SCIENTIFIC ARTICLE

Conjoint Analysis of Treatment Preferences for Nondisplaced Scaphoid Fractures

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Purpose We used conjoint analysis to assess the relative importance of factors that influence a patient's decision between surgical or nonsurgical management of a nondisplaced scaphoid fracture. Our hypothesis was that out-of-pocket costs will have a greater influence on decision making than the time spent in a cast or brace, degree of soreness, or the risk of treatment failure.

Methods Two-hundred and fifty participants were recruited using Amazon Mechanical Turk and asked to assume that they had experienced a nondisplaced scaphoid waist fracture. They then indicated their relative preferences among 13 pairs of alternatives with variations in the following attributes: time in a cast, time in a brace, duration of ongoing soreness, risk of treatment failure (by which we meant scaphoid nonunion), out-of-pocket costs based on estimates of direct costs ($500−2,500), and apprehension about surgery. A conjoint analysis was used to determine the relative importance of these factors when choosing between surgical or nonsurgical management.

Results The factor with the greatest influence on treatment choice was the cost of the procedure. After assessing the respondent's apprehension to undergo surgery, a sensitivity analysis showed the proportion of respondents who would choose surgery given different outcomes. To make the predicted share of those who are "not worried" about surgery equal to those who are "somewhat worried" or "a little worried" would require that the cost of surgery increase by $2,700. In addition, 2 weeks in a cast, 3 weeks in a brace, 2 months of soreness, or a 2% increase in the risk of fracture nonunion generates the same surgical choice probability as a $2,000 increase in the out-of-pocket cost of surgery.

Conclusions As conceptualized in this conjoint analysis, out-of-pocket costs and apprehension about surgery seem to have a greater impact on a decision for surgery than the time spent in a brace or cast and the risk of treatment failure. *(J Hand Surg Am. 2018;43(7):678.e1-e9.*

Type of study/level of evidence Economic and decision analysis III.

Key words Conjoint analysis, hand surgery, patient preferences, scaphoid fracture, shared decision making.

Online Exclusive

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Patients who experience nondisplaced scaphoid fractures may be treated with cast immobilization or surgical treatment with various types of internal fixation. Immobilization of the wrist for at least 6 to 12 weeks is an effective treatment with bony union achieved in greater than 90% of patients.[1–3] However, cast immobilization is cumbersome and may lead to temporary stiffening of the wrist, reduced grip strength, a longer return time to manual work, and a prolonged healing time.[3–5] Internal fixation limits immobilization and provides patients with an earlier return to work and higher rates of union.[5] However, patients undergoing surgery may be at an increased risk for osteoarthritis, soft-tissue injury, and implant-related complications.[5] Furthermore, the risks associated with surgery will vary according to the type of internal fixation selected. Thus, the best treatment for nondisplaced scaphoid fractures remains disputed.

The importance of patient preferences in shared decision making has gained increased attention, and becomes particularly valuable when many effective treatment options exist.[6–14] Often, a person's values may influence his or her treatment preferences. Physicians can weigh patient preferences in the context of the available clinical evidence to facilitate shared decision making. Conjoint analysis is one method that has been successfully used to develop outcome measures and to study how a person's values may affect his or her treatment preferences.[6,15–18] Conjoint analysis is based on the premise that each treatment derives value from its expected advantages and disadvantages. It provides estimates of what are the most important factors to patients when deciding amongst treatments.[7,15–22] Furthermore, when out-of-pocket cost is incorporated as a study attribute, the conjoint analysis can provide an estimate about how much a person is willing to pay for a change in a given attribute.[23–26] In this study, we tested the hypothesis that out-of-pocket costs would have a greater influence on decision making for the management of a scaphoid fracture when compared with the time spent in a cast or brace, degree of soreness, or the risk of treatment failure. We also determined the relative importance of each attribute as it relates to a surgical or nonsurgical treatment.

