

# Effect of Taping of Thoracic and Abdominal Muscles on Pelvic Alignment and Forward Reach Distance Among Stroke Subjects: A Randomized Controlled Trial

Annals of Neurosciences  
26(3–4) 10–16, 2019  
© 2020 Indian Academy of Neurosciences  
Reprints and permissions:  
in.sagepub.com/journals-permissions-india  
DOI: 10.1177/0972753119887321  
journals.sagepub.com/home/aon



Megha Mehta<sup>1</sup>, Abraham M. Joshua<sup>2</sup>, Suruliraj Karthikbabu<sup>3</sup>, Zulkifli Misri<sup>4</sup>, Bhaskaran Unnikrishnan<sup>5</sup>, Prasanna Mithra<sup>5</sup>, and Akshatha Nayak<sup>2</sup>

## Abstract

**Introduction:** The objective of this study was to find the immediate as well as short-term effect on pelvic alignment and forward arm reach distance in sitting among stroke patients following thoracic spine and abdominal muscles taping along with conventional therapy.

**Methods:** Thirty subjects with stroke attending the physiotherapy programme at Department of Physiotherapy at a tertiary care hospital underwent this randomized controlled experimental study. Subjects in the experimental group received taping, along with conventional physiotherapy treatment, for restricting thoracic kyphosis and facilitating abdominal muscles. Subjects in the control group received only conventional physiotherapy treatment. To assess the change in pelvic alignment and forward arm reach distance while sitting, Palpation Meter™ (PALM™) and sit and reach test were used, respectively.

**Results:** In the experimental group, pelvic obliquity was corrected ( $4.1 \pm 0.94$ ) and anterior pelvic tilt revealed improvement ( $4.9 \pm 2.1$ ,  $p$  value  $< 0.001$ ). In the control group, no improvement in pelvic alignment was recorded. Improvement in forward arm reach distance was similar in both groups ( $p$  value = 0.804).

**Conclusion:** Taping as an adjunctive treatment method to physiotherapy can cause immediate as well as short-term improvement of pelvic alignment in sitting, following stroke. It also, immediately improves the sit and reach distance in the same population.

## Keywords

Stroke, taping, pelvic alignment, trunk muscles

## Introduction

Stroke, one of the major causes of disability, results in sensory and motor impairment which influences postural control, balance and postural symmetry.<sup>1,2</sup> Stroke survivors often adapt compensatory strategies to maintain balance which leads to poor sitting ability.<sup>3,4</sup> Sitting, being a skill that is critical to independent living, is one of the useful prognostic indicators of functional outcome for stroke population. Re-establishment of control in sitting for function is an important early goal in stroke rehabilitation.<sup>5</sup>

In sitting, postural control depends on trunk alignment,<sup>6</sup> particularly the position of pelvis.<sup>7,8</sup> Due to disturbed postural symmetry, stroke subjects sit with flexed thoracic spine and often show lateropulsion, characterized by elevation of pelvis on the unaffected side, lateropulsion probably results from compensation of weak bilateral trunk lateral flexors and rotators.<sup>7,9</sup> Postural asymmetry following stroke may limit

the ability to independently perform reach-out activities.<sup>3</sup> Earlier literatures<sup>10–12</sup> have used Palpation Meter (PALM™) and sit and reach test (SRT)<sup>13</sup> to objectively assess the pelvic asymmetry and forward reaching distance, respectively.

<sup>1</sup> College of Physiotherapy, Sumandeep Vidyapeeth an Institution Deemed to be University, Piparia, Gujarat, India.

<sup>2</sup> Department of Physiotherapy, Kasturba Medical College, Mangalore; Manipal Academy of Higher Education, Manipal, India.

<sup>3</sup> Department of Physiotherapy, Manipal College of Health Professions, Manipal Hospital, Bangalore; Manipal Academy of Higher Education, Manipal, India.

<sup>4</sup> Department of Neurology, Kasturba Medical College, Mangalore; Manipal Academy of Higher Education, Manipal, India.

