Patient Compliance With Postoperative Lower Extremity Touch-down Weight-bearing Orders at a Level I Academic Trauma Center

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abstract

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After lower extremity fracture or surgery, physicians often prescribe limited weight bearing. The current study was performed to evaluate teaching and compliance of touch-down weight bearing (defined as 25 lb) at a level I academic trauma center. A survey was distributed to physical therapists (PTs) from the orthopedic ward to gauge their training methods and their confidence in patients’ ability to comply. Patients with recommended touch-down weight bearing were then evaluated on the day of discharge and again at their first follow-up appointment using the SmartStep weight-bearing measurement device (Andante Medical Devices, Inc, White Plains, New York). Fifteen PTs completed the survey (average of 14 years in practice). Inconsistency was observed in weight-bearing teaching methods: verbal cues were used 87% of the time, tactile methods were used 41%, demonstration was used 23%, and a scale was used only 1%. Limited confidence was found in the instruction efficacy by those surveyed. Twenty-one patients were seen the day of discharge and 18 of those were seen at first follow-up. At discharge, average minimum and maximum weight bearing were 3.2 and 30.2 lb, respectively. Only 31% of steps were within an acceptable range of 15 to 35 lb. At first follow-up, average minimum and maximum weight bearing were 12.2 and 50.8 lb, respectively. Only 27% of steps were within the acceptable range. The majority of steps were less than the prescribed weight at discharge, whereas the majority of steps were greater than the prescribed weight at first follow-up. These data suggest that more uniform and effective teaching methods for prescribed weight-bearing orders are warranted assuming compliance is an important clinical objective.

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Following lower extremity orthopedic fracture or surgery, patients are often instructed on how much weight to bear through the affected limb. Common instructions include touch-down weight bearing, partial weight bearing with a specific weight limit, or weight bearing as tolerated.

The rationale of restricting weight bearing is to limit the load on an extremity after injury or operative repair. One potential concern is that a single excessive load or repetitive loading over a tolerance point could lead to deformation or loss of alignment and fixation. Conversely, a need exists for advancing weight bearing to expose an injured site to loads, facilitating osteoblastic responses consistent with Wolfe’s law, which is essential for improving early bone strength and remodeling.

Although limited weight bearing is a common recommendation in the rehabilitation of orthopedic patients, controversy exists regarding its effectiveness and the ability of patients to perform the proper orders. Compliance with limited weight bearing may be restricted by many factors, including the ability of the physician or physical therapist (PT) to teach the patient, the ability to accurately assess whether the patient is bearing the correct amount of weight, patient comprehension, and intrinsic patient factors that may limit the patient’s ability to perform the movement (ie, dementia, poor upper body strength).

Instruction methods and the assessment of limited weight bearing vary widely, without a gold standard. No method is without limitation, and each has issues. Methods include traditional scale training, visual observation of a trainer offering feedback, and tactile methods of having the patient place the foot on top of the trainer’s hand or foot to feel what the patient is doing.

The most advanced form of training involves auditory or tactile biofeedback. This can include a shoe insert or the use of a force plate to measure weight bearing and deliver real-time feedback. Studies have found this to be a superior form of training because it can be used during dynamic gait, with the patient receiving immediate feedback with good training retention. However, many of these studies were performed on healthy participants and almost exclusively in research settings due to the high cost and complexity of existing biofeedback systems.

The purposes to the current study were to evaluate limited weight-bearing training with a mixed practice of PTs at a level I academic trauma center, to assess patient compliance with instructions for touch-down weight bearing (defined as 25 lb) at the time of discharge, and to assess patient compliance with instructions at their first outpatient follow-up. This will elucidate the compliance with current methods of limited weight-bearing training in a clinical cohort and improve on the existing studies on asymptomatic participants from the literature.

Materials and Methods

Survey Study

At the author’s institution, no formal guidelines are in place regarding the methods of teaching limited weight bearing to fracture or trauma patients. However, patients are kept in the hospital until they are medically cleared and found to be safe from a rehabilitation perspective. Accordingly, preparedness for discharge implies some level of confidence from the PT working with the patient that they can comply with the recommended mobilization instructions.

A survey was distributed to hospital PTs from the orthopedic ward to assess current weight-bearing teaching methods. Demographic data about the PTs were gathered. Questions regarding weight bearing included the following: percentage of time in which each teaching method was used (verbal cues, scale training, hand under foot, and demonstration), confidence in the training methods and in patients’ ability to comply (not confident, minimally confident, moderately confident, and very confident), and the challenges in teaching limited weight bearing.

