–	Planter Flexed
Extended	–	(C5–C7)	(S1,S2)	–	Dorsiflexed
			(L4)	–	Everted
FOREARM			(L4)	–	Pronated
Supinated	–	(C6-T1)	(L5,S1)	–	Inverted
Pronated	–	(C5–C6)	(LS,S1)	–	Supinated
WRIST			**BIG TOE**		
Flexed	–	(C6–C8)	(L5)	–	Flexion
Extended	–	(C6-T1)	(S1,S2)	–	Extension
Radial deviated	–	(C7–C8)	(S1,S2)	–	Abducted/varus
Ulnar deviated	–	(C6–C7)	(L5,S1)	–	Adducted/Valgus
THUMB			**TOES**		
Flexed	–	(C7-T1)	(L5)	–	Flexed
Extended	–	(C6-T1)	(S1,S2)	–	Extended
Abducted	–	(C8-T1)			
Adducted	–	(C6-T1)			
FINGER					
Flexed	–	(C6-T1)			
Extended	–	(C7-T1)			
Abducted	–	(C8-T1)			
Adducted		(C8-T1)			

effects of the MYK System in patients diagnosed with MTSS and determine if larger scale investigation is warranted. We hypothesized that patients diagnosed with MTSS would experience clinically and statistically significant improvement when treated with the MYK System.

2. Methods

2.1. Design

A multi-site exploratory study was conducted at two athletic training clinics in two states. Treatments were provided by four certified athletic trainers (2 male, 2 female) with a mean of 9.25 (±4.57) years of experience. All clinicians received 20 h of instruction by the creator of the MYK System, by means of a formal course that focused on assessing posture and selecting treatments using the MYK System. Each patient was assigned to a single clinician who collected all measurements and administered all treatments to maintain consistency.

2.2. Patients

Institutional Review Board approval was granted for the collection of data, IRB approval number 00000843. All participants completed an informed consent. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. All patients were physically active individuals participating in repetitive weight bearing activities (e.g., running) for a minimum of 30 min a day, three times a week. Patients meeting the diagnostic criteria for a minimum of three weeks for MTSS were included in the study: reported diffuse pain of 5 cm or more over the posteromedial tibia, reported a Numeric Pain Rating Scale (NPRS) of ≥2, and reported pain induced by exercise that lasted a few hours or days after exercise (Burrus et al., 2015; Yates and White, 2004; Reinking et al., 2007; Bennett et al., 2001; Moen et al., 2012A; Bartosik et al., 2010; Crabtree, 2009; Edwards et al., 2005; Hubbard et al., 2009; Mubarak et al., 1988; Pell et al., 2004; Pietrzak, 2014; Plisky et al., 2007; Reinking, 2007; Schulze et al., 2014). Patients being treated for other leg pathologies, or who presented with open skin lesions, paresthesia, cancer, or fracture over the posteromedial border of the tibia, were excluded. Eighteen patients (6 female, 12 male) between the ages of 18 and 25 (19.89 ± 1.32) years participated in the study.

2.3. Procedures

A standardized orthopedic examination was completed to determine diagnosis. Once diagnosed with MTSS, patients were assessed using the MYK postural analysis (Table 1). Postural analysis was used to identify primary nerve root dysfunction and establish MYK treatment parameters (i.e., nerve root) for each patient. Posture analysis was conducted prior to each treatment to identify any change between sessions. If a patient's postural exam changed, the clinician recorded the change and adjusted the treatment accordingly to the new nerve root treatment level within the MYK System. The primary outcome measures collected at intake, follow-up treatments, and at discharge were the NPRS and the Disablement in the Physically Active (DPA) scale.

The NPRS is a patient perceived rating scale from zero to ten, by which the patient represents his or her level of pain with a number. Zero indicates no pain while a ten represents the "worst pain imaginable," as perceived by the patient. A decrease of two points indicates a minimal clinically important difference (MCID) (Krebs et al., 2007). The NPRS was used to track changes of patient reported pain. Pre- and post-intervention NPRS scores were recorded in a weight bearing position, at each treatment through discharge.