<sup>5</sup> Department of Community Medicine, Kasturba Medical College, Mangalore; Manipal Academy of Higher Education, Manipal, India.

## Corresponding author:

Abraham M. Joshua, Department of Physiotherapy Kasturba Medical College, Mangalore 575001, Manipal Academy of Higher Education, Manipal, India.  
E-mail: abraham.joshua@manipal.edu



Considerable amount of work has been done in training the postural symmetry for stroke subjects, in standing and gait using treatment techniques including Bobath's, motor learning, task-related training and feedback approach.<sup>3,4,14</sup> Among chronic stroke subjects, during ambulation, for immediate correction of postural asymmetry, taping has been used. Hypoallergic sports tape helps to align the joint and enhance muscle retraining by balancing the tissue length–tension relationship, thus assisting neuromuscular control and postural re-education. Taping may also improve joint proprioception and effective loading of the affected extremity and may minimize thoracic kyphosis and facilitate abdominal muscles.<sup>15–17</sup> Studies related to immediate and short-term effect of taping on pelvic alignment and forward arm reach distance among stroke subjects are limited. The purpose of this study was to find the immediate and the short-term (three-day) effect of taping thoracic spine and abdominal muscles to improve pelvic alignment and forward arm reach distance in sitting.

## Methods

### Design

Following approval from the Institutional Ethics Committee (IEC), Kasturba Medical College, Mangalore, Karnataka, India, a pilot study was performed on five stroke subjects to calculate the sample size, feasibility and flaws in the methodology. During the study period (March 2011–February 2012), informed consent was obtained from each subject referred by the neurologists. A total of 41 interested stroke participants (excluding the five stroke subjects who participated for the pilot study) were screened for the inclusion and exclusion criteria and 30 subjects who met the inclusion criteria were enrolled for this study. Eligible subjects were assigned to the study groups by block randomization. Block size of 6 was used in the trial to allocate the participants to two study groups; each block consisted of three experimental and three control interventions. The allocation concealment was done using sealed opaque envelopes which were sequentially arranged. Post allocation of subjects into experimental ( $n = 15$ ) and control ( $n = 15$ ) groups, baseline data and demographic data of the eligible participants were taken. Both the groups received three days of conventional physiotherapy and the experimental group received taping as an adjunct. The outcomes were assessed by a blinded independent assessor at three levels. Level 1 (baseline data) was one day before the commencement of the treatment session, level 2 was immediately after the first treatment session and level 3 was immediately at the end of the third treatment session.

### Participants, Therapists, Centres

The study was conducted at the Department of Physiotherapy, in the study institute. Following screening for the inclusion and exclusion criteria, 24 hours before the commencement of the study, patch tests were performed to check whether eligible participants were allergic to tape.

### Inclusion criteria

1. First episode of unilateral supratentorial stroke diagnosed by the neurologist
2. Sitting unsupported on a stable surface for more than 1 minute
3. MMSE score of  $\geq 23$ .

### Exclusion criteria

1. Any known disease other than stroke that could influence the sitting balance
2. Pusher syndrome or other perceptual deficits
3. Loss of skin integrity or hypersensitive skin in the part where taping needs to be applied.

Both the principle investigator and the independent blinded observer were qualified physiotherapists of the Department of Physiotherapy.

### Intervention

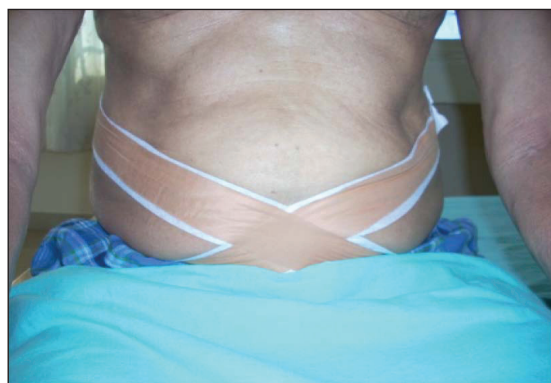
Both groups received conventional physiotherapy focussing on the length of muscle, normalization of tone, motor control improvement, strengthening for hemiplegic side extremities and trunk, and balance training. Each treatment session lasted for approximately an hour. The distribution of time spent and the number of repetitions given for each component of conventional therapy was uniform for all the participants.

