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Comparison of Positive Pressure Gloves on Hand Function in Adults With Burns

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The purpose of this study was to analyze the impact of a standard, custom-made pressure glove vs The NewYork-Presbyterian Dexterity Glove (NYPDG) with silon application on the palmer surface on functional hand use of burn survivors. A standard, custom made pressure glove and NYPDG were given to 18 participants in a randomized order. Subjects wore each glove for 7 to 10 days during all activities of daily living (ADL). Variables such as hand function, difficulty of fine and gross motor ADL, and participant glove preference were assessed with each glove condition. Data collection of the second glove took place 7 to 10 days later incorporating a quasiexperimental, repeated measure design. A crossover design was used to analyze the data. The NYPDG demonstrated significantly better results in all of the four outcome categories measured: time to complete the Jebsen, the Jebsen Likert scale, fine motor ADL, and gross motor ADL. This study demonstrated that functional tasks took less time to complete and were more easily performed when using the NYPDG. (J Burn Care Res 2006;27:339–344)

Custom made pressure garments commonly are recommended after a burn injury for prophylactic management of hypertrophic scar tissue.[1–4] Burn survivors routinely wear the elasticized garments 23 hours a day during all activities in an effort to minimize scarring. Patients who have sustained hand burns report that pressure gloves can interfere with activities of daily living (ADL) because of the poor frictional properties of the materials used in the glove's palmer surface. It has been described in the literature how the use of conventional gloves can negatively influence grip force,[5–7] grip and pinch strength,[8] grip fatigue,[9] functional sensation,[5,7,10] and dexterity,[10–13] all of which impact functional hand use.

Gloves worn by individuals in the workplace typically have leather or plastic material applied to the entire surface of the palm. Ergonomic studies have demonstrated the positive impact of these work gloves on tasks involving manipulation of select tools.[11,12] More recently, an ergonomic study has shown that selective placement of the material on designated areas of the palmer surface is more effective.[6] Given this information, the NewYork Presbyterian Dexterity Glove (NYPDG) was designed with selective suede placement on the palmer surface of a positive pressure glove. The results of a study conducted on uninjured participants found that functional tasks as well as fine motor and gross motor ADL were easier to execute and took less time to complete with the prototype design of the NYPDG.[17]

The purpose of this study was to compare the functional benefits of The NewYork Presbyterian Dexterity Glove (NYPDG; Figure 1) to a standard burn pressure glove (SPG; Figure 2) in patients who had sustained hand burns. It was hypothesized that adults with hand burns would demonstrate more ease in performing daily tasks when wearing the NYPDG as compared with when wearing the SPG. It was hypothesized that wearing the NYPDG would facilitate the ease of performing daily tasks as compared with wearing the SPG for adults with hand burns.

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MATERIALS AND METHODS

Subjects

Adults who had sustained hand burns requiring pressure garments were recruited from April 2004 to October 2004 for this quasiexperimental, repeated measure study. Subjects served as their own control,

Figure 1. The NewYork-Presbyterian Dexterity Glove.

Figure 2. A standard positive pressure glove typically worn by patients with hand burns.

receiving each glove in a randomized order. Exclusion criteria were any known orthopedic, neurologic, or developmental disorders of the involved upper extremity. Those subjects unable to follow three-step commands in English also were excluded. Twenty-three adults signed a written consent approved by the Institutional Review Board of NewYork-Presbyterian/Weill Cornell Medical Center. Demographic data collected included age, sex, race, hand dominance, TBSA burn, and etiology of injury.

Instrumentation

The first two authors made minimal modifications to the prototype suede design of the NYPDG based on feedback received from the previous study on uninjured adults. The suede was changed to silon, which is more flexible and can be sewn into the seams of the glove for increased durability. The Jobskin Division of the Torbot Group, Inc. (Toledo, OH) manufactured the gloves from the authors' design. That final design was used for the 23 gloves subsequently ordered for the subjects in the study. Procedures for assessing the variables were similar to that of a previous study of pressure garments by the first two authors as is described in this article.[17]

Participants were tested with the following objective and subjective measures while wearing each type of glove: the Jebsen Hand Function Test, a Likert scale of the Jebsen tasks, a Likert scale of fine motor ADL, and a Likert scale of gross motor ADL.

1. The Jebsen Hand Function Test (WisdomKing.com, Inc., Oceanside, CA) consists of seven standardized, objective tasks. The seven timed test items include unilateral tasks that comprise daily activities (Table 1). This reliable Jebsen hand function[18] test has been used across a variety of diagnoses, including hemiparesis,[18] traumatic quadriplegia,[18] rheumatoid arthritis,[18,19] burn injuries,[20,21] and with uninjured subjects.[17,18] The Jebsen also has been used to evaluate various interventions such as medications,[18] orthoses,[22] type of positive pressure gloves,[17] treatment pro-

Table 1. The tasks on the Jebsen Hand Function test

Writing
Turning cards (simulated page turning)
Picking up small objects
Simulated feeding
Stacking checkers
Lifting large light objects
Lifting large heavy objects

tocols,[20] functional impact of surgery,[22] functional impact of immobilization,[23] and to predict outcomes.[20,21]