The DPA scale was used as a patient reported outcome instrument to measure perceived disablement. The instrument consists of 16 questions measured on a 5-point Likert type scale with a focus on four constructs: impairment, functional limitation, disability, and quality of life (Vela and Denegar, 2010). The sum of the values from each question is calculated, and 16 is subtracted to determine the final score. The final score ranges from 0 (no disablement) to 64 (severe disablement). The minimal clinically important difference is nine points for acute injuries, and six points for persistent injuries (Vela and Denegar, 2010). The DPA scale was used to record changes in patient perceived disablement as measured by the theoretical constructs of impairment, functional limitation, disability, and quality of life at each visit from intake to discharge.

The MYK treatment was matched to each patient's postural assessment. Patients who presented with multiple primary nerve root dysfunctions, were assessed using the dichotomous key to determine one primary dysfunction. After determining the primary nerve root dysfunction, each treatment took approximately ten minutes to complete. Manual stimulation of each muscle innervated at the identified nerve root was applied bilaterally with alternating patterns of 4–10 passive movement (Fig. 1) repetitions immediately followed by 4–10 active repetitions (Fig. 2). Stimulation was applied during the passive and active muscle lengthening motions by using light or deep compressions, glides, or cross-friction (Brody et al 2015A, 2015B; Uriarte, 2010). Patients were asked to not curtail their regular physical activity. Patients were considered for discharge when the NPRS was reported ≤1 and DPA scale score was reported within normal standards for individuals returning to sports after injury (i.e., ≤23) for two consecutive treatment days (Krebs et al., 2007; Vela and Denegar, 2010).

Fig. 1. The starting (left) and ending (right) positions for MyoKinesthetic System passive treatment of the piriformis, one of the six external rotator muscles. The clinician provides tactile stimulation just inferior to the sacroiliac joint with the hip abducted 10° as the clinician passively rotates the hip in the medial direction.

Fig. 2. The starting (left) and ending (right) positions for MyoKinesthetic System active treatment of the gastroc-soleus muscles. The clinician provides tactile stimulation to the gastroc-soleus group as the patient actively dorsiflexes the ankle.

2.4. Statistical analysis

Data was reviewed and analyzed using International Business Machines' SPSS Statistical Software 23.0 (2015). Descriptive statistics were calculated on the full sample and by subgroup according to nerve root treatment level. Treatment level subgroups included S1, L4, L5, and those that changed nerve root level over the course of treatment. Paired sample T-Tests were used to determine if statistical change existed between initial and discharge NPRS and DPA scores for all patients treated. The alpha level was set at $p \leq .05$ and Cohen's d was calculated (X_D/S_D) to assess effect size (Cohen, 1988).

3. Results

Using the MYK postural assessment, 77.8% of patients (n = 14) were classified with an S1 nerve root dysfunction, 10.5% of patients (n = 2) had multiple nerve root dysfunctions, one patient was classified with L4 dysfunction, and one patient was classified with L5 dysfunction. Descriptive statistics of each subgroup, based on the nerve root pathways treated, is outlined in Table 2. All patients (N = 18) met discharge criteria after a mean of 8.06 (±7.66) treatments over 1.81 (±1.02) weeks. One patient received a total of 35 treatments before being discharged. The participant was identified as a statistical outlier (i.e., more than 3 standard deviations from the mean) and removed from the group analysis. When the outlying participant's data was removed, the mean number of treatments reduced to 6.47 (±3.78) over 1.67 (±0.86) weeks (Table 2).

At discharge, 83.3% (n = 15) of patients reported complete resolution of pain. A change was found between NPRS scores from initial intervention 5.50 (±2.31) to discharge 0.22 (±0.55) which was statistically significant ($t_{(17)} = 10.48$, $p < .001$, Cohen's d = 2.48). The change represented an average decrease of 96% in patient reported pain. The mean decrease in NPRS score was 5.28 (±2.14), 95% CI [4.22 to 6.34], which exceeds the MCID for the NPRS (Krebs et al., 2007).

The change in DPA scale scores from initial intervention, 21.72 (±10.94), to discharge, 2.56 (±4.26), was statistically significant ($t_{(17)} = 7.39$, $p < .001$, Cohen's d = 1.74). The change represented an average decrease of 88.2% in patient reported disablement. The mean decrease in DPA scale scores was 19.17 (±11.01) points, 95% CI [13.69 to 24.64], exceeding the MCID for the DPA scale (Vela and Denegar, 2010). Both NPRS and DPA scale Cohen's d values indicate a large effect size, as illustrated in Tables 3 and 4, respectively (Cohen, 1988).