The experimental group received taping along with conventional physiotherapy. The skin area where taping was applied was cleaned with medical spirit. Prior to the application of the tape, to remove skin hair, the area was shaved. For providing and maintaining proper alignment, first Fixomull® (BSN Medical, Hamburg, Deutschland) stretch tape, which is an underwrap to avoid skin damage, was applied prior to the application of a 2 inch width rigid Leukotape® (BSN Medical, Hamburg, Deutschland). Based on the previous literature,<sup>17,18</sup> to restrict and correct the thoracic kyphosis, each participant was made to sit with erect spine with or without assistance and tapes were applied diagonally across the upper back starting from the anterior aspect of shoulder towards inferio-medial aspect of the scapula. Similarly, to facilitate the oblique muscles on either side, each of the participants was positioned supine with hips flexed to approximately 45° to place the pelvis in neutral position and shoulders flexed over head to elongate the trunk musculature. The length of the tapes were measured from participants' anterior superior iliac spine (ASIS) to the opposite 10th rib, following which the tapes were anchored at the ASIS and applied towards the participants' 10th rib stretching across the umbilicus. Figures 1 and 2 depict the post-application appearance of tapes for restricting thoracic kyphosis and facilitation of abdominal muscles, respectively. All the participants were able to tolerate the taping protocol until it was removed on the third day following the completion of the trial. The flowchart of the study is given in Figure 3.



**Figure 1.** Taping for Restricting Thoracic Kyphosis

**Source:** The authors.



**Figure 2.** Taping for Facilitating Abdominal Muscles

**Source:** The authors.

### Outcome Measures

To evaluate the pelvic alignment and forward arm reach distance, the PALM™ and SRT were used respectively. For pelvic alignment, each participant was made to sit on a plinth with no back support, with thighs fully supported on plinth, hips, knees and ankles at 90° of flexion, and feet positioned flat on the floor in the same line with the knees. Commands like 'sit as tall as possible' or 'sit tall' were given after positioning. Pelvic obliquity was measured in the frontal plane and the anterior pelvic tilt was measured in the sagittal plane. Pelvic obliquity was measured in degrees, with the lever arms of the PALM™ placed on the left and right ASIS (Figure 4). The direction of obliquity (i.e., the left or right side lower) was noted based on the earlier literature.<sup>10</sup> Anterior pelvic tilt on the hemiparetic side was measured with the lever arms of the

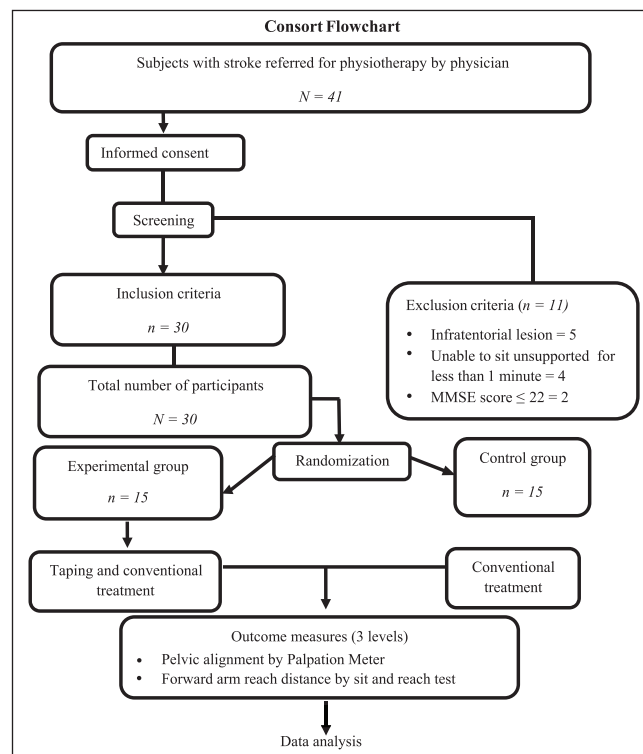
PALM™ placed on the ASIS and posterior superior iliac spine (PSIS) of the hemiparetic side (Figure 5). Three test trials of pelvic obliquity and anterior pelvic tilt were performed, and the mean reading was used for analysis. Standard procedure was used for measuring the forward arm reach distance using SRT.<sup>13</sup>

