Compensation by the Uninjured Arm After Brachial Plexus Injury

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Abstract

Background: The goals of this study were to assess how preoperative and postoperative patients use their uninjured arm to compensate for adult brachial plexus injury (BPI) and to determine whether the Disabilities of Arm, Shoulder, and Hand (DASH) Questionnaire measures this compensation. **Methods:** Ten preoperative and 13 postoperative patients were enrolled in this qualitative-quantitative study. During the qualitative phase, patients were asked how they compensated because of BPI; responses were analyzed with grounded theory. During the quantitative phase, patients completed a standard-DASH reflecting the ability to do activities in any way using both arms as necessary, and a qualified-DASH reflecting their estimated ability to do activities using the uninjured arm the way they otherwise usually would. Two DASH scores were calculated (range, 0-100, higher = worse) and were compared with paired *t* tests. **Results:** There were 3 categories of compensation: using the uninjured arm more, exclusively, or to position the injured arm so that the hand (if functional) could be used. The mean standard-DASH and qualified-DASH scores, respectively, were 52 and 74 for preoperative patients (difference 22, *P* < .0001), and 41 and 64 for postoperative patients (difference 23, *P* = .0008). **Conclusions:** Patients with BPI report different types of compensation by the uninjured arm which can be discerned by the DASH.

Keywords: compensation, accommodation, brachial plexus injury, DASH, qualitative

Introduction

A brachial plexus injury (BPI) in an adult is a dramatic life-altering event.^{1,9,11,15} Patients make major modifications and accommodations that often include changing employment and educational goals, altering residence, and becoming financially and physically dependent on others. Patients also make constant modifications to almost every aspect of daily life.^{5,9,10,15}

Advances in BPI surgical techniques have made surgery an option for more patients; however, surgery is not curative and the goals are to improve severe symptoms and to restore as much function and quality of life as possible.^{5,14} Function has been measured in various ways, such as with surgeons' ratings of motion and sensation, therapists' ratings of performance-based tasks (ie, grasp), and patients' ratings of ability to do essential and discretionary activities.^{1,3,7,8,13-15}

The most widely used patient-reported scale for BPI is the Disabilities of the Arm, Shoulder, and Hand (DASH) which addresses symptoms, ability to perform certain tasks, such as change a light bulb, and ability to engage in complex

activities, such as participate in social and work activities.¹² Most questions do not distinguish between performance with the injured and uninjured arm, thus some researchers have questioned to what degree does the DASH measure disability (of the injured arm) versus compensation (of the uninjured arm).¹⁰ This question is particularly salient for BPI because the time to recovery is prolonged due to the need for nerve regeneration and patients must compensate during the long recuperation period. Thus, compensation to some degree is essential for all patients, regardless of prognosis.^{5,10}

Although the role of compensation is widely acknowledged, there have been few reports describing the nature and extent of compensation in patients with BPI.^{7,9} It is likely that patients compensate according to their degree of injury, and the use of the uninjured arm is pivotal in this

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process. Among patients with an injured arm due to unilateral BPI, the goals of this study were to assess compensation by the contralateral uninjured arm using the DASH. A mixed qualitative-quantitative methodology was used and both preoperative and postoperative patients were included.

Materials and Methods

This cross-sectional study was approved by the institutional review board (IRB) at the Hospital for Special Surgery, and all patients provided written informed consent and permission to use protected health information.

This study was part of a larger project to ascertain BPI patients' disabilities to develop a BPI-specific functional status survey. A convenience sample of consecutive patients was enrolled. Patients were eligible if they were 18 years of age or older, spoke English, and had sustained a partial or complete BPI either by a traumatic accident or as an inadvertent consequence of other medical care. Preoperative patients were included if they were scheduled to undergo surgery within the next several days and postoperative patients were included if they had had surgery within the prior 9 to 24 months. The short-term postoperative period was selected because during this time, patients can still attribute functional limitations distinctly to BPI, the degree of permanent disability has not yet been determined, and rehabilitation is still in progress. Patients were approached at the time of a routine office visit and were interviewed in person by the same investigator at that time.

Qualitative Methods

Patients were first asked a series of open-ended questions about the impact of BPI on their physical and emotional well-being.¹⁶ Several questions asked what modifications and compensations they had made because of BPI: "What bothers you the most about your arm? What bothers you the most about your situation? How have you modified activities because of your arm? What accommodations have you had to make because of your arm?" Patients were not specifically asked about the role of the uninjured arm. Patients were encouraged to volunteer as many comments as they wished and their responses were recorded verbatim in field notes.

