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How accurate is partial weight bearing?

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Abstract

Question: Is 50% Partial Weight Bearing Really 50%.

Design: Twelve volunteers participated in this prospective, case-control study utilising a portable limb load monitor (NCOunters VIC) to measure the PWB load exerted. The device was attached and calibrated to the individual's body weight. 50%, 25% and 5% PWB were tested with crutches and a four wheel frame (4WF). The tests were repeated following physiotherapy education. Participants: 12 healthy volunteers.

Intervention: gait aids- crutches, 4WF. Results measured pre- and post- physiotherapy instruction. Outcome Measures: percentage weight bearing was measured for each participant with both crutches and a 4WF both prior to and post physiotherapy instruction. Accuracy of partial weight bearing was measured using the NCounters device which was calibrated for each participant's individual body weight to assess the accuracy of their respective attempts using each gait aid both before and after physiotherapy instruction.

Results: On initial attempt with crutches, subjects exceeded their 50%PWB (mean 58%, range 18-100%), 25% PWB (mean 36%, range 11-73%) and 5%PWB (mean 23%, range 4-64%) respectively. Volunteers performed better with a 4WF, however this did not reach statistical significance 50%PWB (mean 58% vs 38%, p= 0.07), 25%PWB (mena 36% vs 27%, p=0.33) or 5%PWB (mean 23% vs 16%, p=0.29). Following physiotherapy education, the 50%, 25% and 5%PWB attempts respectively averaged 31% (p=0.02), 15% (p=0.01) and 10% (p=0.04).

Conclusion: There is wide variability of PWB between individual with a tendency towards exceeding designated targets. Physiotherapy education and possibly use of 4WF over crutches demonstrated improved performance.

Keywords: Orthopaedic surgery, rehabilitation, physiotherapy

Introduction

It is well documented that excessive mechanical loading may lead to early failure of fracture fixation or arthroplasty [1]. For this reason, partial weight bearing is a common instruction for rehabilitation after such operations [2]. Previous studies have demonstrated that patients are not able to accurately reproduce instructed partial weight bearing [3-5]. Failure to comply with partial weight bearing instruction, in particular exceeding weight bearing instruction, may lead to implant failure and in turn significant morbidity in the form of pain, immobility or need for further surgery.

To date there exists a lack of evidence regarding quantification of the accuracy of partial weight bearing, or the ability of different gaitaids to improveit. Feedback devices exist which are designed to aid instruction and information retention, however the success of these systems in improving the accuracy of partial weight-bearing (PWB) has been varied [2,7-10].

This study was designed to investigate and quantify the accuracy of current education and assessment of partial weight bearing and assess for potential improvements inaccuracy using two commonly employed gait aids. There were three main aims of the study which are listed below.

Study aims

-To investigate the accuracy of partial weight bearing.
-To investigate the accuracy of partial weight bearing post-physiotherapy instruction.
-To investigate whether 4wheel frames improves the accuracy of partial weight bearing compared with crutches.

Methods

Twelve healthy volunteers(six female, six male)participated in this prospective case controlled study utilising a portable limb load monitor (NCounters, VIC) to measure the PWB load exerted (exclusion criteria: <18yo, current limb injuries). Participants ranged in age from 24yo - 30yo (mean 25.83, SD 1.70), ranged in height from 163cm -196cm (mean 178.42, SD 9.66) with a weight range of 60kg -100kg (mean 78, SD 12.66).During this study, the device was attached and calibrated to the individual's body weight, with full weight bearing representing 100% load. 50%, 25% and 5% PWB were tested with crutches and a four-wheel frame (4WF) respectively. The tests were repeated following physiotherapy instruction and 15 minutes post physiotherapy instructionwith crutches, to assess the effectiveness of information retention among participants. At each stage, the peak load transmitted through the device during the gait cycle was taken for comparison between type of gait aid and method of instruction employed.

Physiotherapy instruction involved an experienced physiotherapist educating participants for 10-15 minutes on how to achieve the desired weight bearing status with correct use of the assigned gait aid (crutches or a 4WF), including a demonstration. Additional cues when educating on touch weight bearing, included instructing participants to imagine they had a marshmallow under their foot and were not to squash it during the gait cycle. The physiotherapist then observed the participant performing the task and provided individualised feedback as appropriate. If the physiotherapist was unsure if the participant was adequately offloading the limb being tested, they assessed the amount of weight bearing by placing their own foot under the participants'limb as they walked. Appropriate feedback was then provided to the participant based on the physiotherapists subjective perception of load/ weight bearing. No additional equipment (eg. live biofeedback or scales) was used as an adjunct to the physiotherapist's instruction. (See appendix 1 for full study design).

Results

Data was collected using the NCounters limb load device and a mean value calculated for each weight bearing parameter and gait aid for the 12 participants. The student t-test was then applied to determine statistical significance of resultsgiven a normal distribution (statistical significance p=<0.05). In order to minimise type 1 error, a Bonferroni correction was then applied to p-values in which more than twogroups were compared in order to determine the statistical significance of the observed results.

Discussion

On initial attempts with crutches, subjects exceeded their 50%PWB, 25%PWB and 5%PWB targets with a mean of 58% (range 18-100%, p=0.54), 36% (range 11-73%, p=0.18) and 23% (range 4-64%, p=0.01) respectively. Volunteers also performed better with a 4WF, with a general tendency towards a lower percentage of weight bearing than instructed: 50%PWB (mean 58% vs 38%), 25%PWB (mean 36% vs 27%) or 5%PWB (mean 23% vs 16%). (**Table 1**).