### Data Analysis

The collected data were analysed using IBM SPSS for Windows, Version 25.0 (IBM Corp, Armonk, NY). Normality of the outcome measures was statistically verified using the Kolmogorov–Smirnov Z test. For between group comparison, Student's *t* test was used. For within group comparison, paired *t* test was used. Chi square test was used for descriptive statistics. A *p* value of less than 0.05 was considered as statistically significant.

### Result

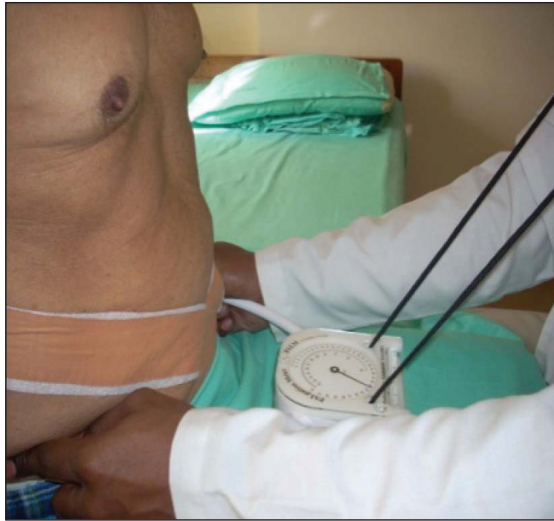
Baseline characteristics of experimental and control groups are depicted in Table 1. Except the duration since stroke ( $p = 0.02$ ), all the variables were similar between the groups. In order to find the immediate effect of taping, level 1 and level 2 data within the experimental group were compared and to find the short-term effect, level 1 and level 3 data for either group were compared.



**Figure 3.** Flowchart of Participant Enrollment and Analysis

**Source:** Consolidated Standards of Reporting Trials (CONSORT) diagram adapted to the current study.





**Figure 4.** Assessing Pelvic Obliquity with Palpation Meter (PALM™)

**Source:** The authors.



**Figure 5.** Assessing Anterior Pelvic Tilt on the Hemiplegic Side with Palpation Meter (PALM™)

**Source:** The authors.

**Table 1.** Demographic Data

Demographic Data		Experimental Group (n = 15)	Controls Group (n = 15)	P Value
<b>Age mean (SD) years</b>		60 (8.6)	62 (5.6)	0.57
<b>Gender</b>	<b>Male, n (%)</b>	10 (67)	11 (73)	0.69
	<b>Female, n (%)</b>	5 (33)	4 (27)	
<b>Duration since stroke mean (SD) days</b>		47 (58)	16 (2.9)	0.02*
<b>Affected side</b>	<b>Right, n (%)</b>	10 (67)	8 (53)	0.36
	<b>Left, n (%)</b>	5 (33)	7 (47)	

**Source:** The authors.

**Abbreviation:** SD, standard deviation.

**Notes:** \* significant; n, number of participants.

## Pelvic Alignment

Taping had shown statistically significant improvement in pelvic obliquity and anterior pelvic tilt in the experimental group. As shown in Table 2, pelvic obliquity improved and reached closer towards neutral and anterior pelvic tilt improved by 4.5°.

There was significant short-term improvement in the pelvic alignment within the experimental group. Pelvic obliquity improved towards neutral and anterior pelvic tilt improved by 4.9°. On the contrary, within the control group, pelvic obliquity remained the same and anterior pelvic tilt increased marginally to 0.07° which was statistically not significant (Table 3).

