

Beliefs and Attitudes of Members of the American Academy of Orthopaedic Surgeons Regarding the Treatment of Anterior Cruciate Ligament Injury

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Purpose: The purpose of the study was to quantify the amount of agreement among orthopaedic surgeons regarding the natural history of the anterior cruciate ligament (ACL)-deficient knee, surgery, and rehabilitation, and the treatment of these patients. **Type of Study:** Physician mail survey. **Methods:** Orthopaedic surgeons were randomly selected from the American Academy of Orthopaedic Surgeons (AAOS) directory. Only individuals who treated or referred ACL-insufficient patients for treatment within the past year were asked to complete the 3-page survey. The survey included 25 questions regarding clinical opinion. Clinical agreement was present when 80% or more of the surgeons agreed on the same response option. **Results:** The total number of surgeons who responded to the survey was 397 (response rate, 54.8%) and the number who had treated or referred ACL-insufficient patients in the past year was 261. Among surgeons who completed the questionnaire, the response rates to the individual questions ranged from 92% to 100%. The mean response rate for all questions was 97.4%. The mean age of the surgeons was 48.4 years, and 35.8% considered their practice to be a subspecialty in sports medicine or knee surgery. For 12 questions (48%), there was clinical disagreement among the surgeons. Surgical volume was associated with clinical opinion for 16 of 25 questions ($P \leq .05$). **Conclusions:** Significant variation is seen in clinical opinion and decision-making regarding ACL injuries among members of the AAOS, particularly regarding whether ACL-deficient patients can participate in all recreational sports activities, that ACL reconstruction reduces the rate of arthrosis, and on the use of braces in the postoperative period. Additionally, surgeons disagreed on the effect of 4 patient characteristics (age over 40, presence of pain, irreparable meniscal tear, injury involving Workers' Compensation) on the decision to perform surgery. Areas of significant clinical uncertainty should be the focus of future research and medical education for orthopaedic surgeons who treat ACL injuries. **Key Words:** Ligament—Knee—Surgery—Practice—Arthroscopy—Reconstruction.

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Recent surveys have shown significant differences of opinion among orthopaedic surgeons with respect to total hip and total knee arthroplasty.^{1,2} Differences of opinion regarding clinical issues lead to differences in practice patterns. It has been shown that large variations in rates of surgical procedures exist based on geographic location.³⁻⁶ These geographic differences in practice patterns have been shown to be directly linked to surgeons' varying indications for the procedures in question.⁷

Currently, significant controversy exists regarding the management of the anterior cruciate ligament (ACL)-insufficient knee due in large part to the lack of evidence to support clinical decisions. For example, the natural history of the condition itself remains controversial.⁸⁻¹² Similarly, without definitive knowledge regarding the natural history of this injury, one would expect varying opinions regarding the optimal treatment. Controversy also exists regarding ACL reconstruction in young¹³ and old patients.¹⁴ The technique of ACL surgery is rapidly evolving, and issues such as the timing of surgery have recently received attention.^{15,16} Similarly, advances in rehabilitative management after ACL reconstruction has been reported in the past decade.^{17,18} However, not all practicing surgeons may be aware of recent trends in the management of these injuries. Significant variation with respect to surgical indications and technique was identified in a recently published survey of Canadian orthopaedic surgeons.¹⁹

A mail survey of orthopaedic surgeons was used to determine their attitudes regarding the natural history of the ACL-deficient knee, surgery, and rehabilitation. The purpose of the study was to quantify the amount of agreement among orthopaedic surgeons regarding these issues and the treatment of patients with this condition.

METHODS

A mail survey of a random sample of members of the American Academy of Orthopaedic Surgeons (AAOS) was used to determine their attitudes regarding the natural history of the ACL-deficient knee, surgery, and rehabilitation. A random number generator (SPSS, Chicago, IL) was used to select 725 orthopaedists at random from the most recent AAOS directory (approximately 4%).²⁰ The survey was conducted in late 1998 and early 1999.

A survey that could be completed in 10 minutes or less was sought to encourage participation. The number of questions and explanations was limited to allow

the entire survey to fit on 3 8½ × 11 inch sheets of paper in a 12-point font size. The questions used either yes/no or multiple-choice responses. An introductory letter requesting participation, signed by the senior author (R.F.W.), was enclosed.²¹ A self-addressed, stamped envelope was provided. If the survey was not returned within 4 weeks, another copy was sent with a letter to encourage participation. Confidentiality was assured, and the surveys were identified using a number code.