2. Subjects used Likert scores ranging from 1 (very easy) to 5 (very difficult) to individually rate the seven tasks after completing the Jebsen test.[17]
3. A list of fine motor ADLs that are difficult to execute while wearing pressure gloves was identified by a panel of physical and occupational therapists from the NewYork-Presbyterian Hospital burn unit. The subjects were asked to rate the level of difficulty performing 15 fine motor tasks on a Likert scale from 1 (very easy) to 5 (very difficult) (Table 2).[17]
4. Eleven gross motor skills were identified and selected in the same manner (Table 3). The subjects were asked to rate their level of difficulty from 1 (very easy) to 5 (very difficult).[17]

Procedure

After consent was obtained, the subjects' involved hand(s) were measured by an experienced representative from Stahl Surgical Company (Riverdale, NY) who was trained and deemed competent by the manufacturer. At this first encounter, circumferential measurements were taken at specified anatomical sites as per standard practice. Both sets of pressure gloves were designed from the same measurement with closed tips, extended to the wrist, and provided approximately 20–30 mm Hg (as per manufacturer).

At the second encounter, subjects were assigned randomly either the SPG or the NYPDG for the first trial. The garment was assessed for adequate fit by the first author. Verbal and written instructions were conveyed to the subjects to gradually increase glove wear from 4 hours to 23 hours during a 6-day time frame. Once the 23 hour per day schedule was attained, subjects were instructed to wear the glove during all daily activities, removing the glove for bathing and hygienic purposes only. This wearing schedule would continue until the subject's scar reached maturity as per standard of care. Subjects were provided with the ADL Likert scales to take home and instructed to rate the difficulty of the select fine motor and gross motor ADL while wearing the assigned glove during the week when performing the actual task.

After 7 to 10 days of wearing the glove for 23 hours per day, subjects returned for the third encounter. One of two randomly assigned physical therapists administered the Jebsen Hand Function Test to the patient while he or she wore the glove, along with a Likert scale to rate the difficulty of the seven Jebsen tasks. The Jebsen test was administered using standardized procedures. In an armless chair, each subject was seated in an upright position with feet supported on the floor and the table at elbow height. Verbal instructions were quoted from the Jebsen's manual before each task. Participants also returned the ADL Likert scales they had completed at home while wearing the assigned glove. Subjects were then fit with the remaining glove and the tester reviewed the verbal instructions for its wearing regime.

The fourth visit was scheduled 7 to 10 days later in an attempt to decrease the learning effect from the Jebsen Test, which was found in the previous study.[17] The second tester administered the Jebsen Hand Function Test and was blind to the results of the first trial. All other procedures remained the same as the third visit. Upon completion, subjects were asked which glove they preferred to wear during their ADL.

Table 2. Items on the Fine Motor ADL Likert Scale

Buttoning
Zippers
Tying shoes
Using a fork and knife
Twisting a bottle cap
Opening a soda can
Locking/unlocking a door
Placing/removing coins from a pocket
Placing/removing bills from a wallet
Putting coins into a machine
Using a Metrocard (ie, subway card)
Using an automated bank machine
Dialing a phone
Turning pages in a book or magazine
Signing one's name

Table 3. Items on the Gross Motor ADL Likert Scale

Placing/Removing Heavy Objects From a Shelf
Holding a phone
Holding handrails on stairs
Turning a steering wheel
Turning a door knob
Pouring a cup of liquid
Bringing cup to mouth
Holding pot/pan
Pouring cereal box
Pouring a carton of milk
Brushing teeth

Statistical Analysis

The statistical software package SPSS (SPSS Inc., Chicago, IL) was used to analyze the data. To investigate the order, period, and treatment effects, a crossover analyses was performed. The order effect assessed whether receiving the gloves in a different sequence affected the outcomes. A period effect addressed whether, regardless of the glove received, responses to the first administration of the Jebsen test were different from those involving the second administration. The treatment effect assessed whether the treatment, the NYPDG, affected the outcomes differently than the control, the SPG.

RESULTS

Eighteen (17 men) of 23 subjects completed the study. Three subjects did not return after receiving the NYPDG, one subject was lost to follow up, and one discontinued wearing all pressure garments. Subjects' ages ranged from 22 to 65 years (40 ± 13.7 years), TBSA burn ranged from 1–49% (22.9 ± 16.6%), 100% of participants were right hand dominant; however, 50% were tested with their nondominant hand as well.

The order in which the subjects received the gloves (order effect) did not statistically influence any of the four the outcome categories (Table 4). A significant period effect was found for the Jebsen test only (Table 4). Subjects' performed the Jebsen quicker the second time regardless of which glove they wore ($P < .02$). Of greater importance, statistically significant treatment effects were found in all four outcome categories (Table 4). On average, subjects completed the Jebsen Hand Function Test 21 seconds faster with the NYPDG ($P < .01$; Figure 3). The Jebsen Likert scale revealed that tasks were significantly easier to perform with the NYPDG ($P < .01$; Figure 4) and fine and gross motor ADL were less difficult to complete with the NYPDG compared with the SPG ($P < .04$; $P < .01$; Figure 4). Seventeen of 18 participants (94%) preferred the NYPDG to the standard glove.