MATERIALS AND METHODS

The Institutional Review Board granted an exempt research status to this protocol. The authors of this study selected 5 attributes that were deemed to influence a person's quality of life after a wrist fracture. These included time in a cast, time in a brace, remaining soreness and stiffness, risk of treatment failure, and out-of-pocket cost. We also assessed an individual's level of apprehension about surgery. The attributes selected for this study are those that have been consistently addressed in research and patient care. Our survey was developed based on the interpretation of the best available evidence from randomized clinical trials that compare cast immobilization and screw fixation for a nondisplaced scaphoid fracture, with the understanding that there are various interpretations of the best available evidence (Table E1, available on the *Journal's* Web site at www.jhandsurg.org).[5,27–33] This method of attribute selection has been employed in previous studies.[34–36] The various levels for each attribute reflect current practice patterns and data as described in the literature. By providing different levels of each attribute for 13 hypothetical relative preference experiments, it is possible to estimate a value of each level for each respondent. The levels assigned to each attribute are presented in Table E1, and are as follows: time in a cast (2, 4, or 8 wk), time in a brace (2, 4, or 8 wk), remaining soreness or stiffness (2, 4, or 6 months), risk of treatment failure (3%, 5%, or 10%), and out-of-pocket costs ($500, $1,000, or $2,500). A complete example of the administered survey may be found in Appendix A (available on the *Journal's* Web site at www.jhandsurg.org).

Participants and survey process

Participants of this survey were recruited from an online panel of members using Amazon Mechanical Turk (MTurk) to administer an electronic survey.[37] This provides a large pool of users who can be recruited for academic or private sector research surveys. The MTurk method of data collection has been previously validated in obtaining high-quality data in an inexpensive and rapid manner.[6,7,10,12,19,22,34,38–43] Similar papers have suggested that a sample size can be based on prior studies.[42] On the basis of the limited number of reports in the medical[6,7,21,34,41] and orthopedic literature,[19,42] the authors concluded that the appropriate sample size for this study was approximately 250 surveys. Furthermore, before releasing the finalized survey, a separate pilot test of the survey was conducted to provide assurance that the survey was well comprehended and that a sample of 250 responses would produce sufficiently small standard errors and stable measures of the importance of the tested surgical procedures. Using the online MTurk survey, introductory questions first assessed similar past injuries, relative activity levels, types of

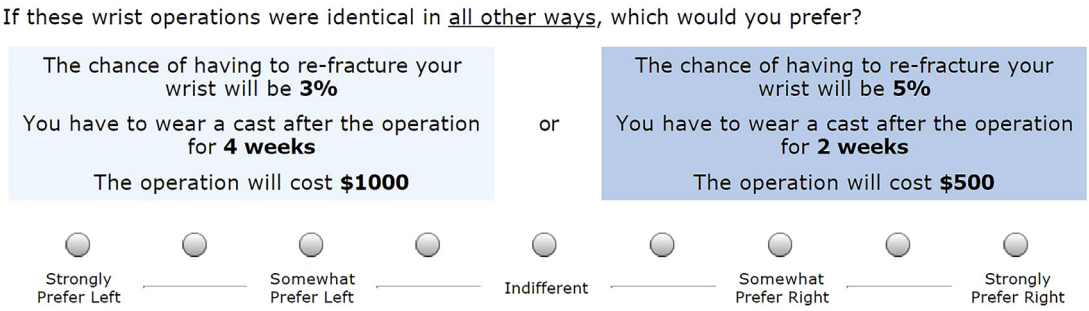

FIGURE 1: Representative example of 1 of 13 hypothetical choice experiments that the survey respondents were asked to answer.

work (eg, manual), and handedness. Survey respondents were then asked how they feel about the possible outcomes (time in a cast, time in a brace, remaining soreness and stiffness, risk of treatment failure, and cost) for the treatment of this injury to their dominant hand.

