CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

In elderly patients 1-2 weeks post-stroke with pusher syndrome, is visual feedback therapy more effective than body weight supported ambulation in reducing pushing through the uninvolved side?

AUTHOR

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CLINICAL SCENARIO

The setting of inpatient rehabilitation provides physical therapists with the challenge of treating patients with pusher syndrome post-stroke, which occurs in approximately 10% of the stroke population.[1] It is essential to treat pushing behaviour itself prior to progressing to more advanced functional skills.[1] In inpatient rehab, one 66-year-old male presented with severe pusher syndrome 1 week following a stroke. In therapy, he had difficulty transitioning from sitting balance to standing balance due to the patient's heavy push through his uninvolved right lower extremity. The use of visual feedback therapy is a common intervention used for patients with pusher syndrome post-stroke. Despite use of visual feedback therapy, some patients may continue to require max to total assist to stand. It is important to identify alterative treatment strategies that can be used instead of or in conjunction with visual feedback in order to minimize pusher syndrome recovery time and progress to advanced functional training. One potential intervention to explore for this patient population is the use of body weight supported (BWS) ambulation in an effort to reorient the patient's vertical alignment, encourage symmetrical weight bearing, and reducing pushing behaviour. If BWS ambulation is proven to be effective in reducing pushing behaviour and improving motor control, it is important to integrate this intervention for patients with pusher syndrome so that they will regain equilibrium and progress in balance activities more quickly.

SUMMARY OF SEARCH

- Ten studies were retrieved from three databases that met the inclusion/exclusion criteria. The articles included 4 randomized controlled trials (RCT) or pilot RCTs, 1 randomized cross-over study, 1 case series, 1 case control study, 1 case report, and 2 cohort or prospective cohort studies. Three studies were selected for thorough analysis. Given the limited quantity of evidence available for pusher syndrome, the search was expanded to include the general stroke population.

- Evidence from the three studies selected for thorough analysis indicates that:
    - The use of mirror-based therapy results in immediate reductions in pushing behaviour, but the change is not statistically significant according to one study of poor design.[2]
    - The use of visual feedback, both computerized and mirror-based, demonstrated statistically significant improvements in reducing pushing behaviour and improving motor control over the course of 3 weeks. This is a high-quality study with strong evidence.[3]
    - The use of intensive gait-based interventions, such as BWS ambulation, in the acute stage of stroke rehabilitation is a safe and effective tool to improve gait and motor control for the general stroke population.[4]

CLINICAL BOTTOM LINE

The current evidence available for patients with pusher syndrome suggests that the use of visual feedback is an effective tool to reduce pusher behaviour and improve motor control. Although mirror-based therapy is the current standard of care, physical therapists may integrate more advanced technology visual feedback for this patient population to allow patients to integrate more robust self-correction in order to reduce pusher tendencies. In contrast, limited evidence is available regarding the use of BWS ambulation in pushing behaviour. While this technique is an appropriate intervention for the general stroke population, no conclusions can be derived and applied to patients with pusher syndrome without additional research.

This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
Elderly Older adult Geriatric Stroke CVA Cerebrovascular incident Cerebrovascular accident Cerebral Infarct Pusher Syndrome Pusher* Contraversive Push* Contralateral Push*	Visual feedback Visual therapy Mirror therapy Mirror Visual	Body weight support* BWS Partial body weight support Gait Ambulation Walk*	Pushing push* Pusher Syndrome

Final search strategy:

Search Strategy for PubMed:

#1	(Stroke OR CVA OR "cerebrovascular incident" OR "cerebrovascular accident" OR "cerebral infarct") AND (pusher OR pushing OR "pusher syndrome")	168
#2	(elderly OR "older adult*" OR geriatric OR ageing OR aging)	4722165
#3	(mirror* OR visual* OR "mirror visual*"OR "visual feedback")	616582
#4	("Body weight support*" OR BWS* OR "body-weight support*" OR "partial body weight support*" OR "partial body-weight support*" OR "partial body support*") AND (gait OR ambulation OR walk*)	629
#5	#1 AND #2 AND #3 AND #4	0
#6	#1 AND #2 AND #3	16
#7	#1 AND #2 AND #4	0
#8	#1 AND #4	0
#9	(Stroke OR CVA OR "cerebrovascular incident" OR "cerebrovascular accident" OR "cerebral Infarct") AND (Pusher OR pushing OR "pusher syndrome" OR "pushing behaviour" OR "pushing behavior" OR "contralateral push*" OR "contraversive push*")	174
#10	#2 AND #3 AND #4 AND #9	0
#11	#2 AND #3 AND #9	**20**
#12	#2 AND #4 AND #9	0
#13	#4 AND #9	0
#14	("Body weight support*" OR BWS* OR "body-weight support*" OR "partial body weight support*" OR "partial body-weight support*" OR "partial body support*")	10854
#15	#1 AND #14	0
#16	(Stroke OR CVA OR "cerebrovascular incident" OR "cerebrovascular accident" OR "cerebral Infarct")	260886
#17	#16 AND #2 AND #4	107
#18	(Stroke OR CVA OR "cerebrovascular incident" OR "cerebrovascular accident" OR "cerebral Infarct") NOT ("spinal cord injury" OR SCI or "complete spinal cord injury" OR "incomplete spinal cord injury")	251554
#19	#17 AND #2 AND #4	104
#20	acute AND #19	9
#21	(("Body weight support*" OR BWS* OR "body-weight support*" OR "partial body weight support*" OR "partial body-weight support*" OR "partial body support*") AND (gait OR ambulation OR walk*)) NOT (treadmill OR "treadmill training")	265
#22	#18 AND #21	**33**

Databases and Sites Searched	Number of results	Limits applied, revised number of results (if applicable)

PubMed	**53**	• Revised inclusion criteria to include case reports, case series, and cohort studies
		  ○ Results = 16
		• Revised results to include more terms for Pusher Syndrome, based on review of original results
		  ○ Revised number of results = 20
		• Revised population for comparison group to:
		  ○ Remove "pusher" subtype of stroke
		  ○ Add search terms to restrict SCI-related articles
		  ○ Add search terms to restrict BWS treadmill training
		  ○ Result = 33