The questionnaire was prepared in 3 stages. First, the questions were selected based on discussions with 10 orthopaedic surgeons who perform ACL reconstruction. The surgeons then reviewed the questionnaire and the wording. Questions were revised for content and clarity. Finally, the survey questionnaire was field tested by 15 orthopaedic surgeons who were either in a sports medicine practice or fellowship. The survey sought to ascertain the surgeons' opinions with respect to the natural history of the ACL-insufficient knee, aspects of treatment and the effect of specific patient factors on outcome, and the decision to perform surgery. A copy of the survey may be obtained by contacting the corresponding author (R.G.M). Data entry was performed using a digital scanner.

Only individuals who had treated or referred ACL-insufficient patients (at least one) for treatment within the past year were asked to complete the survey. To facilitate interpretation of the questions, the following sentences were printed at the beginning of the survey: "Questions do not pertain to elite athletes (i.e., professional or intercollegiate level). Questions are to be answered as if all other factors were optimal, unless otherwise specified."

To facilitate presentation and interpretation of the data, certain response options from the questionnaire were consolidated. For questions relating to clinical opinions regarding natural history and surgical indications, the responses "agree" and "strongly agree" as well as the responses "disagree" and "strongly disagree" were collapsed into "agree" and "disagree," respectively. For questions relating to the effect of patient characteristics on surgeons' decisions to perform ACL reconstruction, the responses "positive" and "somewhat positive" as well as "negative" and "somewhat negative" were collapsed into "positive factor" and "negative factor," respectively. We used the original (nonconsolidated) data to calculate correlation coefficients and for the Mann-Whitney *U* test.

We defined "clinical agreement" to be present when 80% or more of the surgeons selected the same response. This is based on previous research on agree-

ment for orthopaedic problems.² Wright et al.² used 90% as the cutoff denoting agreement among orthopaedic surgeons' opinions regarding knee arthroplasty surgery. Therefore, if more than 10% of individuals disagreed, these authors believed that clinical disagreement had occurred. In a survey of primary care physicians' opinions regarding knee osteoarthritis, 60% was used as the cutoff.²² Neither study discussed the rationale for the selection of the cutoff for agreement.

We believed that the 90% level risked overstating disagreement. Conversely, we believe that physicians should generally agree on clinical issues at a greater rate than 60%. We therefore made the a priori decision to use 80% as our cutoff. We concluded that there was "clinical disagreement" if greater than 20% of the orthopaedic surgeons surveyed in this study disagreed with respect to a specific issue. Ultimately, the reader may choose to decide what constitutes agreement because the totals for each question are provided.

The bivariate correlation between the responses to each question and the surgeons' stated volume (ACL reconstructions in the previous year) was calculated for the 25 questions that reflect clinical opinion, using the Spearman correlation coefficient for ordinal responses and Student *t* test for binary responses; $P < .05$ was considered significant. The *P* values were adjusted using the Bonferroni correction factor; therefore, $P < .002$ was considered significant for the 25 comparisons.²³ The correlations between age and clinical opinion were calculated in the same fashion.

Sample Size Calculation

Previous orthopaedic surveys have shown response rates from 35% to 72%.^{1,2,22} For binary response questions, to obtain a 95% confidence interval of $\pm 6\%$ or less, we required 250 respondents. The first mailing involved 500 surgeons, and a second mailing was planned based on the response rate of the first mailing, to arrive at the final total of at least 250 completed questionnaires.

RESULTS

The survey was sent to 500 orthopaedic surgeons, selected at random from the AAOS directory. Of the surgeons who initially responded, 190 had treated or referred ACL-insufficient patients in the past year. A second mailing to an additional 225 surgeons was performed to try to obtain a total of 250 surgeons who

had treated or referred patients for an ACL injury in the past year.

A total of 397 surgeons responded (54.8%). Of these respondents, 112 had not treated or referred patients for ACL insufficiency in the past year, 19 were retired, 3 had died, and 2 were on leave. This brought the total of surgeons who had responded to the survey and who had treated or referred ACL-insufficient patients in the past year to 261. Among surgeons who completed the questionnaire, the response rates to the individual questions ranged from 92% to 100%. The mean response rate for all questions was 97.4%.

The mean stated age of the 261 surgeons who completed the questionnaire was 48.4 years (range, 31 to 83 years). They estimated having seen a mean of 6.3 ACL-insufficient patients in the month before completing the survey (range, 0 to 30 patients) and having performed a mean of 21.9 ACL reconstructions in the previous year (range, 0 to 200). A total of 35.8% of these surgeons considered their practice to be a subspecialty in sports medicine or knee surgery, and 48.1% were the primary physician responsible for the coverage of a high school, college, semiprofessional, or professional sports team. The distance from their office to a major referral center was estimated to be less than 50 miles by 75%, 50 to 100 miles by 18.7%, 100 to 300 by 5.6%, and more than 300 miles by 0.8%.