Participants were then asked to imagine having recently experienced a wrist fracture, and to consider their reaction to a series of possible outcomes and treatment options. The preference experiment presented each participant with 13 hypothetical comparisons that were generated by combining various levels of the 5 attributes of interest in an Adaptive Conjoint Analysis using Sawtooth Software.[44] Figure 1 gives an example of one of the preference choice tasks. Each pair of choice options was designed algorithmically for each participant to maximize the information gained about each participant's preferences through a limited number of responses. Based on how each person responded to the 13 hypothetical comparisons, it is possible to estimate the relative importance of the individual attributes that best reflects the judgments for each respondent.[44] After making his or her relative preferences, each respondent was then shown a graph (Fig. 2) that reflected the importance of each attribute in his or her individual judgments. Respondents indicated their reaction to this graph to assess how well the conjoint survey reflected their individual values.

The final portion of the survey reflected a conversation that a patient may have with his or her surgeon when discussing the treatment options for his or her injury (Appendix A, available on the *Journal's* Web site at www.jhandsurg.org). After being informed and educated about both surgical and nonsurgical options, the respondents indicated their level of apprehension for undergoing surgery (1 = not worried, 2 = a little bit worried, 3 = somewhat worried, and 4 = very worried). This question is important as it provides an assessment of apprehension about surgery that is independent of the costs and benefits that were assessed earlier. Finally, the respondents were asked to make their decision between surgery and no surgery as is shown in Figure 3.

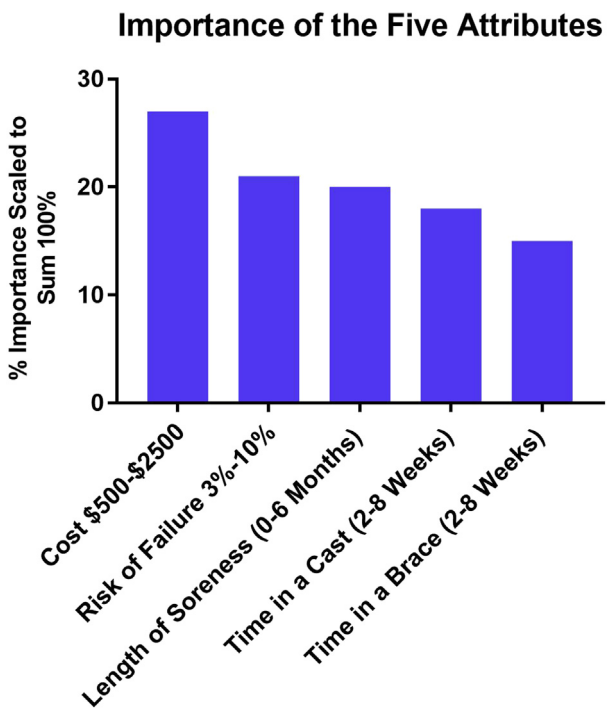

FIGURE 2: Relative importance of the 5 attributes, scaled to sum to 100%. The values listed are representative of the average values across respondents. The majority of respondents deemed cost to be the most important attribute, followed by the risk of treatment failure, length of soreness, time in a cast, and then time in a brace.

Statistical analysis

Results of the conjoint analysis were calculated with Sawtooth Software, using hierarchical Bayesian modeling to generate the individual-level conjoint utilities that best reproduced each respondent's choices.[15,45] These conjoint utilities provided a basis for distinguishing respondents' feelings about individual aspects of potential treatment options, for