Web of Science	**20**	• Revised population for comparison group to:
		  ○ Remove "pusher" subtype of stroke
		  ○ Add search terms to restrict SCI-related articles
		  ○ Add search terms to restrict BWS treadmill training
		  ○ Add acute timeframe
		  ○ Result = 11

CINAHL	**24**	• Revised intervention search to:
		  ○ Remove "elderly" population restriction
		  ○ Result = 10
		• Revised population for comparison group to:
		  ○ Remove "pusher" subtype of stroke
		  ○ Add search terms to restrict BWS treadmill training
		  ○ Add search terms to restrict "chronic" patients
		  ○ Result = 14

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
• Published in English • Published up to August 2016 • Randomized controlled trials, randomized cross-over studies, controlled trials,

uncontrolled trials, cohort studies, case series, case reports
- Protocol included visual feedback therapy in physical therapy (PT) intervention, and/or protocol included body weight supported gait in PT intervention for the comparison group

Exclusion Criteria

- Opinion and response articles
- Article reviews
- Studies investigating stroke patients with orthopaedic conditions

RESULTS OF SEARCH

Summary of articles retrieved that met inclusion and exclusion criteria

Author (Year)	Study quality score	Level of Evidence	Study design
Yang Y-R, Chen Y-H, Chang H-C, Chan R-C, Wei S-H, Wang R-Y (2015)[3]	7/10 (PEDro Score)	2b	Pilot Randomized Controlled Trial
Paci N, Nannetti L (2004)[5]	10/29 (Downs & Black)	5	Case report
Gandolfi M, Geroin C, Ferrari F, La Marchina E, Varalta V, Fonte C, Picelli A, Dimitrova E, Munari D, Valè N, Waldner A, Smania N (2016)[6]	7/10 (PEDro Score)	2b	Pilot Randomized Controlled Trial
Broetz D, Johannsen L, Karnath HO (2004)[1]	12/29 (Downs & Black)	4	Case Series
Krewer C, Rieß K, Bergmann J, Müller F, Jahn K, Koenig E (2013)[2]	4/11 (PEDro Score)	2b	Randomized Cross-over Study
Rao N, Zielke D, Keller S, Burns M, Sharma A, Krieger R, Aruin AS (2013)[7]	5/10 (PEDro Score)	2b	Randomized Controlled Trial
Ng MFW, Tong RKY, Li LSW (2008)[8]	6/10 (PEDro Score)	2b	Pilot Randomized Controlled Trial
Karttunen AH, Kallinen M, Peurala SH, Häkkinen A (2015)[9]	16/29 (Downs & Black)	2b	Prospective Cohort Study
Peurala SH, Araksinen O, Huuskonen P, Jäkälä P, Juhakoski M, Sandell K, Tarkka IM, Sivenius J (2009)[4]	5/10 (PEDro Score)	2b	Randomized Controlled Trial
Fujino Y, Amimoto K, Sugimoto S, Fukata K, Inoue M, Takahashi H, Makita s (2016)[10]	10/29 (Downs & Black)	5	Case Report

BEST EVIDENCE

The following 3 studies were identified as the 'best' evidence and selected for critical appraisal. Reasons for selecting these studies were:

- **Krewer C, Rieß K, Bergmann J, Müller F, Jahn K, Koenig E (2013)**[2] was chosen because it is a higher level of evidence compared with the other studies found in the search. In addition,

this article provides a direct comparison for 2 interventions of pusher syndrome, both of which are relevant to the original question.

- **Yang Y-R, Chen Y-H, Chang H-C, Chan R-C, Wei S-H, Wang R-Y (2015)**[3] was chosen because it scored high on the PEDro scale and is a high "level of evidence." This is one of the only randomized controlled trial that investigated the intervention of interest in the original question.
- **Peurala SH, Araksinen O, Huuskonen P, Jäkälä P, Juhakoski M, Sandell K, Tarkka IM, Sivenius J** (2009)[4] was chosen above the Ng MFW, Tong RKY, Li LSW (2008)[8] article. Although the latter article does assess BWS and ranks higher on PEDro, the primary focus of the article is the influence of functional electrical stimulation. In contrast, the Peurala et al. article compares BWS intervention with a control and a walking group, which is more applicable to the original question. In addition, this is a high level of evidence (RCT) compared to the other listed studies. Although this study examines the general stroke population rather than the pusher syndrome subpopulation, the inclusion of balance outcome measures makes this an appropriate selection for the original question.

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of *Immediate effectiveness of single-session therapeutic interventions in pusher behaviour* by Carmen Krewer, Katrin Rieß, Jeannine Bergmann, Friedemann Müller, Klaus Jahn, Eberhard Koenig (2013).[2]

Aim/Objective of the Study/Systematic Review:

The objective of the study was to evaluate the immediate results of various interventions on patients with pusher syndrome post-stroke. The interventions included PT utilizing visual feedback (PT-vf), galvanic vestibular stimulation (GVS), and assisted gait training (DGO) using the Lokomat machine.

Study Design

- Randomized cross-over trial
- Assessor blinded
- Subjects were a convenience sample of patients with hemiparesis, recruited in one hospital between January 2010 and May 2011
- All patients with pusher syndrome were automatically allocated to the experimental group; all patients without pusher syndrome were automatically allocated to the control group.
- Randomization: The order of interventions for each participant was determined by a computer, referred to as "pseudo-random order" by experimenters (pg. 248)
- Concealment allocation: An individual who was not involved in the experiment procedures placed the intervention sequences in opaque envelopes to ensure concealment
- Outcomes were measures immediately before and immediately after the interventions; the outcome measures were performed in the same room pre- and post-test
- All of the outcomes were performed by one trained experimenter, who was blinded to the intervention
- Due to lack of follow-up intervention and pilot study nature of this experiment, intention-to-treat analysis was not included
- No imputation method was performed for missing data
- Kruskall-Wallis test applied to identify between-group differences
- Mann-Whitney *U*-test applied for paired comparisons
- Wilcoxon tests was used to determine significance of change between pre- and post-intervention scores
- Package for the Social Sciences (PSS) used for statistical calculations and analyses

Setting

Subjects received treatment at an inpatient rehabilitation facility of the University Hospital Munich in Munich, Germany.