The questionnaires included 25 questions regarding clinical opinion. For 12 of these (48%), there was clinical disagreement among the surgeons. For example, there was significant disagreement in response to the 2 questions concerning the use of postoperative braces (Table 1).

There was agreement on 8 of 12 patient characteristics as either positive or negative factors in the decision to perform ACL reconstruction (Table 2). Surgeons disagreed on age over 40, pain, irreparable meniscal tear, and Workers' Compensation as having a positive, negative, or no effect on the decision to perform ACL reconstruction. Additionally, we found a significant range of opinions with reference to the amount of time recommended for physical therapy and resumption of full weight bearing, range of motion, and participation in all sports (Figs 1-3).

The most commonly used method for ACL reconstruction cited was endoscopic (single incision), with 177 of 248 (71.4%) surgeons preferring this technique. A 2-incision technique was preferred by 61 of 248 (24.6%) surgeons, and arthrotomy by 10 (4.0%) surgeons. The use of autogenous patellar tendon was

TABLE 1. Clinical Opinion of 261 AAOS Members Regarding Natural History and Surgical Indication for Treatment of ACL Patients

Statement	No	Indifferent	Yes
Clinical agreement*			
ACL disruption is associated with an <i>increased rate</i> of arthrosis	25 (9.6)	20 (7.6)	216 (82.8)
ACL-deficient, ligamentously lax individuals are more symptomatic	18 (6.9)	32 (12.3)	211 (80.8)
Hamstring and quadriceps strength affects function in ACL-deficient knees	7 (2.7)	11 (4.2)	242 (93.1)
Bracing is useful for the ACL-deficient knee treated nonoperatively	31 (11.9)	NA	229 (88.1)
Physical therapy is useful in the ACL-deficient knee treated nonoperatively	17 (6.5)	NA	243 (93.5)
Clinical disagreement†			
Patients with ACL-deficient knees who have not had surgery are able to participate in <i>all</i> recreational sporting activities	200 (76.9)	21 (8.1)	39 (15.0)
ACL reconstruction reduces the rate of arthrosis in ACL-deficient knees	43 (16.5)	82 (31.4)	136 (52.1)
I recommend a brace for at least the first 6 weeks in the postoperative period for my patients	96 (40.0)	NA	144 (60.0)
I recommend a brace for participation in sports postoperatively	89 (37.1)	NA	151 (62.9)

*A total of 80% or more agreed.

†Less than 80% agreed.

the most common graft choice, with 197 of 249 (79.1%) surgeons electing to use it for ACL reconstruction (Fig 4). Only 30 of 249 (12.0%) surgeons preferred autogenous hamstring tendons as primary graft choice.

To determine if surgical volume was associated with surgeons' responses to the 25 questions regarding clinical opinion, we performed a correlation between responses and stated number of ACL reconstructions in the past year. Of those, 16 of 25 were determined to

TABLE 2. Effect of Patient Characteristics on the Decisions of 261 AAOS Member Surgeons to Perform ACL Reconstruction

Patient Characteristic	Negative Factor	Not a Factor	Positive Factor
Clinical agreement*			
Open growth plates are a positive factor influencing your decision to perform ACL reconstruction	217 (84.1)	26 (10.1)	15 (5.8)
Female sex is a positive factor influencing your decision to perform ACL reconstruction	14 (5.4)	227 (87.6)	18 (6.9)
Giving way with activities of daily living is a positive factor influencing your decision to perform ACL reconstruction	2 (0.8)	0 (0.0)	256 (99.2)
Giving way with sporting activities only is a positive factor influencing your decision to perform ACL reconstruction	2 (0.8)	3 (1.2)	255 (98.0)
High-demand activity is a positive factor influencing your decision to perform ACL reconstruction	1 (0.4)	4 (1.6)	255 (98.0)
Recurrent swelling of the knee is a positive factor influencing your decision to perform ACL reconstruction	15 (5.8)	23 (8.8)	222 (85.4)
Radiographic evidence of osteoarthritis is a positive factor influencing your decision to perform ACL reconstruction	218 (84.8)	25 (9.7)	14 (5.5)
Repairable meniscal tear is a positive factor influencing your decision to perform ACL reconstruction	1 (0.4)	23 (8.9)	235 (90.7)
Clinical disagreement†			
Age over 40 is a positive factor influencing your decision to perform ACL reconstruction	179 (68.8)	73 (28.1)	8 (3.1)
Pain is a positive factor influencing your decision to perform ACL reconstruction	26 (10.0)	59 (22.7)	175 (67.3)
Irreparable meniscal tear is a positive factor influencing your decision to perform ACL reconstruction	11 (4.3)	110 (42.6)	137 (53.1)
Workers' Compensation is a positive factor influencing your decision to perform ACL reconstruction	97 (38.4)	153 (59.3)	6 (2.3)