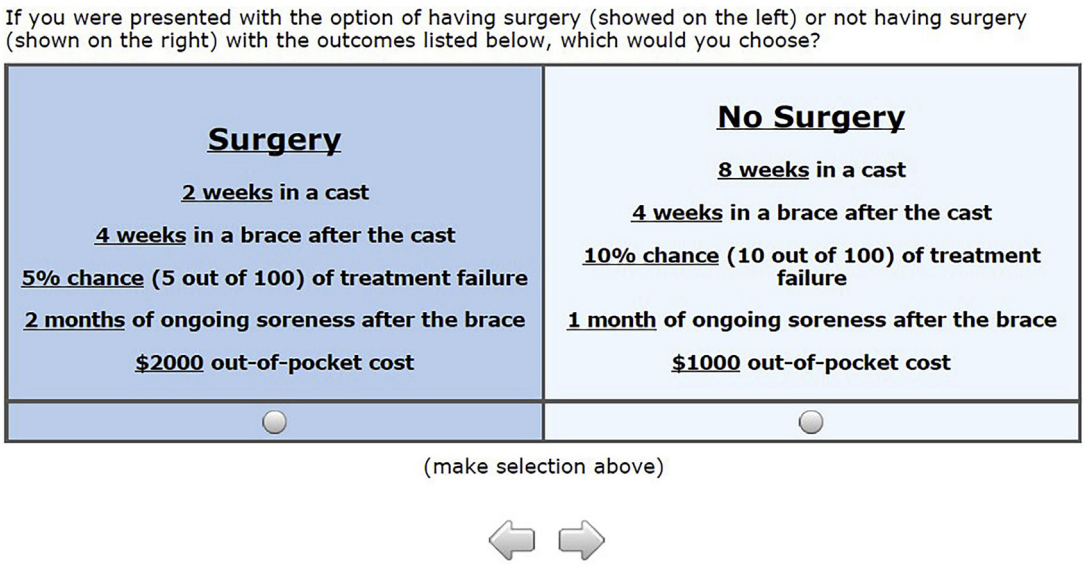

FIGURE 3: Final decision-making task. Respondents were asked to make a final decision between undergoing surgery and no surgery for the treatment of their nondisplaced scaphoid fracture.

identifying the relative importance of each tested attribute, and for projecting likely reactions to other plausible treatment options (eg, an increase in the out-of-pocket cost of surgery). Conjoint parameter estimates were exported and analyzed alongside other survey data. The preference values obtained from the 13 pairwise judgments did not directly account for an emotional response a patient might have had for the specific surgery shown in Figure 3. Thus, we built a logistic model that predicted an individual's choice to undergo the surgery as a function of the individual utility difference for the 5 attributes, and included 3 variables to reflect the 4 levels of an individual's level of apprehension for undergoing surgery. This model allowed us to estimate the percent of respondents who would choose surgery for cases that differed from those provided in Figure 3, and for respondents who had varying levels of apprehension. The logistic regression model could then be used to generate an analysis that projects the percent of respondents who would choose to undergo surgery under various attribute conditions. In particular, the sensitivity analysis is able to estimate the change needed for each attribute to compensate for a $500 increase in out-of-pocket costs.

RESULTS

A total of 250 individuals participated in the survey. The demographic and individual characteristics of the cohort are shown in Table 1. Although respondents were not drawn directly from a patient population, they reported moderate familiarity with injuries of this type. In the sample, 21% (n = 53) said that they had previously broken their wrist, 40% (n = 100) said that they have had a different wrist injury that interfered with their normal activities, 14% (n = 36) had broken a different part of their arm or hand before, and 16% (n = 39) had broken a bone outside of their arm/hand. However, 39% (n = 90) reported that they had never experienced an injury like that described in the scenario. In addition, 47% (n = 118) of respondents denoted that they had previously undergone some type of surgery. Twenty-five percent (n = 63) of respondents reported that their work involved regular manual labor or heavy lifting, and the sample was generally reflective of national norms for income, education, and employment status.