Quantitative Methods

Patients were asked to complete the DASH, a 30-item questionnaire addressing symptoms and limitations due to upper extremity injury or dysfunction.¹² The first 21 items ask patients about difficulty performing specific tasks with 5 response options ranging from "no difficulty" to "unable." The remaining 9 items ask about symptoms and limitations in broad activities (eg, social and daily activities) due to the injured arm. The questionnaire is scored from 0 to 100, with

higher scores reflecting more limitation. An important difference in score is considered to be 15 points.² The DASH is one of the most widely used self-report questionnaires for patients with BPI and there are reports of preoperative and postoperative scores from multiple previous studies.¹⁷ In addition, a score of 10 ± 14 has been reported as the normative value for the general US population.¹⁸

For our study, patients were asked to complete the first 21 items of the DASH twice from 2 perspectives. First, from the perspective of the standard format in which patients rate their ability to do the activities in any way using both arms as necessary. Second, from the qualified perspective of doing the activities using the uninjured arm as if there had been no injury (ie, the way they otherwise usually would). Specifically, they were instructed to rate how difficult it would be to do each activity "if you used your uninjured arm only as much as you usually would." The simple nature of most of the activities somewhat mitigates this imperfect methodology (discussed further below), which also includes relying on patients to estimate difficulty based on their experiences doing these activities before the injury. The standard-DASH was always administered first followed immediately by the qualified-DASH because we wanted patients to juxtapose how they currently and previously performed activities and thus compensated. Patients understood the purpose of the qualified perspective and readily responded to each item.

Information also was obtained from patients and charts about how the injury occurred, time since injury, degree and side of injury, and dominant side.

Qualitative Data Analysis

Responses to open-ended questions were reviewed with standard qualitative techniques using grounded theory, a methodology in which patients' responses are sequentially aggregated into larger themes through an iterative process.^{4,19} Specifically, all verbatim responses were analyzed line by line to identify unique concepts. Concepts were then aggregated into categories based on similarities to each or based on specific phenomena.¹⁹ The entire process was driven by patients' perspectives and not by investigators' a priori hypotheses. Data acquisition continued until no new perspectives were volunteered, that is, data saturation. The qualitative analysis was corroborated by 2 investigators: one was a methodologist with expertise in qualitative research and the other was an orthopedic surgeon with expertise in upper extremity surgery. Each investigator conducted the qualitative analysis independently and then through consensus arrived at the final set of categories.

Quantitative Data Analysis

Two sets of DASH scores were calculated: 1 for scores based on the perspective of doing activities using both arms

Table 1. Demographic and Clinical Characteristics.

Characteristic	Preoperative patients (n = 10)	Postoperative patients (n = 13)
Age, mean, years (range)	38 (24-63)	36 (19-59)
Men	10	9
Occupation at time of injury		
Professional/managerial ^a	2	5
Manual work ^b	8	4
Student ^c	0	4
On disability/stopped school at time of enrollment	9	8
Mode of injury		
Motor vehicle ^d	9	11
Consequence of treatment for other medical condition ^e	1	2
Location of injury		
Dominant side	7	6
Non-dominant side	3	7
Degree of injury		
Partial	4	6
Complete	6	7

^aTeacher, lawyer, financial analyst, chiropractor, business manager.

^bMechanic, construction worker, truck driver, restaurant/retail worker.

^cFull-time college.

^dMotorcycle, automobile, recreational vehicle.

^eRadiation therapy, malposition during coma.

in any way necessary (standard-DASH) and 1 for scores based on the qualified perspective of using the uninjured arm only as they usually would (qualified-DASH). The authors of the DASH acknowledged our use of the DASH in this way for the purposes of this study, affirming the caveat that the DASH was designed to measure ability to do activities in any way possible and not to measure disability of either limb. Both sets of scores had normal distributions, thus means and standard deviations were calculated for each set of scores and compared with paired *t* tests. Scores were also compared based on whether the injury was on the dominant side.