Participants

- 25 patients were recruited for the study

    - Control group N = 10
    - Experimental group N = 14
    - 1 patient dropped out due to psychotic event, group assignment not documented
- Diagnosis of pusher syndrome identified via Scale for Contraversive Pushing (SCP), score > 0 for each subcategory of SCP required
- Patients were recruited from inpatient rehabilitation facility at one hospital. The subjects comprised a sample of convenience.
- All patients presented with hemiparesis following a stroke
- Key Demographics Experimental Group
    - Gender: 3 Females, 11 Males
    - Mean Age = 68 (SD 8)
    - Mean months post-stroke = 7.2 (SD 2.8)
    - Lesion Side: 3 L, 11 R
    - Aetiology: 7 ischemic stroke, 11 intracranial haemorrhage
- Key Demographics Control Group
    - Gender: 4 Females, 6 Males
    - Mean Age = 63 (SD 11)
    - Mean months post-stroke = 8.2 (SD 4.1)
    - Lesion Side: 1 L, 9 R
    - Aetiology: 7 ischemic stroke, 11 intracranial haemorrhage
- Missing Data Experimental Group
    - 2 patients unable to perform GVS intervention
    - 1 patient unable to perform DGO intervention
- Missing Data Control Group
    - 1 patient unable to tolerate DGO intervention
    - 1 patient "developed enterocolitis," missing intervention not specified (pg. 248)

Intervention Investigated

Control (stroke without pusher syndrome) and Experimental (stroke with pusher syndrome) groups performed the same interventions described below.

- Participants received all three interventions in pseudo-random order over the course of 1 week.
- Each intervention was a single session, with a minimum of one day between interventions.
- All interventions were performed in the inpatient rehabilitation facility of one hospital.
- GVS
    - One 20-minute session of GVS stimulation at the vestibular threshold
    - GVS is applied using a constant-current stimulator
    - Cathode electrode placed on mastoid of the side with the lesion, anode electrode placed on mastoid of the contralesional side
    - The vestibular threshold was identified by applied a series of currents for 30 seconds (1 mA, 1.25 mA, 1.5 mA, 1.75 mA, and 2 mA); patients indicated when they felt tingling sensation. This level was selected as the vestibular threshold
    - If patient did not feel tingling sensation, 1.5 mA was selected as the default threshold
    - The person who performed the GVS intervention was not specifically identified
- DGO
    - One 20-minute session of walking with Lokomat trainer, which guides lower extremity hip and knee joints during gait
    - All patients received 1 Lokomat pre-intervention session for fitting adjustment (time not indicated)
    - DGO was set at 100% guidance for bilateral lower extremities
    - Patient wore harness in addition to Lokomat for safety and body weight support
    - Patients ambulated on treadmill with speed set at 2 km/hr and body weight support reduced to 50%, if possible
    - Dorsiflexion assist provided with foot plates during swing phase
    - The person who performed the DGO intervention was not specifically identified
- PT-vf
    - One 30-minute intervention performed by physical therapist
    - Included transfer training and weight shifting in order to improve "spatial orientation" (pg. 247)
    - Integrated use of external feedback, such as a vertical doorframe, to encourage the patient to re-align body with reference cue

Outcome Measures

- Scale for Contraversive Pushing (SCP)
  - Score ranges from 0-6 points
  - A lower score indicates better performance (i.e. lack of pushing behaviour)
  - Three subcategories of this test with subscores 0-2 points
  - For this experiment, a patient was considered to present with pushing behaviour if each subcategory score was > 0 points.
- Burke Lateropulsion Scale (BLS)
  - Score ranges from 0-17 points
  - A lower score indicates better performance (i.e. lack of lateralpulsion)
  - Three subcategories of this test with subscores 0-3 points, two subcategories of this test with subscores 0-4 points
  - For this experiment, cut-off score ≥ 2 points indicated presence of lateralpulsion
- Authors did not indicate which outcome measure was considered primary measure
- One experimenter performed the outcome measures immediately pre- and post-intervention in the same room, located in the facility
- The experimenter was trained in using the outcome measures

Main Findings

Statistical analysis was performed to determine individual change and effect size for each group. However, raw data were not included in table form. Unable to discern exact mean scores, mean difference, effect size, or confidence interval for the outcome measures.

Median score changes for the group with pusher syndrome pre- and post intervention for BLS, per *Figure 1* (graph)

- PT-vf: 0 points
- GVS: 1 point
- DGO: 1 point
- *Cannot calculate mean because distribution of scores is not provided*

The results indicate that there were no statistically significant differences in SCP between the 3 interventions for the group with pushing behaviour. There were no statistically significant differences in the BLS for either the GVS or the PT-vf intervention in the group with pushing behaviour. However, the results do indicate a statistically significant improvement on the BLS for the group with pushing behaviour following the DGO intervention.

In the paired comparison between PT-vf and DGO using the Mann-Whitney *U*-test for the BLS outcome measure, results indicate significant difference in favour of the DGO intervention for the group with pushing behaviour. No other paired comparisons revealed significant differences between interventions for the group with pushing behaviour.

The control group did not show any changes following any of the interventions. For calculations comparing the interventions for participants without pusher syndrome, no significant difference was identified.

Original Authors' Conclusions

Given that the SCP did not detect significant changes following interventions and the BLS did detect some significant changes, the authors conclude that the BLS outcome measure is more sensitive to change in pushing behaviour as compared to the SCP.

The authors also conclude that applying the DGO Lokomat intervention with patients demonstrating pusher syndrome is more effective in the short-term to reduce pushing behaviour than GVS and PT-vf interventions. The authors conclude the forcing patients with pusher syndrome to stand to perform gait training has a positive effect on pushing behaviour in the short-term.