*A total of 80% or more agreed.

†Less than 80% agreed.

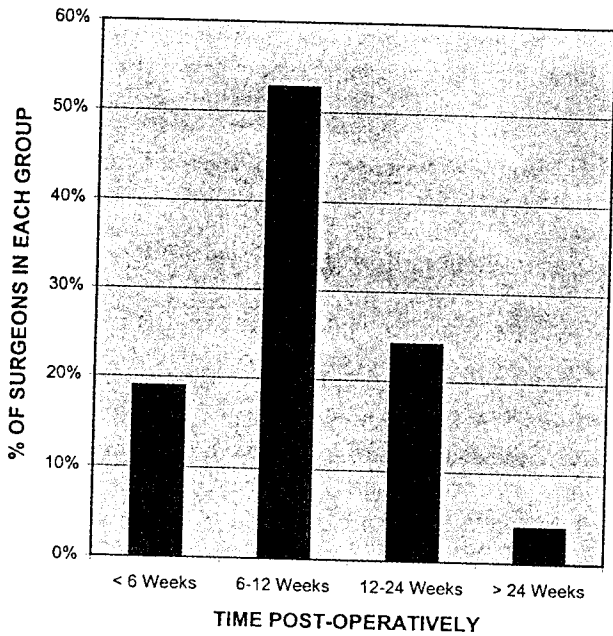


FIGURE 1. How long is a physical therapist required postoperatively?

be statistically significant ($P \leq .05$). These correlations were then analyzed using a Bonferroni correction factor. Eight remained statistically significant (original $P \leq .002$). Responses to the questions regarding patients with ACL deficiencies playing sports ($r = .22, P = .00002$), ACL deficiency causing arthritis ($r = .20, P = .002$), and the decision to perform surgery on patients whose knee gives way during activities of daily living or during sports ($r = .24, P = .00009$, and $r = .33, P = .000001$, respectively) were among the statistically significant. The

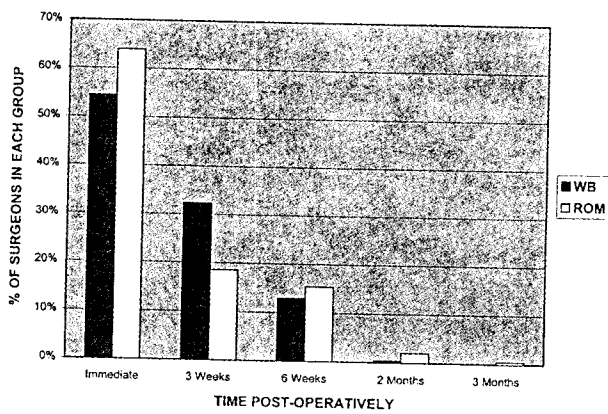


FIGURE 2. When are full weight bearing (WB) and full range of motion (ROM) permitted postoperatively (no associated procedure)?

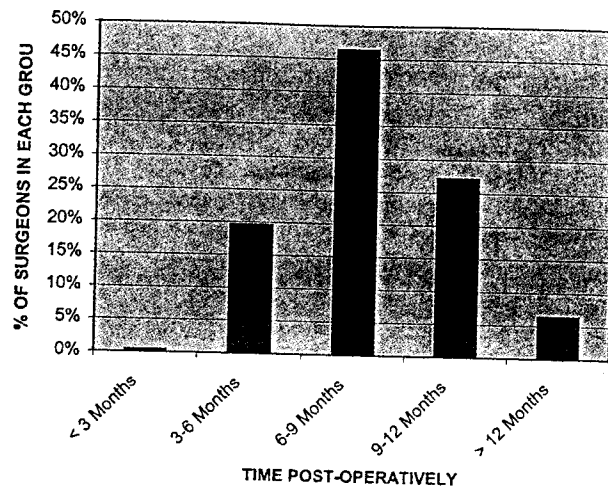


FIGURE 3. What time is allotted from surgery until the full resumption of all sports?

age of the surgeon was correlated with clinical opinion in 10 of the questions ($P < .05$) and only 4 (16%) remained statistically significant when corrected for the multiple comparisons. Furthermore, age was highly inversely correlated with surgical volume, because older surgeons perform fewer surgeries ($r = -.27, P = .000009$). Because surgeon age and volume are strongly inversely correlated, it is impossible to know if one or the other was primarily responsible for the relationship with clinical opinion.