3.1. Results by MYK sub-classification

Patients within the S1 group reported decreases in NPRS and DPA scale scores following treatment, 4.86 (±2.13) and 18.00 (±11.40) points respectively. Changes were observed over an average of six treatments across 1.46 (±0.72) weeks. The patient with L4 nerve root dysfunction reported a decrease in NPRS score of eight points, and a DPA score of 13 points, after 3 treatments over one week. The patient classified to the L5 treatment group reported a decrease in NPRS score of eight points, and a DPA score of 17 points, in six treatments over 2.14 weeks (Tables 2–4).

On average, the two patients requiring multiple nerve root treatments reported decreases in pain of 5.5 (±0.71) points on the NPRS and 31.5 (±2.12) points on the DPA scale. Changes were observed after an average of 23 treatments, over a mean of 3.57 (±0.81) weeks. During follow-up postural assessments, these patients presented with a change in primary dysfunction. The clinicians treated the new primary imbalances as they arose, aligning clinical judgment with the MYK guidelines of treating the primary postural nerve root dysfunction. Both patients began treatment with an S1 nerve root dysfunction. Postures were reassessed, and treatments were provided based on the new levels of dysfunction

Table 2
Descriptive statistics for initial and discharge results for pain and physical disablement.

	All Participants	w/o Outlier	S1 Group	L5 Group	L4 Group	Multiple
	(n = 18)	(n = 17)	(n = 14)	(n = 1)	(n = 1)	(n = 2)
	(F = 6, M = 12)	(F = 5, M = 12)	(F = 3, M = 11)	(F = 1, M = 0)	(F = 1, M = 0)	(F = 1, M = 1)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
# of Treatments	8.06 (±7.66)	6.47 (±3.78)	6.50 (±3.96)	6.00 (±0.00)	3.00 (±0.00)	23.00 (±18.39)
# of Weeks	1.81 (±1.02)	1.67 (±0.86)	1.59 (±0.85)	2.14 (±0.00)	1.00 (±0.00)	3.57 (±0.81)
Initial NPRS	5.50 (±2.31)	5.57 (±2.37)	5.07 (±2.40)	8.00 (±0.00)	8.00 (±0.00)	6.00 (±0.00)
Discharge NPRS	0.22 (±0.55)	0.24 (±0.56)	0.21 (±0.58)	0.00 (±0.00)	0.00 (±0.00)	0.50 (±0.71)
Initial DPAS	21.72 (±10.94)	21.24 (±11.07)	20.93 (±11.52)	17.00 (±0.00)	16.00 (±0.00)	32.50 (±3.54)
Discharge DPAS	2.56 (±4.26)	2.71 (±4.34)	2.93 (±4.75)	0.00 (±0.00)	3.0 (±0.0)	1.00 (±1.41)

Table 3
Paired Sample *t*-Test for NPRS: Initial to Discharge.

	Paired Differences					t	df	Sig. (2-tailed)	Cohen's d
	Mean	SD	SEM	95% CI					
				Lower	Upper				
All Participants	5.28	2.14	0.50	4.22	6.34	10.48	17	<0.001	2.48
S1 Group	4.86	2.14	0.57	3.62	6.09	8.48	13	<0.001	2.27

Table 4
Paired Sample *t*-Test for DPAS: Initial to Discharge.

	Paired Differences					t	df	Sig. (2-tailed)	Cohen's d
	Mean	SD	SEM	95% CI					
				Lower	Upper				
All Participants	19.17	11.01	2.59	13.69	24.64	7.39	17	<0.001	1.74
S1 Group	18.00	11.40	3.05	11.42	24.58	5.91	13	<0.001	1.63

(e.g. S2, C5, L4). Symptoms were resolved after treating other nerve roots and eventually returning to S1 treatments.

4. Discussion

Participants experienced clinically and statistically significant improvements in self-reported pain and disability, and all participants met discharge criteria. Participants treated with MYK reported significant changes in NPRS and DPA scale scores and were discharged after an average of two weeks, as outlined in Table 2. The results of MYK treatments appear to outperform traditional interventions without the need of rest (Griebert et al., 2014; Loudon and Dolphino, 2010; Winters et al., 2014; Moen et al., 2012B; Smith, 1986) Galbraith suggested 2–6 weeks of rest with cessation or scaling of aggravating activities with a gradual pain free return to play (Galbraith and Lavallee, 2009) which could take up to 100 days (Moen et al., 2012B; Rompe et al., 2009). No other single treatment or combination of interventions has been shown to eliminate pain while allowing the patient to continue activities and report full recovery.