Finally, the authors acknowledge that there can be no conclusions drawn regarding the long-term effects of the tested interventions based on this study given the lack of follow-up.

Critical Appraisal

Validity

- Although this is not a randomized controlled trial, the PEDro Scale was used to evaluate the article given that this is an intervention study.
- PEDro Scale Score: 4/11 based on eligibility criteria: Yes; Random allocation: Yes; Concealed allocation: Yes; Baseline comparability: No; Blind subjects: No; Blind therapists: No; Blind assessors: Yes; Adequate follow-up: No; Intention-to-treat analysis: No; Between-group comparisons: No; Point estimates and variability: No.
- The **strengths** of the study include:
    - Use of one blinded experimenter to perform all of the evaluations following the intervention and the use of computer-generated order of interventions
    - Use of a third party to ensure concealment allocation
    - Use of statistically tests provides meaningful intra- and inter-group comparisons
- The study avoided potential sources of bias in many ways, including:
    - Blinded assessor to avoid measurement bias
    - One assessor to perform all evaluations to avoid measurement bias
    - Assessor used the same two outcome measures for all interventions to reduce instrument bias
- There are many **limitations** of this study, including the following:
    - This study did have a small sample size, with N = 24 accounting for dropout. As a result, the outlier participant data can strongly influence the results of the data. However, the small sample size is appropriate for this pilot study.
    - The authors did not describe the experience or training of the individual who performed the DGO and GVS intervention. In order to replicate this study, additional information about the individuals performing the intervention would be necessary.
    - The authors fail to discuss to influence of dropouts on the statistics.
    - The authors fail to include any tables providing raw scores the outcome measures that were performed pre- and post-intervention.
    - There was no long-term follow-up to assess the permanence of the intervention results.
- Potential sources of **bias**
    - The convenience sampling of participants from one hospital could be a source of population bias for this study.
    - Given the location of the patients in an inpatient rehabilitation facility, participants are likely receiving concurrent therapies. This could result in intervention bias.
- It would be appropriate to include the presence of concurrent therapy during the week of this trial in order to account for potential other influencers on pushing behaviour.
- The authors deny conflict of interest for the experimenters performing this study.
- The authors allude to reducing the hospital length of stay for this patient population in the introduction, but fail to incorporate this facet of the introduction into conclusions or implications for future research.

Interpretation of Results

As indicated by the authors, the data do demonstrate that the Lokomat training has positive short-term effects on pushing behaviour. However, the authors do not discuss the outliers that are evident in the scatter plot (*Fig. 3*). Specifically, the PT-vf is the most pertinent intervention in relation to the PICO question stated above. As seen in *Fig. 3 A*, there are two clear outliers evident. As a result, the data for this intervention is likely skewed. The influence of these outliers is compounded by the small sample size.

The most glaring issue with this paper is the lack of raw data reported. The authors report the results of their statistical tests, but do not include any tables to demonstrate pre- or post-test scoring for any of the interventions. As a result, it is difficult for the reader to determine effect size for the interventions. The figures provided *do not* replace a table, as graph values must be approximated by the viewer. If the author had included the distribution of the scores, the box plot (*Fig.* 2) would have been more meaningful, as the reader would be able to assess mean scores.

The findings indicate that more research should be performed regarding these interventions, to be performed with a larger sample size. In addition, inclusion of a follow-up assessment is critical in order to glean more meaningful clinical implications. Specifically, it is essential to know if the positive intervention results are long lasting in order to (1) identify the most effective intervention

and (2) identify if these interventions could help to reduce hospital stay.

(2) Description and appraisal of *Effects of interactive visual feedback training on post-stroke pusher syndrome: a pilot randomized controlled study* by Yang Y-R, Chen Y-H, Chang H-C, Chan R-C, Wei S-H, Wang R-Y (2015).[3]

Aim/Objective of the Study/Systematic Review:

The objective of the study was to compare the effectiveness of two different visual feedback interventions to reduce pushing behaviour post-stroke. The interventions were (1) visual feedback with integrated postural control using a computerized system (experimental group) and (2) mirror visual feedback PT (control group).

Study Design

- Randomized Controlled Trial
- Assessor blinded
- Participants were referred to the study by one outpatient rehabilitation facility of a medical center in Taiwan
- Concealment and Randomization: Each participant selected a sealed envelope that contained a group allocation. Prior to the drawing, the group assignments had been randomly placed into the envelopes. Authors do not described the specific randomization technique.
- Outcome measures were performed two times: (1) on the day prior to initiation of intervention and (2) on the day following completion of the 3-week intervention
- All of the outcome measures were performed by one trained experimenter, who was blinded to the participant's group allocation
- Due to lack of follow-up assessment and pilot study nature of this experiment, intention-to-treat analysis was not included
- Mann-Whitney *U*-test was applied for comparison between groups
- Chi-square test was applied for comparison of key demographic differences between groups
- Wilcoxon signed-rank test was used to determine intragroup differences
- SPSS 16.0 was used for statistical calculations and analyses

Setting

The study took place in an outpatient facility in Taipei, Taiwan. Specific information about location of interventions is not included.