## Forward Arm Reach Distance

Forward arm reach distance improved immediately in the experimental group by 3 cm with a *p* value of 0.016 (Table 2). With respect to the short-term effects of taping, both the groups showed significant improvement in forward arm reach distance. However, visual inspection of the data reveals that the experimental group had a better improvement when compared to the control group (Table 4).

**Table 2.** Immediate Effect of Taping on Pelvic Alignment and Forward Arm Reach Distance in the Experimental Group

Variables	Baseline Mean (SD)	IET Mean (SD)	P Value
<b>Pelvic obliquity</b>	4.4° (0.75)	0.27° (0.80)	< 0.001*
<b>Anterior pelvic tilt</b>	2.3° (2.4)	6.8° (1.64)	< 0.001*
<b>Forward arm reach distance (cm)</b>	32 (7.8)	35 (4.9)	0.016*

**Source:** The authors.

**Abbreviations:** IET, immediate effect of taping; SD, standard deviation; cm, centimetres.

**Note:** \* significant.

**Table 3.** Short-term Effect of Taping on Pelvic Alignment in Experimental and Control Group

Group	Pelvic Obliquity			Anterior Pelvic Tilt		
	Base-line Mean (SD)	SET Mean (SD)	P Value	Base-line Mean (SD)	SET Mean (SD)	P Value
<b>Experimental (n = 15)</b>	4.4° (0.75)	0.27° (0.79)	<0.001*	2.3° (2.4)	7.2° (1.9)	<0.001*
<b>Control (n = 15)</b>	3.5° (1.1)	3.5° (1.1)	0.334	2.2° (1.7)	2.2° (1.8)	0.334

**Source:** The authors.

**Abbreviation:** SET, short-term effect.

**Notes:** \* significant; n, number of participants.

**Table 4.** Short-term Effect of Taping on Forward Arm Reach Distance in Experimental and Control Group

Group	Forward Arm Reach Distance (cm)		P Value
	Baseline Mean (SD)	SET Mean (SD)	
Experimental (n = 15)	32 (7.8)	37 (6.2)	0.009*
Control (n = 15)	27 (4.8)	31 (4.4)	0.006*

**Source:** The authors.

**Abbreviations:** cm, centimetre; SD, standard deviation; SET, short-term effect of taping.

**Notes:** \*, significant; n, number of participants.

**Table 5.** Change Scores of Pelvic Alignment and Forward Arm Reach Distance in Experimental and Control Group

Change Scores	Experimental (n = 15)	Controls (n = 15)	P Value
Pelvic obliquity mean (SD)	4.1° (0.94)	0.00	<0.001*
Anterior pelvic tilt mean (SD)	4.9° (2.1)	0.06° (0.26)	<0.001*
Forward arm reach distance (cm) mean (SD)	4.5 (5.4)	4.0 (4.8)	0.804

**Source:** The authors.

**Abbreviations:** SD, standard deviation; cm, centimetre.

**Notes:** \*, significant; n, number of participants.

Table 5 depicts the change scores (pre to post intervention difference) of pelvic alignments and forward arm reach distance across the experimental and the control groups. Except for the forward arm reach distance, the experimental group showed statistically significant improvement in postural alignment when compared to the control group.

## Discussion

To the best of our knowledge, this is a preliminary study to examine the immediate and the short-term effect of taping as an adjunct to conventional physiotherapy in improvising sitting postural control. In this study, we assumed that taping of the thoracic spine and abdominal muscles may improve the pelvic alignment and forward reach among stroke patients.

Descriptive statistics of demographic data revealed significant difference in post-stroke duration in experimental and control groups (Table 1). Inclusion of three participants with post-stroke duration of more than three months under the experimental group made the post-stroke data skewed; otherwise, all the rest of the parameters were comparable between the groups.

Thirteen out of fifteen participants in the experimental group were able to achieve neutral horizontal alignment. Remaining two subjects achieved near-neutral alignment.