Results

Twenty-three consecutive patients (10 preoperative, 13 postoperative) were enrolled from April 2013 to March 2014. Most patients were young men and had traumatic BPI from a motor vehicle accident (Table 1). Injury levels were C5-C6 (3 patients), C5-C7 (6 patients), C7-T1 (2 patients), and complete (10 patients) and upper trunk (2 patients). For preoperative patients, the mean time from injury to enrollment was 7 ± 3 months and from enrollment to subsequent surgery was 12 ± 13 days. For postoperative patients, the mean time from injury to enrollment

was 33 ± 37 months and from surgery to enrollment was 14 ± 4 months. All patients were in school or working full-time when the injury occurred, and 17 were on disability or had stopped school because of BPI at the time of enrollment. All preoperative and 12 postoperative patients were right-side dominant, and BPI occurred on both the dominant and non-dominant sides.

Qualitative Results

Patients volunteered a series of responses to the open-ended questions about how they compensated because of BPI. Some responses related specifically to the uninjured arm and were grouped with qualitative analysis into 3 categories (Table 2). The first category included comments about using the uninjured arm more than previously, primarily to learn how to do tasks, including writing, in different ways. The second category reflected complete loss of function of the injured arm and the necessity to use the uninjured arm to do all tasks; this obviously was the scenario for the 5-level injured patients. The third category reflected innovation in using the uninjured arm to help the injured arm participate in tasks. Most often this involved positioning the injured arm so that the hand (if functional) could be used.

Quantitative Results

The standard-DASH and qualified-DASH mean scores were calculated for preoperative and postoperative patients separately (Table 3). For both groups, the qualified-DASH scores were higher (worse) than the standard-DASH scores. This indicates that patients had more difficulty performing the activities if they used the uninjured arm only as they usually would. Preoperative patients reported they would be completely unable to do 52% of tasks (qualified-DASH) versus 19% (standard-DASH), and postoperative patients reported they would be completely unable to do 46% of tasks (qualified-DASH) versus 18% (standard-DASH). These findings provide preliminary evidence that disability and compensation are both reflected in the standard-DASH score. In addition, the mean within-patient difference between qualified-DASH and standard-DASH scores exceeded a clinically important difference for both preoperative and postoperative patients; thus, the role of compensation is clinically relevant.

For preoperative patients, both the standard-DASH and qualified-DASH scores were worse if the injury was on the dominant versus the non-dominant side (60 vs 34, $P = .03$; and 81 vs 58, $P = .02$). For postoperative patients, the standard score was the same whether the injury was on the dominant or the non-dominant side (29 vs 51, $P = .17$) but the qualified score was worse if the injury was on the non-dominant side (49 vs 77, $P = .04$).

Table 2. Types of Compensation Made by Uninjured Arm.

Uninjured arm does more of task than usual
“There are things I still cannot do, you have to get used to it. Once you get over it, you find you still can do a lot with the use of the other hand.”
“Fortunately I was already ambidextrous before the accident. I already could use my left side as well as my right before the accident. That has been a big help.”
“I have to learn to do everything with my left hand. Writing takes forever . . . I changed my daughter’s diaper for the first time this week.”
“I still work. It takes more effort and I use my left arm now and I get the other limbs involved.”
“I am a rightie. I am learning to use my left hand.”
Uninjured arm does the task alone
“I learned to do everything with my left hand. I learned by trial and error. There is a way to do everything with one hand.”
“Fortunately the injury is on the left and I manage to drive with only the other hand.”
“I eat with my left hand. I do everything now with my left hand.”
“I am right handed; it is hard to accept but I can’t do anything with the right. I am using only the left.”
Uninjured arm potentiates ability of injured arm
“I use my right hand to lift my left arm to the correct position when I am cooking. Once my arm is there, I can then use my hand.”
“I have to grab my right wrist with my left hand to position it so that I can use it to do things at or above my elbow level. I have to consciously do this otherwise I can’t use my right hand.”

Table 3. Comparison of Standard-DASH and Qualified-DASH^a Scores Reflecting Compensation by Uninjured Arm.

Surgical status and side of injury	Standard score ^b	Qualified score ^c	Difference ^d	P
Preoperative patients				
All (n = 10)	52 ± 19	74 ± 15	22 ± 9	<.0001
Injury on dominant side (n = 7)	60 ± 17	81 ± 13	21 ± 10	.002
Injury on non-dominant side (n = 3)	34 ± 5	58 ± 5	24 ± 6	.03
Postoperative patients				
All (n = 13)	41 ± 28	64 ± 25	23 ± 19	.0008
Injury on dominant side (n = 6)	29 ± 21	49 ± 26	20 ± 23	.09
Injury on non-dominant side (n = 7)	51 ± 31	77 ± 17	26 ± 16	.005

Note. DASH, Disabilities of Arm, Shoulder, and Hand.