Clinical Study

This study was approved by the authors’ institutional review board and all patients gave informed consent to participate. Patients were voluntarily enrolled in the study, which was approved by the Human Investigations Committee. Inclusion criteria were touch down weight-bearing orders (defined at the authors’ center as 25 lb), age older than 18 years, English speaking, not on contact precautions (ie, the patient had not tested positive for methicillin-resistant Staphylococcus aureus, and it was considered safe to use the same equipment for multiple patients without decontamination), having worked with a PT and cleared for mobilization with touch-down weight bearing, able to walk at least 30 steps at discharge, no other major injuries preventing use of an assist device, and cognitively intact.

Weight bearing was monitored using the SmartStep weight-bearing measurement device (Andante Medical Devices, Inc, White Plains, New York). This system consists of an insole insert and a small receiver strapped to the ankle that communicates wirelessly with a computer, continuously monitoring the weight bearing of the patient. Patients who had proximal lower extremity injuries were fitted with an insole and a tennis shoe (Figure 1). Patients with distal lower extremity injuries who were in a cast or splint had the insole wrapped to the bottom of their cast or splint between 2 pieces of molded plastic. The device was originally designed and validated for use in a shoe, which restricted its use to patients with injuries above the knee. The authors constructed a plastic platform that could be wrapped using an elastic bandage to the bottom of a splint to hold the device and mimic a shoe. This was validated with a bathroom scale and found to be sufficiently accurate ($r^2=0.9891$).
At their last physical therapy session before discharge, the SmartStep weight-bearing measurement device was attached and secured to the affected limb and patients were asked to walk approximately 50 steps with their recommended or preferred weight-bearing assistive device (crutches or walker). Patients and PTs were blinded to the data obtained from the SmartStep weight-bearing measurement device, and no further teaching was done based on the weight-bearing measurements from the system.

Patients returned approximately 2 weeks after discharge for their first outpatient follow-up. Prior to seeing the physician or having their cast removed, weight bearing was reassessed in the same manner as before with the SmartStep weight-bearing measurement device.

Data were analyzed using STATA version 11.2 software (StataCorp, LP, College Station, Texas). Statistical comparisons of weight-bearing status before discharge and at first follow-up were made using paired t tests. Error bars in the figures represent standard error of the mean. The level of significance was set at P=.05.

RESULTS
Survey Study
Twenty surveys were distributed to orthopedic ward PTs, with 15 surveys completed (75% response rate). Average years in practice was 13.8 years. When training patients, PTs used verbal cues an average of 87% of the time, tactile methods were used (hand or foot under patient’s foot) 41% of the time, demonstration was used 23% of the time, and a scale only 1% of the time. These percentages total more than 100% because multiple methods were often used together.

Only 7% of PTs felt very confident that patients were learning and maintaining the prescribed weight-bearing status, whereas 53% felt moderately confident, 32% felt minimally confident, and 8% did not feel confident at all. They attributed the low confidence to patient lack of understanding, lack of precise teaching methods, and patient pain. Others found patient fear or poor comprehension to be significant challenges. Most importantly, all PTs were interested in a new teaching method.

Patient Compliance With Partial Weight-bearing Orders
Thirty-two patients who met inclusion criteria for the study were identified. Of these, 11 patients withdrew and 3 were found to be ineligible due to not bearing any weight at either visit. In total, day of discharge data were collected from 21 patients, of which 18 returned for the first follow-up.

Study cohort demographics are seen in Table 1. Affected limb, type of assist device, injury type, and shoe vs splint were distributed evenly.

On the day of discharge, average weight bearing was 13.9 lb, with an average minimum and maximum of 3.2 of 30.2 lb, respectively (Figure 2). At first follow-up, average weight bearing was 33.0 lb, with an average minimum and maximum of 12.2 and 50.8 lb, respectively (Figure 2).