The graph in Figure 2 reflects how important each attribute was across respondents. The relative importance of an attribute to an individual respondent varied, with a standard deviation of approximately 10 percentage points across the sample cohort. Subjects rated cost of treatment as the most important attribute in decision making, followed by the risk of treatment failure, length of remaining soreness or stiffness, time in a cast, and time in a brace. Overall, 48% (n = 121) of respondents indicated that the conjoint survey reflected their views "Very well," 42% (n = 105) said "Well," 9% (n = 23) said "OK," and 0.4% (n = 1) said "Poorly." As shown in Figure 4, the average utilities of the 5 attributes had unequal weight, and were relatively linear when compared within the

TABLE 1. Demographic Information

Characteristic	n = 250	Percentage
Age, y		
18–25	35	14
26–30	83	33.2
31–35	55	22
36–40	44	17.6
41–50	18	7.2
51–60	12	4.8
61–70	3	1.2
Sex		
Male	143	57.2
Female	107	42.4
Race		
White	174	69.6
African American	28	11.2
Other	48	19.2
Handedness		
Right	221	88.4
Left	29	11.6
Education level		
High school/GED	31	12.4
Some college	102	40.8
Four-year college degree	97	38.8
Master's degree	16	6.4
Doctoral degree	4	1.6
Annual household income		
Less than $20,000	34	13.6
$20,000–39,999	89	35.6
$40,000–59,999	57	22.8
$60,000–79,000	41	16.4
$80,000–99,999	15	6.0
$100,000 or more	14	5.6
Employment status		
Full-time employed	169	67.6
Part-time employed	39	15.6
Unemployed seeking work	16	6.4
Disabled	6	2.4
Retired	1	0.4
Other	19	7.6

levels of each attribute. Furthermore, the individual preferences did not systematically differ based on a respondent's familiarity with the injury.

With regard to apprehension about surgery, of the 250 respondents, 27 said that they would be "not worried" about surgery. Of those, 70% (n = 19) chose the surgical option. Of the 89 respondents who said that they were "a little bit worried," 42% (n = 37) chose surgery. Of the 90 respondents who said that they were "somewhat worried," 28% (n = 25) chose surgery. Lastly, of the 44 respondents who said that they were "very worried," 27% (n = 12) chose surgery. To account for differences in apprehension about surgery, we built a logistic regression model that predicted choice of surgery from the options shown in Figure 3 as a function of the individual conjoint utilities plus coefficients for the 4 levels of apprehension about surgery. This regression model then provided an estimate regarding the effect of out-of-pocket cost on an individual's apprehension about surgery. We then determined what changes in out-of-pocket cost would be necessary to predict a choice of surgery for 50% of each apprehension level. Thus, for those who are "not worried," an additional cost of $1,300 would reduce their aggregate choice share from 70% to 50%. For those who are "a little bit worried," out-of-pocket costs would have to be reduced by $500. Finally, for those are "somewhat worried" or "very worried," a reduction of $1,400 in out-of-pocket costs is needed for 50% to choose surgery. For the other attributes, it is possible to ask what changes are needed to compensate for the choice share effects of an additional $500 payment. To avoid a payment of an additional $500, the model predicts that the average respondent will accept 2 weeks in a cast, 3 weeks in a brace, 2 months of soreness, or a 2% increase in the risk of treatment failure.

DISCUSSION

This study offers an initial perspective on individual preferences when deciding between treatment options for a nondisplaced scaphoid fracture. The results of this study suggest that people deem the cost of the procedure and their apprehension about surgery as the most important factors in their decision making.

This survey did not assess the societal costs that are associated with each treatment, but rather assessed the impact of out-of-pocket costs. Previous studies have shown that out-of-pocket costs are a powerful determinant in patient decision making.[19,46] O'Hara et al[19] found that rather than pay an additional $1,000 for a total shoulder arthroplasty, respondents preferred to drive more than 7 hours or wait more than 13 months for surgery. Interestingly, in a study by Kim et al[42] that examined the preferences of patients scheduled for carpal tunnel release using conjoint analysis, the authors found that medical costs were the least important attribute in patient decision making. As the authors suggest, this finding is most likely due to the benefits afforded by the