In addition to the above, the participants also exhibited increased anterior pelvic tilt. Furthermore, this improvement was maintained for three days. Present study findings reveal that the improvement in pelvic alignment could be the result of taping, as conventional treatment was common for both the experimental and the control groups.

Efficient stabilization of spine required for the static and dynamic normal posture is produced by the passive osteoligamentous system, active musculotendinous system and neural control system.<sup>19</sup> In stroke, impairment of the latter two systems leads to altered alignment and disturbed postural symmetry.<sup>20</sup> The results of this study suggest that taping may have improved the active musculotendinous and the neural control component of the stabilizing system of the spine leading to improvement in the pelvic alignment, that is, taping prevented thoracic kyphosis by positioning the pelvis in neutral, thus, promoting better recruitment of obliques. The current findings are reinforced by earlier works of Maguire et al and Kilbreath et al.<sup>15,16</sup>

Hemiparesis results in pronounced weakness of the affected side trunk muscles,<sup>21</sup> with more weight bearing on the unaffected side, elevation of pelvis on the affected side and with impaired sitting balance.<sup>9,22</sup> Though the forward reach in sitting improved in either group, visual inspection of change scores (4.5 cm for experimental group and 4.0 cm for control group) reveals a better result for the experimental group, indicating that the improvement could have been the result of improved postural symmetry and enhanced recruitment of trunk muscles.

Repeated practice might have improved perceptual processes involved in coordinated movement and execution of task<sup>23</sup> and the same would have been responsible for improvement in the forward reach for either group. Besides, subjects in both the groups had relatively normal balance at the beginning of the study as represented by their baseline value for forward arm reach distance, resulting in an almost parallel improvement in sitting balance.

The current study had paid attention to check the immediate and short-term effect of taping on postural control, and not the carry-over or long-term effect of taping. Care is to be taken while generalizing the effect as the current study used a smaller sample size. Future studies are required to see the effect of taping on other functional activities. Incorporation of objective outcome measures for quantitative analysis of the improvement, such as kinematic analysis of reaching and forced platform analysis of postural symmetry in sitting, may provide additional information including true motor improvement and the plausible compensations.

## Conclusion

The result of this study indicates that taping as a treatment adjunct can result in immediate as well as short-term improvement of pelvic alignment while sitting. It may also

result in immediate improvement of sitting balance among stroke patients and may prevent adverse effect of postural asymmetry in sitting following stroke.

### Acknowledgements

We would like to thank Manipal Academy of Higher Education, Manipal, India, and all the participants of the study for all the support.

### Author Contributions

Megha Mehta was the principal investigator for this study. Conceptualization of the study was by Abraham M. Joshua. Supervision of the trial and data collection was done by Suruliraj Karthikbabu. The study was designed and the data analysis was executed by Bhaskaran Unnikrishnan and Prasanna Mithra. Zulkifli K Misri and Akshatha Nayak provided critical inputs and aided with data management. Authors of this study had equally contributed in preparation and editing of this manuscript.

### Ethical Statement

The Institutional Ethical Committee (IEC), Kasturba Medical College, Mangalore, Karnataka, India, approved this study. All participants gave written informed consent before data collection began.

### Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

### Funding

The authors disclosed receipt of the following financial support for the research, authorship and/or publication of this article: The study was partially funded by, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India.