Following physiotherapy education, the 50%, 25% and 5%PWB attempts averaged 31% (p<0.01), 15% (p=0.03) and 10% (p=0.09) respectively. In particular, participants tended to remain below the instructed percentage of weight bearing following physiotherapy education. On retesting of participants with crutches 15 minutes post their initial physiotherapy instruction, there was no significant difference in percentage weight bearing observed. This indicated that participants were able to adequately retain the information on weight bearing instruction provided by the physiotherapist. It is likely that this level of information retention can be applied to all gait aid modalities, however further studies in this area may be required to confirm this hypothesis.

When comparing mean weight bearing (crutches + 4WF) for participant's initial attempt vs physiotherapy feedback, a trend towards lower percentage of weight bearing than instructed was observed for each attempt (**Tables 2** and **3**). For 50% PWB the mean was 48% (p=0.37) for the initial attempt and 34% (p<0.01) for all forms of feedback combined and this was statistically significant. Similarly, for 25% PWB the mean values were 32% (p=0.01) and 19% (p=0.01) respectively, which again showed statistical significance for post physiotherapy feedback. For 5% PWB, both the initial attempt and attempts

Table 1. Average percent weight bearing for each gait aid (crutches and 4WF), feedback technique (physio instruction) and post physio instruction (crutches only).

PWB (gait aid)	50% (crutches)	25% (crutches)	5% (crutches)	50% (4WF)	25% (4WF)	5% (4WF)
Initial attempt	58% (p=0.54)	36% (p=0.18)	23% (p=0.01)	38% (p=0.03)	27% (p=0.37)	15% (p=0.02)
Post physio instruction	31% (p<0.01)	15% (p=0.03)	10% (p=0.09)	29% (p<0.01)	18% (p=0.07)	8% (p=0.03)
15 mins post instruction	36% (p=0.33)	17% (p=0.03)	10% (p=0.03)	-	-	-

Table 2. Average percent weight bearing (crutches + 4WF) initial attempt vs all feedback techniques combined.

Percent weight bearing	50%	25%	5%
Average % weight bearing (initial attempt)	48% (p=0.37)	32% (p=0.08)	19% (p<0.01)
Average % weight bearing (post physio feedback)	34% (p<0.01)	19% (p=0.01)	10% (p<0.01)

Table 3. Average percent weight bearing (crutches vs 4WF).

Crutches vs 4WF	Crutches 50%	Crutches 25%	Crutches 5%	4WF 50%	4WF 25%	4WF 5%
Average (all gait aids/modalities)	43% (p=0.08)	22% (p=0.15)	14% (p<0.01)	31% (p<0.01)	21% (p=0.14)	11% (p<0.01)

using any form of feedback technique on average exceeded the instructed percentage weight bearing (19% p<0.01 and 10% p<0.01 respectively), however following feedback, participants were closer to the instructed value. Participants generally tended to underestimate the percentage of weight bearing when feedback was provided.

Comparing crutches with 4WF over the entire study, in general crutches were more accurate particularly for 50% PWB (43% vs 31%) and 25% (22% vs 21%), however with both crutches and 4WF participants tended to overshoot the target for 5% PWB (14% vs 11% respectively). Using a 4WF afforded participants the ability to be more accurate with 5%PWB than with crutches on initial attempt (15% vs 23%) and post physiotherapy instruction (8% vs 10%), however all exceeded the instructed percentage of weight bearing. This indicates that the ability for participants to comply with 5% PWB instructions is poor, irrespective of the gait aid or feedback technique employed.

Conclusions

There is a wide variability of PWB between individuals, with an overall trend towards exceeding their designated targets on initial attempts with no guidance or feedback. In general, following physiotherapy instruction participants exhibited more accuracy with respect to percentage weight bearing. In particular, there was a general trend towards a lower percentage of weight bearing than instructed following education. There was no significant difference in the accuracy of partial weight bearing 15 minutes post-instruction indicating that short-term recall of education by participants is generally acceptable. Assessment of information retention outside of a young, healthy patient demographic as used in this study may, however render different results and as such may form the basis of future studies on the topic.

In general, compliance with 5%PWB instruction was particularly poor, with participants unable to remain below 5% weight bearing on average, despite two alternate modes of instruction and gait aids being employed. With this in mind, instructing patients to remain non-weight bearing in instances where 5%PWB is to be employed may be more effective in minimising the potential for non-compliance with instruction and therefore mitigate the risk of post-operative complications.

Given that exceeding instructed weight bearing may lead to implant failure, it is clear that providing education and feedback to patients with respect to partial weight bearing may lead to lower implant failure rates and improved outcomes post Orthopaedic Surgery. Further studies involving the use of novel devices employing constant auditory feedback may be useful in assessing the overall utility of such devices for improving the accuracy of partial weight bearing. This study applied partial weight bearing instruction and education to healthy volunteers in order to assess the effectiveness of various education and feedback techniques. Whilst this provides useful information to clinicians, its application to a post-surgical population may be subject to some limitations. Confounding factors such as post-surgical or post-injury pain inhibiting weight bearing may in fact contribute to an improved accuracy of %PWB and a greater compliance with instruction than that observed in this study. In order to analyse its real-world effectiveness, application of this design to real patients in the post-operative setting may provide more meaningful information and future studies in this area may benefit from this approach.

Additional file

Appendix 1

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	DT	AD	LA	AB	AH
Research concept and design	✓	✓	✓	✓	✓
Collection and/or assembly of data	✓	✓	✓	✓	✓
Data analysis and interpretation	✓	✓	✓	✓	✓
Writing the article	✓	--	--	--	--
Critical revision of the article	✓	--	--	--	--
Final approval of article	✓	--	--	--	--
Statistical analysis	✓	--	--	--	--

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