Participants

- 12 patients were recruited for the study
  - Experimental group N = 7
  - Control group N = 5
- Diagnosis of pusher syndrome identified via Scale for Contraversive Pushing (SCP), score > 0 for each subcategory of SCP required.
- Patients were referred to participate in the study by one outpatient rehabilitation facility. The subjects comprised a sample of convenience.
- Key Demographics Experimental Group
  - Gender: 3 Females, 4 Males
  - Mean Age = 62.4 (SD 12.9)
  - Mean months post-stroke = 6.0 (SD 4.0)
  - Side of Hemiparesis: 7 L, 0 R
  - Aetiology: 7 ischemic stroke, 0 intracranial haemorrhage
  - Neglect: 2 with neglect, 5 without neglect
  - Mean hours per week in concurrent therapy during participation in study:
    - PT = 6.4 (SD 1.3)
    - Occupational Therapy = 5.6 (SD 0.5)
    - Acupuncture Therapy = 1.0 (SD 0.8)
- Key Demographics Control Group
  - Gender: 0 Females, 5 Males
  - Mean Age = 57.6 (SD 17.3)
  - Mean months post-stroke = 5.8 (SD 3.3)
  - Side of Hemiparesis: 3 L, 2 R

- Aetiology: 3 ischemic stroke, 2 intracranial haemorrhage
- Neglect: 1 with neglect, 4 without neglect
- Mean hours per week in concurrent therapy during participation in study:
  - PT = 6.4 (SD 2.1)
  - Occupational Therapy = 5.6 (SD 1.1)
  - Acupuncture Therapy = 0.8 (SD 0.8)

- No participants dropped out of the study.

Intervention Investigated

Control

- Control subjects participated in 3 treatment sessions per week for 3 weeks, completing a total of 9 sessions. Each session was 40 minutes total of combined visual feedback and traditional PT.
- During each session, the control subjects received 20 minutes of visual feedback therapy via a full-body mirror, performed by a physical therapist. Visual feedback therapy included activities in sitting and standing while facing the mirror.
- Following each 20-minute intervention, control subjects received 20 minutes of traditional PT performed by a physical therapist, including both upper and lower extremity therapeutic exercise. Specific exercises were not described by the authors.

Experimental

- Experimental subjects participated in 3 treatment sessions per week for 3 weeks, completing a total of 9 sessions. Each session was 40 minutes total of combined interactive visual feedback and traditional PT.
- During each session, the experimental subjects received 20 minutes of computer-generated interactive visual feedback training using a Nintendo Wii balance system.
  - Subjects were assisted onto the Wii balance board by the physical therapist and assumed symmetrical sitting or standing position, depending on the predetermined functional ability of the participant.
  - A monitor connected to the Wii balance board displayed real-time pressure distribution.
  - Subjects were asked to use the visual feedback of the monitor to adjust and maintain centralized pressure for 10 seconds per attempt.
  - Subjects were asked to use the visual feedback of the monitor to maintain their upright posture while performing weight shifting to their "limit of balance" in anterior/poster, medial/lateral, and oblique axes (pg. 989). Trials of weight shifting were performed for 10 seconds at a time.
- Following each 20-minute intervention, experimental subjects, like the control group, received 20 minutes of traditional PT, as described above.

Outcome Measures (Primary and Secondary)

- Scale for Contraversive Pushing (SCP) was used to identify severity pushing behaviour.
  - Score ranges from 0-6 points
  - A lower score indicates better performance (i.e. lack of pushing behaviour)
  - Three subcategories of this test with subscores 0-2 points
  - A patient was considered positive for pushing behaviour if each subcategory score was > 0 points.
- Berg Balance Scale (BBS) was used to assess balance ability.
  - Score ranges from 0-56 points
  - The test includes 14 specific functional activities
  - A higher score indicates better performance
- Fugl-Meyer Assessment scale (FMA) was used to measure motor control (only the "Motor Function" domain of the assessment was used).
  - Upper extremity (UE) score ranges from 0-66
  - Lower extremity (LE) score ranges from 0-34
  - Participants are awarded points (0-2) for partial or complete performance of UE and LE movements.
  - A higher score indicates better performance
- Authors did not indicate which outcome measure was considered primary measure.

- One trained physical therapist, blinded to the group allocation, performed all of the outcome measures.

Main Findings

The results indicate that the experimental group receiving computer-generated visual feedback training showed significant improvement on the SCP, BBS, and FMA LE following the 3-week course of intervention. The pre- to post-mean differences of computerized visual feedback for the SCP, BBS, and FMA LE were 4 points, 14.7 points, and 8.4 points, respectively. There were no significant improvements noted on the FMA UE for the experimental group.

The control group receiving mirror visual feedback also showed significant improvement in mean scores on the SCP, BBS, and FMA LE following the 3-week trial. The effect sizes of mirror visual feedback for the SCP, BBS, and FMA LE were 1.4 points, 7.2 points, and 5.6 points, respectively. There were no significant improvements noted on the FMA UE for the control group.

A comparison between the experimental group and the control group indicates that the effect sizes for the SCP and the BBS are both statistically significant in favour of the experimental group. The values for between-group differences are 2.3 points on the SCP and 9.7 points on the BBS. The comparison between the experimental group and the control group effect sizes on the FMA UE and LE are not statistically significant.

Original Authors' Conclusions

The authors of this study conclude that both computer-generated interactive visual feedback training and traditional mirror visual feedback therapy are effective in reducing pushing behaviour and improving balance post-stroke. However, the authors indicate that computer-based visual feedback training is more effective in reducing pushing behaviour because it requires patients to self-correct postural errors on all planes, while the mirror is less sensitive to multi-planar postural instability.

In addition, the authors state that although the UE motor control did not significantly change following either intervention, both computer-generated and mirror visual feedback therapy can help improve LE motor control post-stroke.

Critical Appraisal

Validity

- PEDro Scale Score: 7/10 based on: Eligibility criteria: No; Random allocation: Yes; Concealed allocation: Yes; Baseline comparability: Yes; Blind subjects: No; Blind therapists: No; Blind assessors: Yes; Adequate follow-up: Yes; Intention-to-treat analysis: No; Between-group comparisons: Yes; Point estimates and variability: Yes.
- The **strengths** of the study include:
    - Use of one blinded physical therapist to perform all of the outcome measures, both prior to initiation of intervention and at the completion of intervention series.
    - The inclusion of concurrent therapies occurring during the study in order to account for other possible sources of improvement.
- There some **limitations** of this study, including:
    - This study did have a small sample size, with N = 12. As a result, the outlier participant data can strongly influence the results of the data. However, the small sample size is appropriate for this pilot study.
    - The authors fail to detail specific information about the location of the interventions and how far apart (in time) the interventions were applied.
    - Authors did not describe how the envelopes were randomly filled with group allocation. It would be beneficial to know if this was computer-generated in order to better assess the randomization of the experiment.
- The study avoided potential sources of bias in many ways, including:
    - Blinded assessor to avoid measurement bias
    - One assessor to perform all evaluations to avoid measurement bias
    - Random selection of group allocation
- The referral of participants from one outpatient facility could be a potential source of referral bias for this study.
- The authors note that there was no conflict of interest for the experimenters performing this study.
- Overall, this study follows appropriate protocol and study design to establish very good

validity.