This trend toward varying opinions among surgeons who perform many ACL reconstructions compared with those who do few was further explored by separating the surgeons into groups. The surgeons were divided into 4 groups based on their stated surgical

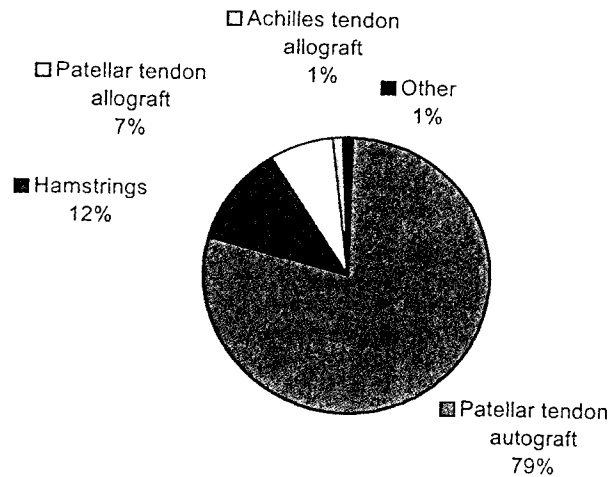


FIGURE 4. Preferred tissue type used for ACL reconstruction.

TABLE 3. When Is Full Weight Bearing Allowed Postoperatively?

	Immediate	3 Weeks	6 Weeks	2 Months	3 Months
All surgeons	135 (54.4)	80 (32.3)	32 (12.9)	1 (0.4)	0
High volume*	46 (70.8)	16 (24.6)	3 (4.6)	0	0
Low volume†	19 (35.2)	18 (33.3)	16 (29.6)	1 (1.9)	0

*Top 25% self-reported ACL reconstructions performed in the past year.

†Bottom 25% self-reported ACL reconstructions performed in the past year.

volume in the past year. We termed the top quartile "high-volume surgeons" and the bottom quartile "low-volume surgeons." The mean number of self-reported ACL reconstructions performed in the previous year for the 4 quartiles (from highest to lowest) was 59.4, 18.1, 8.0, and 1.3.

The high-volume surgeons, of whom 72% described their practice as a subspecialty in sports medicine or knee surgery, allowed their patients unlimited weight bearing and range of motion earlier in the postoperative period ($P = .00001$ and $P = .000002$, respectively; Tables 3 and 4) and were less likely to use braces in the postoperative period (Tables 5 and 6). They also allowed their patients to resume participation in all sports earlier in the postoperative course ($P = .0007$; Table 7). In addition, a smaller percentage of the high-volume surgeons believe that patients with ACL-deficient knees, who have not had surgery, are able to participate in all recreational sporting events ($P = .0004$; Table 8).

The surgeons were also asked to provide an estimate of the percentage of ACL reconstructions that resulted in failure (continued instability or graft failure) and the percentage of patients who were unable to return to their previous activity level. The high-volume surgeons believed that surgical failure occurs with a mean of 8.2% compared with 13.1% estimated by the low-volume surgeons ($P = .001$). The high-volume surgeons also believed that a lower percentage of their patients would fail to return to the same level of activity before surgery; however, this was not statistically significant ($P = .08$).

DISCUSSION

The response rate for this survey was 54.8%, which is higher than other physician surveys that have been recently reported.^{1,21,22} There are several possible explanations for this finding. First, orthopaedic surgeons who treat these patients are interested in this topic, and therefore, they were motivated to take the time to complete the questions. Second, the survey was short and could generally be completed in less than 10 minutes. Finally, the senior author signed the letter that was sent with the survey to the potential participants. The strategy of using a well-known authority in the field to sign a letter asking for participation in a physician survey has been documented in a prospective randomized study to improve the response rate.²¹

Eighty percent was selected as the cutoff indicating agreement among surgeons. This was based both on previous work and on clinical sensibility.²⁴ Other investigators have selected 60%²² and 90%² as the cutoff denoting agreement among physicians. Irrespective of the number chosen to define agreement, uncertainty among the orthopaedic community in the United States with respect to many basic issues regarding the treatment of ACL injuries was found. Significant variation in practice among Canadian orthopaedic surgeons was documented by Mirza et al.¹⁹ The present study expands on this work because the focus was narrowed to a greater number of specific patient characteristics and issues regarding the treatment and natural history of this injury. We also sur-

TABLE 4. When Is Full Range of Motion Allowed Postoperatively?