After completing an initial postural assessment, 77.8% of patients had a S1 nerve root dysfunction, two with a L4 nerve root dysfunction, and one with a L5 nerve root dysfunction. As the soleus has attachments on the posteromedial tibia and is innervated by the S1 nerve root (Gallo et al., 2012; Yuksel et al., 2007), it is theoretically plausible for participants to present with dysfunction at this level. Patients presenting with multiple nerve root dysfunctions may require some dysfunctions to clear before others can be addressed. Further research is necessary to identify any relationship existing between the posture examination and specific pathology, but categorization of patients via the postural examination in this study seems to suggest a relationship between MTSS etiology and the S1 postural nerve root identification.

One of the two participants treated at multiple nerve roots received 35 treatments over four weeks, vastly different from the rest of the participants when compared to the average treatments to discharge of 4.83 (±2.36) over 1.63 (±0.85) weeks. The participant was identified as a statistical outlier (i.e., more than 3 standard deviations from the mean) and removed from the *t*-test analysis. The patient's postural analysis initially revealed S1 dysfunction, but changed to an L4 dysfunction on the 4th visit, and returned to S1 at the 8th visit. During the first 8 visits the patient's DPA scale scores initially dropped by a MCID, but then plateaued. It wasn't until the postural assessment and treatment returned to the S1 root that the patient's DPA scale scores began to show clinically meaningful change again, and ultimately resolved to zero. This patient's nerve root dysfunction may have been driven by an imbalance other than S1, which needed to normalize before the S1 nerve root pathway could be stabilized.

4.1. Limitations

The primary limitations of the study included the lack of a comparison or control group, lack of a long-term follow-up, not establishing intra-rater reliability for the MYK postural assessment, and a relatively small sample size that makes generalization difficult. The observed treatment effects are likely attributed to the intervention, but patients and researchers were not blinded and may have factored bias into the results. Although all clinicians were novice practitioners using the MYK system, Brody discovered that the level of experience (i.e., expert or novice) did not influence the outcome of the postural assessment and that the novice clinician achieved high levels of reliability when compared with the expert (Brody, 2015).

We also find the decision to allow patients to continue activity during treatment to be a limitation from the perspective of data analysis, as it likely limited the strength of our results. One patient, for example, temporarily digressed after sustaining a direct blow to the tibia during activity. The patient continued to respond to treatments and reported complete elimination of pain after each subsequent session. Even with the setback, the patient experienced full resolution of symptoms after two weeks of treatment, still much faster than traditional treatment options (Galbraith and Lavallee, 2009; Rompe et al., 2009; Smith et al., 1986). The promising results, despite unlimited patient activity level, illustrate the clinical strengths and robust nature of the technique.

Our goal in conducting this original research study was to assess the effectiveness of MYK in treating pain and dysfunction in patients diagnosed with MTSS, and to determine if a full-scale clinical investigation is warranted to explore the effects of MYK. Based on the results of this study further examination of the MYK System by comparing it to a sham treatment, other treatment paradigms, or a control group is warranted. Our recommendation for future studies is to establish parameters for treatment protocols, standardizing the amount of treatments to be performed in one session. We also recommend exploring the effects of the MYK System across other patient demographics.

5. Conclusion

Medial tibial stress syndrome is a common condition with an unclear origin. Standardized treatment protocols and treatment recommendations have not been well established, and the evidence for conservative treatments is limited and inconclusive. The MYK System is a global method of examination and treatment that includes a static postural assessment to classifying the body's primary dysfunctions (Brody et al., 2015A). By utilizing a global approach and addressing many potential contributing factors for MTSS (e.g., peripheral neuropathy, motor control dysfunction, etc.) with a single treatment paradigm, we may be able to provide a plausible and realistic option for a standardized treatment protocol. Based on our findings we conclude that the effects of the MYK System warrant a more comprehensive research study to explore MYK being included in a standardized treatment protocol for the care of patients with MTSS.

6. Clinical relevance

- Global approach to treat cause not the symptoms
- Accelerated treatment sessions
- Patients do not have to curtail activity
- Standardized treatment protocol

Conflicts of interest

The authors declare no conflict of interest.

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