Interpretation of Results

This study indicates that although mirror visual feedback therapy can be a useful intervention post-stroke, computer-generated interactive visual feedback is more effective in improving balance and reducing pushing behaviour. However, given that both the experimental group and the control group demonstrated significant mean score improvement on the SCP and the BBS, the traditional mirror-based visual feedback training should still be considered a useful intervention for this patient population. This study underscores that visual feedback is an important element in reducing pushing behaviour by allowing patients to recognize the error and adjust independently. However, there is no direct correlation offered by the authors to indicate reduction in falls risk following improvement on these outcome measures.

Clinically, physical therapists can use computer-based visual feedback training to allow the patient to perceive and self-correct pushing behaviour on multiple planes than that which possible in the traditional mirror-based training.

In addition, the technology required by the computer-generated visual feedback could be a barrier to implementation in the clinic. Facilities that do not have the equipment might choose to continue traditional, low-cost mirror based therapies given the results above. This is one limitation of the application of this study.

(3) Description and appraisal of *Effects of intensive therapy using gait trainer or floor walking exercises early after stroke* by Peurala SH, Araksinen O, Huuskonen P, Jäkälä P, Juhakoski M, Sandell K, Tarkka IM, Sivenius J (2009).[4]

Aim/Objective of the Study/Systematic Review:

The aim of this study was to compare the effects of gait-specific interventions with traditional post-stroke therapeutic interventions on ambulation ability and motor control in acute stage of stroke recovery. The experimental interventions were (1) use of a gait trainer with body weight support (GT) and (2) use of aboveground walking (WALK). The control group received "conventional treatment" (CT).

Study Design

- Randomized Controlled Trial
- Randomization: An independent party randomly allocated participants into one of the three groups. This individual was not involved in the intervention or interaction with participants.
- Allocation Concealment: The group allocation was concealed in sealed envelopes. The group allocations for patients with Functional Ambulatory Category (FAC) of 0-1 were in a separate envelope from allocations for patients with FAC 2-3.
- Outcome measures were performed 4 times: (1) prior to initiating the intervention, (2) after 2 weeks (values not reported), (3) after completing the 3-week intervention course, and (4) 6 months following the completion of the intervention.
- A physical therapist and another independent observer performed the outcome measures for the first 1.5 years of the study. Following an analysis of inter-rater reliability, either the physical therapist *or* the independent observer performed the outcome measures for the remainder of the study.
- The Mann-Whitney *U* test and the Kruskal-Willis tests were used to compare participant key demographics at the beginning of the study
- Independent-samples *t*-test was used for comparison of experimental group values of walking time, distance, perceived exertion (Borg Scale), and heart rate (HR)
- Friedman and Wilcoxon signed-rank test were used to for pre- and post-intervention inter- and intragroup FAC score comparison
- Authors used a relative distance calculation to compare values of 10 Meter Walk Test (10MWT) and 6 Minute Walk Test (6MWT) due to patient's being unable to perform test at initiation of intervention in order to account for missing data.
- SPSS 14.0 was used for statistical calculations and analyses

Setting

This study took place in Kuopio, Finland. The participants in the experimental group received intervention in an inpatient rehabilitation facility of an acute care hospital. Control group participants received interventions at a separate rehabilitation hospital or a health centre, but were transported to and from the hospital for outcome assessments.

Participants

- 56 participants were recruited for this study.
  - Experimental group GT N = 22
  - Experimental group WALK N = 21
  - Control group N = 13
- 9 participants dropped out of the study.
  - GT dropouts N = 5
  - WALK dropouts N = 1
  - Control goup dropouts N = 3
- Participants were recruited from one acute care hospital between June 2003 and February 2007. The subjects comprised a sample of convenience.
- Participants were required to be within 10 days of stroke in order to participate in trial.
- The following key demographic information excludes data from participants who dropped out.
- Key Demographics Experimental Group GT
  - Gender: 9 Females, 8 Males
  - Mean Age = 65.7 (SD 9.2)
  - Mean time post-stroke (days) = 8.6 (SD 2.3)
  - Side of Hemiparesis: 9 L, 8 R
  - Aetiology: 11 ischemic stroke, 6 intracranial haemorrhage
  - Neglect: 4 with neglect, 13 without neglect
  - FAC: FAC 0 = 12 participants; FAC 1 = 3 participants; FAC 3 = 2 participants
  - Barthel Index (BI): 45.5 (SD 23.7)
- Key Demographics Experimental Group WALK
  - Gender: 9 Females, 11 Males
  - Mean Age = 65.3 (SD 9.9)
  - Mean time post-stroke (days) = 7.8 (SD 3.0)
  - Side of Hemiparesis: 12 L, 8 R
  - Aetiology: 16 ischemic stroke, 4 intracranial haemorrhage
  - Neglect: 3 with neglect, 17 without neglect
  - FAC: FAC 0 = 14 participants; FAC 1 = 3 participants; FAC 2 = 3 participants
  - Barthel Index (BI): 44.5 (SD 19.8)
- Key Demographics Control Group
  - Gender: 5 Females, 5 Males
  - Mean Age = 69.5 (SD 11.0)
  - Mean time post-stroke (days) = 9.5 (SD 1.9)
  - Side of Hemiparesis: 6 L, 4 R
  - Aetiology: 8 ischemic stroke, 2 intracranial haemorrhage
  - Neglect: 2 with neglect, 8 without neglect
  - FAC: FAC 0 = 7 participants; FAC 1 = 1 participants; FAC 2 = 1 participants; FAC 3 = 1 participants
  - Barthel Index (BI): 31.6 (SD 13.6)
- Of the 47 participants who completed the course of intervention, 45 were available for follow-up assessment 6 months following the completion of the trial. One participant from each of the experimental groups was not available for follow-up.