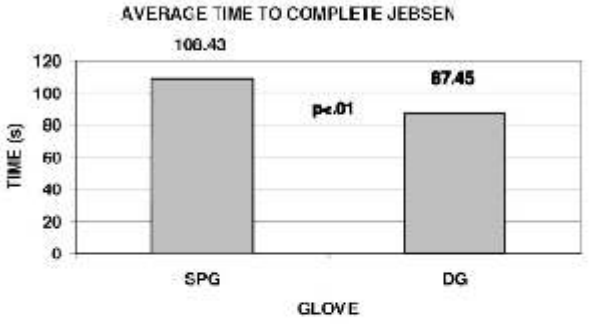

Figure 3. The average time in seconds it took subjects to complete the Jebsen hand test while wearing each of the gloves. *indicates a significant difference ($P < .01$).

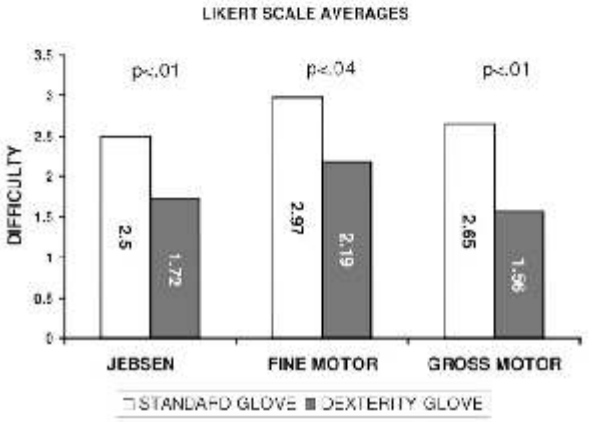

Figure 4. The average scores of the Jebsen Likert scale and fine and gross motor activities of daily living while wearing the gloves.

DISCUSSION

The results of this study indicate that tasks took less time to complete and were easier to perform when

Table 4. Crossover analysis

	Jebsen Test		Jebsen Likert		Fine Motor		Gross Motor	
	F	P Value	F	P Value	F	P Value	F	P Value
Order effect								
$=[[(1)+(3)]-[(2)+(4)]]/2$	0.24	=.63	0.33	<.58	0.41	<.53	0.19	<.67
Period effect								
$=[[(1)+(2)]-[(4)+(3)]]/2$	7.04	<.02	0.18	<.68	0.45	<.52	0.28	<.61
Treatment effect								
$=[[(1)-(2)]+[(4)-(3)]]/2$	10.99	<.01	10.50	<.01	5.50	<.04	19.03	<.01

using the NYPDG as compared with the SPG for patients with hand burns. Objectively, subjects performed the Jebsen Hand Function Test faster with the NYPDG and subjectively, they reported that gross motor and fine motor ADL were easier to complete while wearing the NYPDG. An overwhelming number of participants preferred to wear the NYPDG for functional tasks.

These results are in agreement with the results of previous studies using selective suede placement on a positive pressure glove with uninjured subjects[17] and total palmar coverage of positive pressure glove with leather as tested with a small sample of burn patients.[24] There were two studies that compared the construction and features of pressure garments but did not consider their effect on function.[25,26] Otherwise, there are no other studies to date that examined burn patients' functional hand use with pressure gloves composed of various materials. Moreover, several studies in the burn literature have used range of motion and grip strength as measures of functional outcomes.[27,28] Current thinking as described by the World Health Organization in the International Classification of Functioning, Disability, and Health highlights the importance of an individual's ability to perform activities and participation in daily life,[29] both of which include functional hand use in general tasks and self care. In addition, there is a focus shift in health care to acknowledge the patients' perception of their ability to perform activities as well as their perceived quality of life.[30] This study considers functional hand use, patient perception of activity performance and quality of life with the deliberate selection of the assessment tools used. It is also informative that the findings of the Jebsen Taylor Hand function test, an objective tool, yielded similar results to the subjective scales used and involved the areas that the patients found to make the greatest impact on their life.

In addition to considering patient perspective, the inclusion of subjective patient questionnaires in this study yields a more comprehensive assessment of hand function.[22,31–33]

The authors developed the Likert scales of the Jebsen tasks and the fine and gross motor ADL to integrate subjective and objective information. In isolation, questionnaires can be unreliable and insensitive to changes in function[34]; however, used in combination with objective measures, they offer a comprehensive assessment of the subject's hand function.[31]

Limitations of this study include the following. The sample used was one of convenience and involved subjects, ages 22 to 65, mostly men, from only one metropolitan hospital. The findings therefore cannot be generalized to populations in other settings, individuals older or younger than the designated age range, and individuals with other types of hand injuries without future study. A practice effect is noted in this study with the Jebsen–Taylor hand function test, as was found in a previous study despite increasing the time between trials.[17]

The significance of this study lies in its contribution to the current body of knowledge of functional hand use when wearing positive pressure gloves. Facilitating performance of daily tasks enhances quality of life and is a valuable goal, especially for those suffering from devastating injuries.

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