Stratification of the data into individual steps showed tremendous inter-step variability in the amount of weight the patients loaded on their affected limbs.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Age, mean (range)</td>
<td>41.9 (20-96)</td>
</tr>
<tr>
<td>Sex, No. (%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>7 (33.3)</td>
</tr>
<tr>
<td>Male</td>
<td>14 (66.7)</td>
</tr>
<tr>
<td>BMI, kg/m², mean (range)</td>
<td>27.7 (21.6-38.2)</td>
</tr>
<tr>
<td>Affected limb, No. (%)</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>10 (47.6)</td>
</tr>
<tr>
<td>Left</td>
<td>11 (52.4)</td>
</tr>
<tr>
<td>Assist device, No. (%)</td>
<td></td>
</tr>
<tr>
<td>Crutches</td>
<td>9 (42.9)</td>
</tr>
<tr>
<td>Walkers</td>
<td>12 (57.1)</td>
</tr>
<tr>
<td>Injury type, No. (%)</td>
<td></td>
</tr>
<tr>
<td>Ankle</td>
<td>2 (9.5)</td>
</tr>
<tr>
<td>Tibia</td>
<td>10 (47.6)</td>
</tr>
<tr>
<td>Femur</td>
<td>8 (38.0)</td>
</tr>
<tr>
<td>Acetabulum</td>
<td>1 (4.8)</td>
</tr>
<tr>
<td>Shoe/splint, No. (%)</td>
<td></td>
</tr>
<tr>
<td>Shoe</td>
<td>11 (52.4)</td>
</tr>
<tr>
<td>Splint</td>
<td>10 (47.6)</td>
</tr>
</tbody>
</table>

Abbreviation: BMI, body mass index.
*Eighteen patients were seen at both time points.
bore (Table 2 and Figure 3). Of note, the authors considered 10 lb above and below the prescribed 25 lb order to be a clinically acceptable range. At discharge, a majority (60.9%) of steps were underweight (0 to 14 lb), 31.2% of steps were within an acceptable range (25±10 lb), and 7.9% of steps were overweight (>35 lb). A statistically significant shift occurs in the results seen at the first follow-up, where 32.6% of steps were underweight (0 to 14 lb), 26.5% were in an acceptable range (25±10 lb), and 40.9% were overweight (>35 lb). A statistically significant increase in weight bearing from hospital discharge to first follow-up (Figure 2). However, average weight bearing at discharge was just below the limit delineated as acceptable, and average weight bearing at follow-up was at the upper end of the acceptable range. Although this demonstrated some increase in weight bearing as patients began to heal and have decreased pain, the difference in average weight bearing does not seem clinically striking.

What seemed more remarkable was the range of average values, as well as the percentage of steps above or below the acceptable range. The average maximum weight placed at discharge was 30.2 lb, but the average maximum at follow-up was 50.8 lb, which was more than double the prescribed target. Even more concerning was the average percentage of steps the patients were placing on the affected limb at higher and lower weight ranges. At discharge, a majority (60.9%) of the steps were below the acceptable 15 to 35 lb range, whereas at follow-up a large percentage (40.9%) of the steps were above the acceptable range.

If a patient is bearing an average of 25 lb on the affected limb but most of those steps are nonweight bearing and a few steps are grossly over the limit, the distribution may be unhealthy to the healing leg. Little feedback is available to stimulate bony healing, with a significant risk of hardware failure or further injury with the highly loaded steps. Ideally, to achieve recovery and good outcomes, the
goal is to have all steps within an acceptable range.

Some challenges occurred with the data collection for this study. Multiple patients did not fit inclusion criteria, but the authors were able to gather a sample size with adequate statistical power over a wide range of ages. In addition, 3 patients were excluded from the final data analysis due to their inability to place any weight on the affected limb at either of the study time points. The authors believe that inclusion of these patients would only have confounded the overall results, without help to determine the efficacy of current partial weight-bearing teaching methods. Lastly, the fact that the patients were connected to the SmartStep weight-bearing measurement device and being observed may have altered their behavior and weight bearing. This is impossible to avoid in this type of study, although both the patients and PTs were blinded from the weight-bearing data being collected.

CONCLUSION

Limited weight bearing is a commonly prescribed order after lower extremity fracture or surgery. Unfortunately, no consistent and accurate method of teaching is available. At a level I academic trauma center, the PTs were experienced but many still felt a low level of confidence in their ability to teach and in patients’ ability to comply with touch-down weight-bearing orders. This was evident in the clinical data. Although the total averages of all steps at both discharge and follow-up were within a reasonable limit (25±10 lb), the range of weight (minimums and maximums) and the percentage of steps outside of the range were significant. It is clear that a more effective method of teaching is necessary if compliance is to be achieved. Research has shown that the use of biofeedback devices may be an effective teaching method. Future research may demonstrate that a continual feedback process may be appropriately applied to address this issue.

REFERENCES