^aPossible score range 0-100, higher is more limitation.

^bDoing activities with both arms in any way possible.

^cDoing activities using uninjured arm as usually would.

^dWithin-patient difference in score.

Discussion

Our study showed that patients with BPI compensate with the uninjured arm to fulfill basic physical functions. Compensation includes relying on the uninjured arm to perform activities and using the uninjured arm to potentiate whatever abilities the injured arm still possesses. Using the DASH permitted us to quantify the degree of compensation by showing worse scores if the uninjured arm were used only as it usually would be used. This was the case for both preoperative and postoperative patients.

Our findings have clinical relevance because they show that the DASH, which is a valid measure of upper extremity function, is determined by 2 phenomena in patients with BPI—the underlying injury of the injured arm and the effectiveness of the uninjured arm to compensate. Given a

major goal of treatment for BPI is to restore as much function as possible, our study supports special efforts to teach patients how to compensate with the uninjured arm. This entails additional rehabilitation that is distinct and complementary to what typically is provided for the injured arm.

Our findings also contribute to the ongoing discussion about how to measure the impact of BPI and its treatments, particularly surgery. Whereas it is possible to isolate pain and sensory symptoms of BPI, it is not possible with current patient-reported measures in their standard formats to isolate function to the injured arm. This is because performing basic and complex activities of daily living obviously depends on the contribution of each limb. Furthermore, how function is restored is not as critical an issue for patients as long as they are successful in accomplishing desired tasks. Thus, patient-reported measures of overall physical

function are useful because they reflect what is salient to patients, namely, global function. Of note, from a methodological point of view, it is important to acknowledge that compensation takes time to develop and perhaps should be treated like an intervention occurring primarily after surgery.⁷

We observed that for preoperative patients, both DASH scores were worse if the dominant arm was injured. For postoperative patients, we found no difference for the standard-DASH score but worse qualified-DASH score if the non-dominant arm was injured. One possible explanation may be that the longer time since injury afforded by the postoperative scenario provides more opportunity to learn to compensate, and thus better standard-DASH scores. These observations and hypotheses are preliminary and need to be confirmed with other samples.

Our results support the findings of several recent reports of traumatic BPI. One qualitative study with 12 patients used semi-structured interviews and found adaptation with the other arm to be a major component of dealing with BPI.⁹ In this study, patients reported compensating by learning to use the other hand exclusively and by using special devices, such as a one-handed keyboard. In another study of 36 patients, 2 years after surgery for traumatic BPI, patients still compensated with the uninjured arm for eating, writing, and lifting.⁷ Several recent studies used the DASH before and after surgery and demonstrated marked improvements in score, especially for questions pertaining to performance of certain tasks.^{6,7,11} Other studies used different scales, including ad hoc surveys, and showed marked limitations in multiple areas of function.^{5,15} No other studies, however, attempted to account for compensation by quantifying it with existing scales.

The major limitation of our study was asking patients to estimate how more difficult activities would be if they used their uninjured arm only as the usually would. Although this methodology is imperfect, it is a starting point to show that compensation can be measured and has a consequential impact on a valid scale that is sensitive in this population. Possible future work could focus on validating the method we used by comparing DASH scores with how patients actually perform standard tasks, developing a new patient-reported scale specifically for compensation, and developing a core set of integrated skills that could be followed longitudinally with the contribution of each arm scored separately. Other limitations of our study are that participants were patients in a tertiary care BPI practice and most had motor vehicle injuries; thus, their perspectives may not be generalizable to patients in other settings and with other injuries.

In our study, patients with BPI reported that they relied on the uninjured arm to assist and compensate for the injured arm in simple and complex activities. Our study provides preliminary evidence that compensation by the

uninjured arm can be discerned and is clinically relevant according to a valid patient-reported scale. These findings support the importance of effective and innovative rehabilitation for both arms after BPI. They also highlight the necessity of accounting for compensation when assessing change in function after treatment for BPI.

Ethical Approval

This study was approved by the Institutional Review Board at the Hospital for Special Surgery.

Statement of Human and Animal Rights

This study included only human; there were no animals.

Statement of Informed Consent

All patients provided written informed consent.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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