

PROFESSIONAL PRACTICE

Introducing a New Technique for Limb Prepping in Orthopedic Surgeries

Designing, Construction, and Evaluation of Limb-Lifting Assistive Device

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Abstract: Lifting and holding patients' limbs while preparing the skin for orthopedic surgeries may be a lengthy process causing work-related musculoskeletal disorders (MSDs) for preoperative team members. Studies reported weight limits for lifting and holding limbs; whenever this weight is greater than a specific amount, additional staff or assistive devices are needed because nurses and support staff working in orthopedic operating rooms (ORs) are at high risk of MSDs. The aim of this study was to demonstrate the design, construction, and effectiveness of a limb-lifting assistive device installed in the OR of 5 Azar Hospital affiliated with Golestan University of Medical Sciences and used during the surgical preparation process.

Keywords: nurses, lifting, assistive device, orthopedic procedures, MSDs

One of the major sources of surgical site infection (SSI) is microorganisms on the patient's skin (Cheadle, 2006), and ineffective preoperative skin preparation is one of the risk factors for development of SSIs (Mangram, Horan, Pearson, Silver, & Jarvis, 1999). Thus, proper preparation of the surgical site by the operative team (i.e., nurses or technicians) can prevent SSIs (Owens & Stoessel, 2008).

During the preparation process before orthopedic surgeries, preoperative team members lift and hold patients' limbs for up to 3 minutes using one or both hands. This manual process exerts strong forces on preoperative team members' shoulder and back muscles and joints and may lead to work-related musculoskeletal disorders (MSDs; Waters et al., 2011). Neck and shoulder complaints are more prevalent among operating room (OR) nurses compared with other nurses (Bos, Krol, van der Star, & Groothoff, 2007). In research by Choobineh, Movahed, Tabatabaie, and Kumashiro (2010), OR nurses' lower back pain

was their most common symptom after manual material handling (MMH) activities, and nurses believed that musculoskeletal problems could lead to job change (Choobineh et al., 2010).

Maximum weights to be lifted and held for up to 2 minutes for a one-handed lift of particular parts of a patient's body was assumed to be 5.03 kg and for a two-handed lift was assumed to be 10.1 kg. Whenever these weight limits are exceeded, additional staff or assistive devices are needed to minimize the risk of muscle fatigue and MSDs (Waters et al., 2011).

As nurses and other staff are at risk of developing work-related MSDs while lifting and holding limbs in orthopedic practice settings (Waters et al., 2009), use of an assistive device for lifting and holding a patient's limb during the surgical preparation process could be beneficial for both the patient and preoperative team members. Thus, the aim of this study was to demonstrate the design, construction, and effectiveness of a limb-lifting assistive device installed in the OR of 5 Azar Hospital affiliated with Golestan University of Medical Sciences and used during the surgical preparation process.

Design and Construction

This limb-lifting assistive device was designed and constructed to lift and hold patients' limbs during the prepping process for orthopedic surgeries. Before it was constructed, no standard devices were used for lifting and holding patients' limbs during the preparation process. In the traditional standard manual process, one nurse lifted and held the patient's limb for several minutes while another nurse prepared the skin for surgery, leading to increased risk for MSDs for the nurse lifting and holding the patient's limb.

The limb-lifting/holding device was constructed with six parts: (1) motor and gearbox, (2) unit control, (3) wire rope, (4) pulley, (5) hook, and (6) fixer (Figures 1A and 1B). Motor, gearbox, and unit control were covered by a removable metal frame. The device has an 8-hour rechargeable battery and can be connected to a power source directly, as well. All

components of this device, except the hook, can be sterilized simultaneously during sterilization of the OR. The hook, connected to the patient's limb, is disposable; its minimum width and diameter are designed to prevent the patient's limb from being compressed.

Trained staff and orthopedic surgeons can use this device during surgery and the prepping process. It is installed on the wall of the OR and the wire rope is driven by a pulley from above the patient's bed. After the patient is anesthetized and positioned for limb prepping and surgery, the hook is connected to the limb. The device is turned on, and by pressing the up and down buttons of the remote control, appropriate height and angle of the limb can be set and modified during the preparation process and surgery. The process also protects the limb from damage to the surgical site or further injury (e.g., fracture). When the prepping process is completed, the patient's limb is located in the sterile area to avoid contamination. Figure 2 shows the use of this device in the OR.

Effectiveness Testing

To evaluate the efficacy of using the device during the surgical preparation process, a single blind randomized clinical trial was conducted with 48 patients who underwent orthopedic surgeries in 5 Azar Hospital affiliated with Golestan University of Medical Sciences in 2013. The study was reviewed and approved by the Golestan Research Ethics Committee.

In this study, the patients were randomly assigned to two groups. In the intervention group, patients' limbs were held and

lifted by the assistive device during the preparation process; for the control group, OR nurses lifted and held the limbs with one or two hands (traditional method). Study variables included gender of the OR nurses, duration of the preparation process, number of nurses involved in the preparation process, and OR nurses' satisfaction.

SPSS Version 16 was used to analyze data. To test the association between categorical variables, chi square test was used or two-tailed Fisher exact test was used if the expected cell frequencies were too small. Independent-sample *t* test was used for continuous variables. A *p* value less than .05 was considered statistically significant. In both intervention and control groups, the majority of limbs lifted were feet (95.83% and 58.33%, respectively).