Intervention Investigated

Control

- Patients in the control group received between 1 and 2 conventional PT treatments each day for 3 weeks.
- The authors did not describe the duration or intervention details of the CT.
- Authors note that the CT was intended to be less vigorous than both GT and WALK interventions.
- The CT plans of care were individualized based on each patient's specific goals.

Experimental GT

- Participants in the GT group received the intervention every day for three weeks.
- Participants were allotted one 1-hour session each day in order to perform 20 minutes of total actual walking in the gait training device.
- Participants were provided with rest breaks as needed throughout the hour session.
- The participant's feet were placed on motor-driven footplates of the GT.
- The patient wore a harness for BWS. The amount of BWS varied based on each patient's individual assistance requirements.
- The intervention was progressed by (1) reducing BWS and (2) increasing gait speed. Specific progression protocols were not described by the authors.
- In addition to the 1-hour experimental intervention, GT group participants also received 55 minutes every day of "gait-oriented physiotherapy" (pg. 168). Details of this supplemental intervention were not included.

Experimental WALK

- Participants in the WALK group received the intervention every day for three weeks.
- Participants were allotted one 1-hour session each day in order to perform 20 minutes of total actual walking.
- Either one or two physical therapists provided physical assist for ambulation, depending on the individual's needs. Participants were also allowed to use an assistive device.
- Participants were provided with rest breaks as needed throughout the hour session.
- The intervention was progressed by (1) reducing assist from physical therapists, (2) reducing reliance on assistive device, and (3) increasing gait speed. Specific progression protocols were not described by the authors.
- WALK group participants also received 55 minutes of "gait-oriented physiotherapy" daily.

Outcome Measures (Primary and Secondary)

- The outcome measures were performed by one physical therapist and one independent observer who were not blinded to group allocation (pg 168).
    - For the first 1.5 years, both individuals performed assessments on all participants.
    - For the remainder of the study, either the physical therapist *or* the independent observer performed the outcome measures for each participant.

Primary Outcome Measure

- FAC to assess ambulation ability
    - Score ranges from 0 to 5 points
    - Score is based on ability to ambulate and level of assistance required to ambulate
    - Individuals required to score ≤ 3 on FAC at baseline in order to qualify for study
    - A higher score indicates better performance

Secondary

- 10MWT was used to measure gait speed.
    - Score is equal to time (in seconds) required to ambulate 10 meters
    - There is no maximum score
    - Orthosis and "partial support" by a physical therapists was permitted
    - A lower score indicates better performance
- 6MWT was used to measure walking endurance.
    - Score is equal to distances (in meters) that an individual ambulates in 6 minutes
    - There is no maximum score
    - Orthosis and "partial support" by a physical therapists was permitted
    - A higher score indicates better performance
- Modified Motor Assessment Scale (MMAS) was used to measure motor ability.
    - Score ranges from 0-48 points
    - 8 subcategories are individually score from 0-6 points
    - A higher score indicates better performance
- Rivermead Motor Assessment (RMA)
    - 2 of the 3 RMA subscales used include the gross motor function subscale (RMA g) and the lower limb function plus trunk control (RMA l&t)
    - <u>RMA g</u>
        - Participant is awarded one point for performance of each task
        - Once the participant is unable to perform a task after three attempts, the RMA

g test is terminated.
        - Score ranges from 0 to 13
        - A higher score indicates better performance
    - RMA l&t
        - Participant is awarded one point for performance of each task.
        - The entire RMA l&t is performed despite failure to complete tasks.
        - Score ranges from 0 to 10
        - A higher score indicates better performance
- Rivermead Mobility Index (RMI)
    - Score ranges from 0 to 15
    - Participants are asked if they are able to complete 14 tasks. One point is awarded for each "yes" response.
    - Participant is asked to perform one task. One point is awarded for completion of task.
    - A higher score indicates better performance

Main Findings

The results summarized below do not include all outcome measures used. The outcome measures selected reflect those that are most relevant to the PICO question. The 10MWT and the 6MWT were excluded from the summary because they represent advanced gait evaluation that is not appropriate for patients with pushing behaviour. The FAC evaluates basic assist requirement for gait, which may still be useful for patients with pushing behaviour. The motor control assessments are included because they include balance components, which are applicable to patients with pusher syndrome.

All three groups demonstrated improvement in FAC scores following the 3-week intervention. The authors presented only median and interquartile ranges (IQR) for changes in FAC score, which limits the ability to extrapolate the statistical significance of intragroup change. At the initiation of the trial, none of the groups had participants with FAC score > 3. Following the course of treatment, at least 10% of participants in each group scored ≥ 4 on the FAC (29.4% of GT group, 20% of WALK group, and 10% of CT). The use of ANOVA indicates significant between-group differences in FAC scores in favour of the experimental groups.

All three groups demonstrated statistically significant improvements following the 3-week intervention on MMAS score. The mean pre- and post-score improvement for the GT group, WALK group, and CT group were 13.6 points, 14.4 points, and 5.6 points, respectively. The difference between the experimental group mean post-trial effect size (14 points) and the control group post-trial effect size is 8.4 points. This represents a significant difference in favour of the experimental groups, according to the statistical analysis presented by the authors.

Although all three groups also improved on the RMA subscales, none of the groups demonstrated statistically significant improvement in either the RMA g or the RMA l&t compared to the baseline score. In addition, there were no statistically significant between-group differences at the conclusion of the interventions.

At the 6-month follow-up assessment, all of the participants available demonstrated continued improvement of motor control. However, the experimental groups demonstrated statistically significant improvement in MMAS score at 6 months compared to the control group. In addition, at the 6-month follow-up 52.6% of the WALK group and 62.5% of the GT group scored ≥ 4 on the FAC, compared to 20% of the control group.