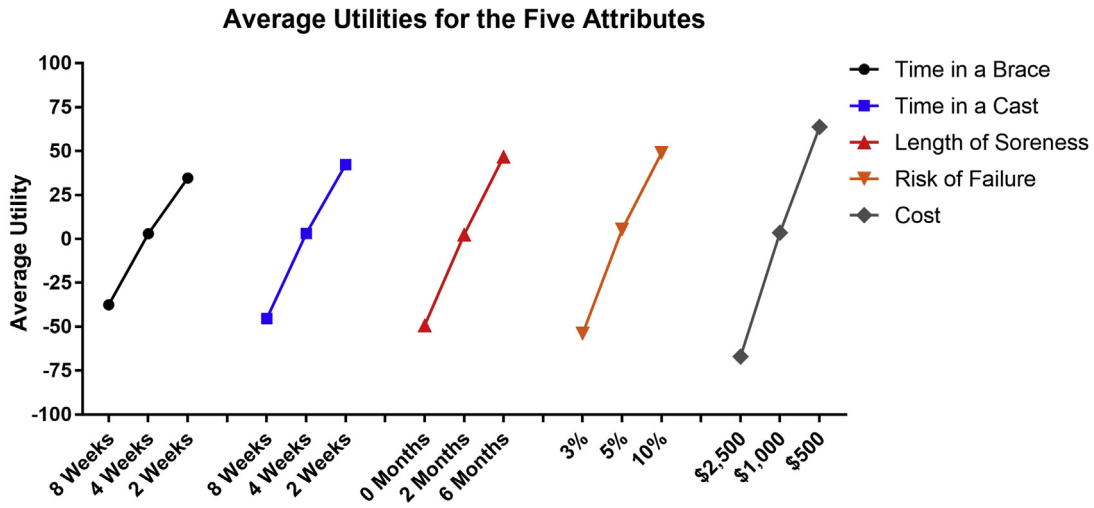

FIGURE 4: The average utilities of the 5 attributes. As depicted in this graph, the average utilities of the 5 attributes have unequal weight, and are relatively linear when compared within the levels of each attribute.

National Health Insurance system in Korea.[42] This is important to acknowledge when considering the applicability of this study's results to countries other than the United States where health care costs are covered by an individual's employer. Because most patients are covered by health insurance, out-of-pocket costs have a reduced influence as compared with a privatized system such as the United States. Therefore, this study's results regarding the influence of out-of-pocket costs may not be generalizable to other countries.

Apprehension about surgery was the second most important factor in a person's decision making. Although this topic has yet to be explored within hand surgery, multiple studies have stressed that preoperative education can help reduce patient apprehension.[47–49] This is important because apprehension about surgery not only influences patient decision making, but also strongly interacts with postoperative outcomes.[50] By educating patients about the risks and benefits of their treatment, surgeons may be able to alleviate the apprehension associated with the concept of surgery to help improve postoperative outcomes. However, there are many reasons a patient may be apprehensive about surgery. Thus, we cannot determine from these results the exact degree to which apprehension about surgery and its individual causes correlate with a person's decision making.

There are several limitations to this study. First, respondents were recruited using Amazon MTurk, potentially introducing selection bias. Prior studies in the surgical literature have used Amazon MTurk as an indirect assessment of patient preferences in medical decision making. Tong et al[6] and more recently Streufert et al[44] used Amazon MTurk in conjunction with conjoint analysis to assess patient preferences in lung cancer treatment and first-time anterior shoulder dislocation, respectively. Nonetheless, injury and treatment of our respondents is hypothetical and is an inherent form of bias in this study. We cannot say with certainty that a patient who has sustained this injury will respond in the same manner as a respondent recruited from Amazon MTurk. Furthermore, a limitation of this study design is that the attributes selected for inclusion were not prescreened in a representative patient focus group. Instead, the authors selected attributes and levels based on available clinical evidence, as has been previously done.[34–36] In addition, the practice patterns presented to respondents partially reflect those of the hand surgeons at our institution, and may differ from those of other surgeons. It is also difficult to control how each respondent interprets different attributes and the language that is used to describe each attribute. We attempted to minimize variability between each respondent's interpretation by providing a detailed description about each attribute before asking the respondents to make a final choice about their preferred treatment. In addition, when describing the treatment options and attributes, the authors purposefully used "plain English" to ensure that the respondents adequately understood the options presented to them. We revised our language until the pilot survey demonstrated that participants understood the questions and descriptions well. However, the way in which each scenario is described in a real-life clinical setting will undoubtedly differ from this survey and will be framed differently by each provider. As