Table 1 shows demographic characteristics, frequency distribution, and mean of studied variables in the sample. No significant differences were found between the two groups in terms of gender ratios ($p = .773$). Use of the assistive device resulted in faster surgical preparation in the intervention group compared with the control group ($p < .0001$).

Furthermore, the number of nurses involved in the preparation process was reduced in the intervention group compared with the control group ($p < .0001$). In addition, satisfaction of nurses in both groups was measured by Visual Analogue Scale (VAS) with a range of 0 to 10, with 10 being *the most satisfied*. The mean satisfaction score was higher in the intervention group compared with the control group ($p < .0001$).

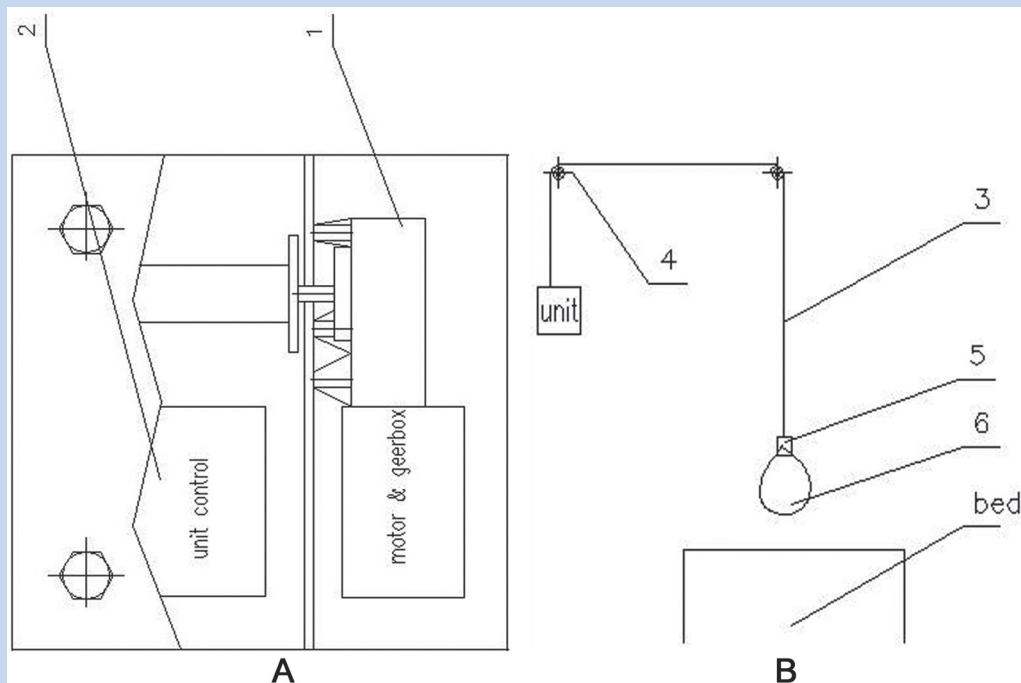


Figure 1. Plan of designed assistive device.

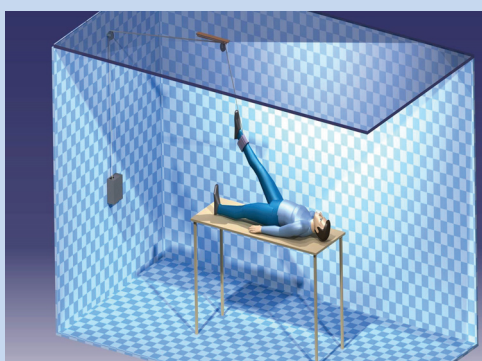


Figure 2. Schematic view of the designed assistive device.

Implications for Occupational Health Nurses

Whereas occupational health nurses have a major role in the prevention of injuries to hospital staff, they should investigate the feasibility of implementing limb-lifting devices such as the one described in this study if traditional, manual processes are currently used. Return on the financial investment can be realized quickly when fewer injuries occur and fewer staff are needed. Employee health nurses should consider measuring adverse patient incidents using manual and mechanized surgical prepping in institutions that adopt limb-lifting devices.

Conclusion

Lifting and holding patients' limbs during the surgical preparation process, using the assistive device, had the following advantages for preoperative team members: facilitating the preparation process by reducing the duration of the process and number of nurses involved in it. In addition,

nurses who used this assistive device were more satisfied with their work compared with those who used the traditional manual preparation method.

It could be inferred that use of this assistive device may reduce injuries to patients during the preparation process and the rate of MSDs among OR nurses; however, further prospective investigations are needed.

Thus, to reduce muscle fatigue and the risk of MSDs related to inconsistency between staff physical capabilities and weight of patients' limbs, time to complete the preparation process, and the number of nurses needed for limb preparation, the use of this assistive device is recommended.

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Conflict of Interest

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Table 1. Demographic Characteristics of Population Studied, Frequency Distribution, and Mean of Studied Variables

	Intervention group	Control group	<i>p</i> *
Sex of nurses (%)			
Male	13 (52%)	12 (48%)	.773
Female	11(47.8%)	12(52.2%)	
Prep process duration (min; <i>M ± SEM</i>)	11.91 ± 0.31	13.66 ± 1.45	<.0001*
Number of nurses involved in prep process (<i>M ± SEM</i>)	1	3	<.0001*
Nurses' satisfaction (score; <i>M ± SEM</i>)	9.33 ± 0.14	3.16 ± 1.30	.019*

Note. SEM = standard error of the mean.

**p* = .05.

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