	Immediate	3 Weeks	6 Weeks	2 Months	3 Months
All surgeons	159 (63.9)	46 (18.5)	38 (15.3)	5 (2.0)	1 (0.4)
High volume*	50 (76.9)	11 (16.9)	4 (6.2)	0	0
Low volume†	21 (38.9)	9 (16.7)	21 (38.9)	3 (5.6)	0

*Top 25% self-reported ACL reconstructions performed in the past year.

†Bottom 25% self-reported ACL reconstructions performed in the past year.

TABLE 5. *I Recommend Use of a Brace for at Least the First 6 Weeks in the Postoperative Period*

	No/Disagree	Yes/Agree
All surgeons	96 (40.0)	144 (60.0)
High volume*	33 (51.6)	31 (48.4)
Low volume†	10 (21.3)	37 (78.7)

*Top 25% self-reported ACL reconstructions performed in the past year.

†Bottom 25% self-reported ACL reconstructions performed in the past year.

veyed American rather than Canadian orthopaedic surgeons.

Presently, over 200,000 ACL injuries occur yearly in the United States.²⁵ In the absence of sound scientific data, the treatment of these individuals may vary greatly depending on the treating surgeon. Although variation for certain aspects of treatment may not affect clinical outcome, in others the impact may be significant (e.g., rehabilitation regimens and surgical indications).

The agreement among the surgeons tended to be greatest in those areas in which adequate evidence exists in the literature to support clinical decision-making. For example, it has been documented that ACL disruption is associated with an increased rate of arthrosis.^{10,26} Giving way with activities of daily living is a positive factor influencing the decision to perform ACL reconstruction,^{8,27} giving way with sporting activities only is a positive factor influencing the decision to perform ACL reconstruction,^{8,27} and repairable meniscal tear is a positive factor influencing the decision to perform ACL reconstruction.²⁸

Disagreement among orthopaedic surgeons who treat ACL injuries may be multifactorial. A lack of adequate peer-reviewed literature, controversy among the available scientific publications, inadequate information dissemination, the preference to rely on clinical experience, or a combination of these factors may lead to such clinical disagreement. For example, the lack of evidence that ACL reconstruction reduces the rate of arthrosis is probably responsible for the clinical disagreement in this case. Although an accelerated rehabilitation program after ACL reconstruction has been documented to be safe and effective, no studies that document the most appropriate duration of physical therapy have been published.^{17,18} Clinical disagreement with respect to the time to full range of motion and full weight bearing postoperatively was probably due to inadequate information dissemination

as well as decision making based on clinical experience rather than the available literature.

For 16 of 25 questions regarding clinical opinion (64%), the surgeons' responses were correlated ($P < .05$) to their stated surgical volume in the past year. Eight of these comparisons remained statistically significant when corrected for multiple comparisons. It remains unknown whether a larger clinical experience results in certain clinical beliefs or whether the surgeons' opinions regarding specific issues lead to a higher or lower rate of surgery.

Significant variation in opinion was found among surgeons regarding the use of braces in the postoperative period. They were split fairly evenly on whether to use a brace for at least the first 6 weeks postoperatively and whether to recommend a brace for sports participation after surgery. It is not clear whether the lack of scientific data on which to base these decisions is a reason for practice pattern variation. However, in both cases, the surgeons who performed more ACL reconstructions reported less brace use. Additionally, the high-volume surgeons were generally more aggressive in their postoperative protocols, particularly with respect to weight bearing, motion, and resumption of sport, and were less likely to use braces for their patients.

There are several possible explanations for the differences of opinion between the high- and low-volume surgeons with regard to postoperative protocols. The high-volume surgeons may be more aware of the literature showing rapid rehabilitation after ACL reconstruction to be safe and effective. Another possible explanation is that the low-volume surgeons may be more conservative in this respect due to a lack of clinical experience. Finally, with less experienced physical therapists, trainers, and office personnel, the low-volume surgeon may prefer an increased level of protection after surgery.