such, the absolute percentages derived from this study do not carry a specific meaning for individual patients and surgeons. Future studies should use focus groups and administer the survey in a clinical setting to build upon the preliminary results of this study. Furthermore, although conjoint analysis attempts to assign monetary value to the trade-offs an individual is willing to make for a form of treatment, this does not fully capture why a person may choose one treatment over another. Although these results do provide an initial perspective regarding a person's treatment preferences, it does not reflect all the considerations a person may contemplate in the decision-making process. Most notably, this survey does not consider the influence of postoperative pain, risks of postsurgical complications (ie, infection), and the risks of anesthesia, all of which may play a role in the decision-making process. Therefore, we cannot consider this report to offer a fully comprehensive perspective.

This study attempts to describe individual preferences for the management of nondisplaced scaphoid fractures, and serves as a step toward the development of a tool to measure preferences about treatment options in hand surgery. These initial results suggest that people were more influenced by out-of-pocket costs and their apprehension about undergoing surgery, than the time spent in a brace or cast, and the risk of their treatment failing. Future studies are needed to further define the individual preferences of patients who experience this injury. The factors that patients deem important in their management may differ from the views of the provider, and the treatment should reflect the patient's preferences.

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TABLE E1. Evidence Used to Formulate Attributes and Levels for the Conjoint Analysis

Author Year	Length of Immobilization (Cast/Brace)	Length of Remaining Soreness and/or Stiffness	Risk of Scaphoid Nonunion	Cost (Direct Costs)
Saeden et al 2001[28]	C: 12 ± 3 wk S: 2 ± 1 wk	Not assessed	C: 7% S: 3%	–
Bond et al 2001[27]	C: 6 wk—union (average of 12 wk) S: until union (average of 7 wk)	Not assessed	C: 0% S: 0%	–
Adolfsson et al 2001[30]	C: 10 wk S: 3 wk	Not assessed	C: 0% S: 4%	–
Dias et al 2005[32] and 2008[29]	C: 8 wk S: no immobilization	Pain*: C: 0/2/6 mo: (4.45/2.29/2.35) S: 0/2/6 mo: (4.05/2.39/2.40) Tenderness†: C: 0/2/6 mo: (2.21/0.76/0.17) S: 0/2/6 mo: (2.14/0.55/0.26)	C: 23% S: 0%	–
McQueen et al 2008[31]	C: 8–12 wk S: no immobilization	Not assessed	C: 13% S: 3%	–
Vinnars et al 2008[5]	C: mean of 10 wk S: mean of 3 wk	Not assessed	C: 2% S: 0%	–
Davis et al 2006[33]	–	–	–	C: $605 (25–64 y) S: $1,747 (25–64 y)
Levels included in conjoint analysis	Cast: 2, 4, 8 wk followed by Brace: 2, 4, 8 wk	0 mo 2 mo 6 mo	3% 5% 10%	$500 $1,000 $2,500

C, cast immobilization; S, surgery.
*Pain was assessed on a scale of 1–10 using the visual analog scale pain score.
†Tenderness was assessed on a scale of 1–7 using the Patient Evaluation Measure Questionnaire 10.