Original Authors' Conclusions

The authors conclude that both GT and aboveground walking interventions result in improvements in motor control and gait performance for patients immediately post-stroke. Although conventional PT does improve motor control, it is much less effective in improving ambulation ability for patients post-stroke. Authors also underscore that early, intensive gait-specific interventions are appropriate and safe for this patient population.

In addition, authors note that early intensive gait training following stroke has more significant long-term effects on motor control performance than traditional PT intervention.

Critical Appraisal

Validity

- PEDro Scale Score = 5/10: Eligibility criteria: Yes; Random allocation: Yes; Concealed allocation: Yes; Baseline comparability: Yes; Blind subjects: No; Blind therapists: No; Blind assessors: No; Adequate follow-up: No; Intention-to-treat analysis: No; Between-group comparisons: Yes; Point estimates and variability: Yes.
- The following represent the **strengths** of this study:
    - The participants were randomly allocation to one of the three groups by an individual with no other connection to the intervention, which reduces potential allocation bias.
    - The authors performed inter-rater reliability analysis during the trial to identify potential measurement bias.
    - A control group provided a standard PT intervention with which to compare the experimental interventions.
    - Follow-up outcome assessment was performed 6 months following the completion of the study, helping to solidify authors' conclusions and provide longer-term results.
- There are many **limitations** of this study, including the following:
    - The authors fail to provide detail regarding the CT. It would be impossible for other researchers to replicate the CT. In addition, it is impossible to determine if the control group intervention is comparable to the experimental interventions because duration of treatment is not included.
    - The authors do not detail the level of assist provided for the WALK participants.
    - The authors fail to include an intention-to-treat analysis. Given the large number of dropouts from the study, an intention-to-treat analysis would have been appropriate to improve the validity of the study.
    - The authors do not provide standard deviation for the FAC scores. Therefore, it is impossible to glean additional statistical information from the limited data provided (median and interquartile ranges).
    - The use of both parametric and non-parametric data confounds the FAC results. Specifically, the ANOVA indicates statistical significance group difference, but the Kruskal-Wallis test does not show statistical significant for "different time-points" (pg.170).
    - Unevenly distributed group size could have affected the results of the study. The control group was nearly half the size of the experimental groups. Therefore, any major outlier could have had a major influence on the data for the control group.
- **Potential sources of bias**
    - The physical therapists and independent observer who performed the outcome measures were not blinded to the group allocation. This could result in potential expectation bias.

Overall, the authors include appropriate protocols to secure validity of the study. However, the various oversights regarding the control group intervention and provision of data diminish the validity of the study. Straightforward adjustments to the study design, such as evaluator blinding, could have made major improvements in the study, which would have amplified the study validity and clinical implications.

Interpretation of Results

This study is meaningful to the physical therapists working with patients post-stroke because it highlights the feasibility of intensive gait-specific interventions following stroke in the acute period of recover. Both experimental groups demonstrated improvements in walking ability and motor control following 3 weeks of intervention and at the 6-month follow-up assessment. Without additional informed regarding CT protocol, it is difficulty to perform an accurate, meaningful assessment of the control group outcomes.

A major limitation of the study is the cost of the experimental GT device for rehabilitation facilities. It is likely that the cost of the GT device is beyond the budget of many facilities. Without the availability of the intervention, the generalizability of this study is reduced.

Despite the fiscal limitations of the GT experimental group, the results of the WALK experimental group demonstrate that the "cost" of using two personnel during post-stroke therapy to facilitate high-intensity gait training could result in major functional rewards for this patient population.

EVIDENCE SYNTHESIS AND IMPLICATIONS

Two articles analysed above evaluate the effects of various interventions on patients with pusher syndrome post-stroke, specifically using the reduction of pushing behaviour and the improvement in motor control as indications for treatment success. The results of these studies indicate that visual feedback, both mirror-based and alternative visual feedback strategies, are appropriate and beneficial tools that require patients to use external cues to recalibrate internal errors, thereby reducing pushing tendencies. Although not all of the intervention results were statistically significant, the evidence of improvement for all visual feedback therapies justifies the continued use of this intervention in early stages of treatment for patients with pusher syndrome. While immediate improvement following visual feedback lacks statistically significant changes, the longer-term benefits of this intervention technique do demonstrate statistically significant improvement.

One study examined the effectiveness of BWS ambulation for individuals post-stroke in early acute rehabilitation, demonstrating that early gait training with BWS has both short-term and long-term improvements for motor control and ambulation independence for patients following a stroke. Although individuals with pusher syndrome were not included in the study, there were participants with complete inability to ambulate prior to initiation of the study (FAC = 0), an ambulation level that is comparable to most individuals with pusher syndrome. The effectiveness of this intervention is not yet determined for patients with pusher syndrome, but the results of this study could help justify a study examining BWS in this stroke subpopulation.

The evidence available with regard to original PICO question is scant. Given that the pusher syndrome condition remains poorly understood, very little high-quality studies investigate intervention approaches for this patient population. Furthermore, the quality of the evidence available is relatively poor. Due to lack of evidence and generally poor quality evidence, it is impossible to answer the original question. However, the highest quality evidence that *is* available underscores the clinical importance of continued use of visual feedback therapies that integrate patient self-correction as one method to reduce pushing behaviour. Clinicians should seek additional methods that require the patient to self-correct, incorporating alternative external cues to accomplish this goal. Computer- and other technology-based visual feedback programs, though costly, could also challenge patient self-correction in a more complex way than traditional visual feedback interventions. These strategies are especially important in the clinical setting if a patient is not responding to traditional mirror-based visual feedback interventions.

There is a great need for evidence identifying the most effective interventions for patients with pusher syndrome. As a subpopulation of stroke patients, it would be appropriate for a study to investigate the effectiveness of BWS ambulation on patients with pusher syndrome, particular for patients with mild to moderate pushing behaviour. In general, there is a major lack of high-quality intervention-based research to help physical therapists guide plan of care with regard to duration, intensity, and progression of intervention techniques.

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