### References

- Chern J, Lo C, Wu C, et al. Dynamic postural control during trunk bending and reaching in healthy adults and stroke patients. *Am J Phys Med Rehabil* 2010; 89: 186–197.
- Karatas M, Cetin N, Bayramoglu M, et al. Trunk muscle strength in relation to balance and functional disability in unihemispheric stroke patients. *Am J Phys Med Rehabil* 2004; 83: 81–87.
- Mudie MH, Winzeler-Mercay U, Radwan S, et al. Training symmetry of weight distribution after stroke: A randomized controlled pilot study comparing task-related reach, Bobath and feedback training approaches. *Clin Rehabil* 2002; 16: 582–592.
- Pellegrino L, Giannoni P, Marinelli L, et al. Effects of continuous visual feedback during sitting balance training in chronic stroke survivors. *J Neuroeng Rehabil* 2017; 14: 107–120.
- Dean CM, Channon EF and Hall JM. Sitting training early after stroke improves sitting ability and quality and carries over to standing up but not to Walking: A randomised controlled trial. *Aus J Physiother* 2007; 53: 97–102.
- Genthon N, Vuillerme N, Monnet JP, et al. Biomechanical assessment of the sitting posture maintenance in patients with stroke. *Clin Biomech* 2007; 22: 1024–1029.
- Zakaria Y, Rashad U and Mohammed R. Assessment of malalignment of trunk and pelvis in stroke patients. *Egypt J Neurol Psychiat Neurosurg* 2010; 47: 599–604.
- Nichols DS, Miller L, Colby LA, et al. Sitting balance: Its relation to function in individual with hemiparesis. *Arch Phys Med Rehabil* 1996; 77: 865–869.
- Karthikbabu S, Chakrapani M, Ganesan S, et al. Relationship between pelvic alignment and weight-bearing asymmetry in community-dwelling chronic stroke survivors. *J Neurosci Rural Prac* 2016; 7: S37–S40.
- Axelsson P, Axelsson DY, Hayes A, et al. *Hip grip pelvic stabilization device for wheelchair users phase II final report*. Minden, NV: Beneficial Designs Inc, 2004.
- Petrone MR, Guinn J, Reddin A, et al. The accuracy of the palpation meter (PALM) for measuring pelvic crest height difference and leg length discrepancy. *J Orthop Sports Phys Ther* 2003; 33(6): 319–325.
- Naval D, Syed N and Karthikbabu S. Intra-rater and inter-rater reliability of measuring pelvic tilt using the palpation meter (PALM™) device in stroke. *Int J Med Health Sci* 2016; 5(4): 276–280.
- Tsang YL and Mak MK. Sit-and-reach test can predict mobility of patients recovering from acute stroke. *Arch Phys Med Rehabil* 2004; 85: 94–98.
- Vasileva D, Lubenova D and Mihova M. Postural control and balance reactions in patients with ischemic stroke in the chronic period. *Sport, Stress, Adaptation—Scientific Journal* 2014; Extra issue: 648–652.
- Maguire C, Sieben JM, Frank M, et al. Hip abductor control in walking following stroke—the immediate effect of canes, taping and theratogs on gait. *Clin Rehabil* 2010; 24: 37–45.
- Kilbreath SL, Perkins S, Crosbie J, et al. Gluteal taping improves hip extension during stance phase of walking following stroke. *Aus J Physiother* 2006; 52: 53–56.
- Cepeda JP, Fishweicher A, Gleeson M, et al. Does Kinesio taping of the abdominal muscles improve the supine-to-sit transition in children with hypotonia? <http://www.kinesiotaping.com> (8 December 2010).
- Boyling JD and Jull GA, eds. *Grieve's modern manual therapy the vertebral column*. Edinburgh: Churchill Livingstone, 2004.

19. Biely S, Smith SS and Silfies SP. Clinical instability of the lumbar spine: Diagnosis and intervention. *Ortho Phys Ther Pract* 2006; 8(3): 11–18.
20. Tasseel-Ponche S, Yelnik AP and Bonan IV. Motor strategies of postural control after hemispheric stroke. *Neurophysiol Clin* 2015; 45(4–5): 327–333.
21. Bohannon R. Recovery and correlates of trunk muscle strength after stroke. *Int J Rehabil Res* 1995; 18: 162–167.
22. Sharma V and Kaur J. Effect of core strengthening with pelvic proprioceptive neuromuscular facilitation on trunk, balance, gait, and function in chronic stroke. *J Exerc Rehabil* 2017; 13: 200–205.
23. Muratori LM, Lamberg EM, Quinn L, et al. Applying principles of motor learning and control to upper extremity rehabilitation. *J Hand Ther* 2013; 26: 94–103.