In general, estimated case load tended to correlate with surgical indications and perception of failure

TABLE 6. *I Recommend Use of a Brace for Participation in Sports Postoperatively*

	No/Disagree	Yes/Agree
All surgeons	89 (37.1)	151 (62.9)
High volume*	30 (46.2)	35 (53.8)
Low volume†	14 (28.6)	35 (71.4)

*Top 25% self-reported ACL reconstructions performed in the past year.

†Bottom 25% self-reported ACL reconstructions performed in the past year.

TABLE 7. What is the Time Allotted From Surgery Until the Full Resumption of All Sports?

	<3 Months	3-6 Months	6-9 Months	9-12 Months	>12 Months
All surgeons	1 (0.4)	49 (19.6)	116 (46.4)	68 (27.2)	16 (6.4)
High volume*	0	24 (36.9)	29 (44.6)	12 (18.5)	0
Low volume†	0	7 (12.7)	28 (50.9)	13 (23.6)	7 (12.7)

*Top 25% self-reported ACL reconstructions performed in the past year.

†Bottom 25% self-reported ACL reconstructions performed in the past year.

rates. It is unknown whether this perception is indeed true (that high-volume providers have patients who experience improved outcomes) or whether the surgeons' perception of outcome leads to an increased rate of surgery, which may or may not be appropriate. Different rates of complications between high- and low-volume orthopaedic surgeons have been documented for hip arthroplasty.²⁹ The present study did not address this issue with respect to ACL surgery, and further research in this area is warranted in light of our findings.

This study has several limitations. First, it is difficult for physicians to report feelings, clinical opinions, and practice strategies in a survey. Another limitation of the methodology is that the complexities of clinical decision-making were simplified by the survey questions. Finally, only members of the AAOS were surveyed, and therefore the results are not necessarily generalizable to other countries or to American orthopaedic surgeons who are not members of the AAOS. Although 397 surgeons responded (54.8%), only those who were involved in the case of ACL-insufficient patients were asked to complete the questionnaire (261 surgeons; 65.7% of the respondents and 36.0% of all potential respondents).

Surgeons may consider using this information when counseling patients regarding ACL reconstructive surgery. For variables for which excellent agreement was found, surgeons may confidently advise patients that

there is consensus among their peers. For the other factors, surgeons may wish to advise patients of the uncertainty among orthopaedic surgeons.

In conclusion, there are many areas of significant clinical disagreement in the treatment of ACL injuries, including whether ACL-deficient patients can participate in all recreational sporting activities, that ACL reconstruction reduces the rate of arthrosis, and regarding the use of braces in the postoperative period. Additionally, surgeons disagree on the effect of 4 patient characteristics (age over 40, presence of pain, irreparable meniscal tear, and injuries involving Workers' Compensation) on the decision to perform surgery. Surgeons' clinical volume appears to be related to their clinical opinions. Areas of significant clinical uncertainty should be the focus of future research and medical education for orthopaedic surgeons who treat ACL injuries.

REFERENCES

1. Mancuso CA, Ranawat CS, Esdaile JM, et al. Indications for total hip and total knee arthroplasties: Results of orthopaedic surveys. *J Arthroplasty* 1996;11:34-46.
2. Wright JG, Coyte P, Hawker G, et al. Variation in orthopedic surgeons' perceptions of the indications for and outcomes of knee replacement. *Can Med Assoc J* 1995;152:687-697.
3. Peterson MG, Hollenberg JP, Szatrowski TP, et al. Geographic variations in the rates of elective total hip and knee arthroplasties among Medicare beneficiaries in the United States. *J Bone Joint Surg Am* 1992;74:1530-1539.
4. Vitale MG, Krant JJ, Gelijns AC, et al. Geographic variations in the rates of operative procedures involving the shoulder, including total shoulder replacement, humeral head replacement, and rotator cuff repair. *J Bone Joint Surg Am* 1999;81:763-772.
5. Wennberg J, Gittelsohn M. Small area variations in health care delivery. *Science* 1973;182:1102-1108.
6. Wright J, Heck D, Hawker G, et al. Rates of tibial osteotomies in Canada and the United States. *Clin Orthop* 1995;319:266-275.
7. Keller RB, Soule DN, Wennberg JE, Hanley DF, et al. Dealing with geographic variations in the use of hospitals: The experience of the Maine medical assessment foundation orthopaedic study group. *J Bone Joint Surg Am* 1990;72:1286-1293.
8. Barrack RL, Bruckner JD, Kneisl J, et al. The outcome of nonoperatively treated complete tears of the anterior cruciate ligament in active young adults. *Clin Orthop* 1990; 259:192-199.

TABLE 8. Patients With ACL-Deficient Knees Who Have Not Had Surgery are Able to Participate in All Recreational Sporting Activities

	No/Disagree	Indifferent	Yes/Agree
All surgeons	200 (76.9)	21 (8.1)	39 (15.0)
High volume*	57 (87.7)	4 (6.1)	4 (6.1)
Low volume†	28 (60.3)	7 (11.1)	18 (28.6)

*Top 25% self-reported ACL reconstructions performed in the past year.

†Bottom 25% self-reported ACL reconstructions performed in the past year.

9. Buss DD, Min R, Skyhar M, et al. Nonoperative treatment of acute anterior cruciate ligament injuries in a selected group of patients. *Am J Sports Med* 1995;23:160-165.
10. Caborn DN, Johnson BM. The natural history of the anterior cruciate ligament-deficient knee: A review. *Clin Sports Med* 1993;12:625-636.
11. Neusel E, Maibaum S, Rompe G. Five-year results of conservatively treated tears of the anterior cruciate ligament. *Arch Orthop Trauma Surg* 1996;115:332-336.
12. Shirakura K, Terauchi M, Kizuki S, et al. The natural history of untreated anterior cruciate tears in recreational athletes. *Clin Orthop* 1995; 319:227-236.
13. Lo IK, Bell DM, Fowler PJ. Anterior cruciate ligament injuries in the skeletally immature patient. *Instr Course Lect* 1998;47: 351-359.
14. Plancher KD, Steadman JR, Briggs KK, Hutton KS. Reconstruction of the anterior cruciate ligament in patients who are at least forty years old: A long-term follow-up and outcome study. *J Bone Joint Surg Am* 1998;80:184-197.
15. Mohtadi NG, Webster-Bogaert S, Fowler PJ. Limitation of motion following anterior cruciate ligament reconstruction: A case-control study. *Am J Sports Med* 1991;19:620-625.
16. Shelbourne KD, Wilckens JH, Mollabashy A, DeCarlo M. Arthrofibrosis in acute anterior cruciate ligament reconstruction: The effect of timing of reconstruction and rehabilitation. *Am J Sports Med* 1991;19:332-336.
17. Shelbourne KD, Klootwyk TE, DeCarlo MS. Update on accelerated rehabilitation after anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther* 1992;15:303-308.
18. Shelbourne KD, Nitz P. Accelerated rehabilitation after anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther* 1992;15:256-263.
19. Mirza F, Mai DD, Kirkley A, et al. Management of injuries to the anterior cruciate ligament: Results of a survey of orthopaedic surgeons in Canada. *Clin J Sport Med* 2000;10:85-88.
20. AAOS. *American Academy of Orthopaedic Surgeons membership directory*. Rosemont, IL: 1997-1998.
21. Man-Son-Hing M, Molnar F, St. John P, et al. Increasing physicians' response rate to mailed surveys: Effects of investigator's name recognition. *Ann R Coll Phys Surg Can* 2000; 33:7-9.
22. Mamlin LA, Melfi CA, Parchman ML, et al. Management of osteoarthritis of the knee by primary care physicians. *Arch Fam Med* 1998;7:563-567.
23. Rosner B. *Fundamentals of biostatistics*. Toronto: Duxbury Press, 1995; 315.
24. Feinstein AR. *Clinometrics*. New Haven: Yale University Press, 1987; 141-166.
25. Albright JC, Carpenter JE, Graf BK, Richmond JC. Knee and leg: Soft-tissue trauma. In: JH Beaty, ed. *Orthopaedic knowledge update*. Rosemont, IL: American Academy of Orthopaedic Surgeons, 1999;533-557.
26. Roos H, Adalberth T, Dahlberg L, Lohmander LS. Osteoarthritis of the knee after injury to the anterior cruciate ligament or meniscus: The influence of time and age. *Osteoarthritis Cartilage* 1995;3:261-267.
27. Andersson C, Odensten M, Good L, Gillquist J. Surgical or non-surgical treatment of acute rupture of the anterior cruciate ligament: A randomized study with long-term follow-up. *J Bone Joint Surg Am* 1989;71:965-974.
28. Keene GC, Bickerstaff D, Rae PJ, Paterson RS. The natural history of meniscal tears in anterior cruciate ligament insufficiency. *Am J Sports Med* 1993;21:672-679.
29. Kreder HJ, Deyo RA, Koepsell T, et al. Relationship between the volume of total hip replacements performed by providers and the rates of postoperative complications in the state of Washington. *J Bone Joint Surg Am* 1997;79:485-494.