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Background: Revision anterior cruciate ligament (ACL) reconstruction has worse outcomes than primary reconstructions. Predictors for these worse outcomes are not known. The Multicenter ACL Revision Study (MARS) Group was developed to perform a multisurgeon, multicenter prospective longitudinal study to obtain sufficient subjects to allow multivariable analysis to determine predictors of clinical outcome.

Purpose: To describe the formation of MARS and provide descriptive analysis of patient demographics and clinical features for the initial 460 enrolled patients to date in this prospective cohort.

Study Design: Cross-sectional study; Level of evidence, 2.

Methods: After training and institutional review board approval, surgeons began enrolling patients undergoing revision ACL reconstruction, recording patient demographics, previous ACL reconstruction methods, intra-articular injuries, and current revision techniques. Enrolled subjects completed a questionnaire consisting of validated patient-based outcome measures.

Results: As of April 1, 2009, 87 surgeons have enrolled a total of 460 patients (57% men; median age, 26 years). For 89%, the reconstruction was the first revision. Mode of failure as deemed by the revising surgeon was traumatic (32%), technical (24%), biologic (7%), combination (37%), infection (<1%), and no response (<1%). Previous graft present at the time of injury was 70% autograft, 27% allograft, 2% combination, and 1% unknown. Sixty-two percent were more than 2 years removed from their last reconstruction. Graft choice for revision ACL reconstruction was 45% autograft, 54% allograft, and more than 1% both allograft and autograft. Meniscus and/or chondral damage was found in 90% of patients.

Conclusion: The MARS Group has been able to quickly accumulate the largest revision ACL reconstruction cohort reported to date. Traumatic reinjury is deemed by surgeons to be the most common single mode of failure, but a combination of factors represents the most common mode of failure. Allograft graft choice is more common in the revision setting than autograft. Concomitant knee injury is extremely common in this population.

Keywords: revision; anterior cruciate ligament (ACL); reconstruction; epidemiology

Revision ACL reconstruction represents an infrequent but clinically important challenge in orthopaedic practice.[8,18,20,24,25,29,31] Technical issues require specific revision techniques to address complications such as retained hardware, bone tunnel defects, and incorrect tunnel placement. Moreover, it is commonly reported that the results of revision surgery remain inferior to primary reconstructions.[1,30] These poorer outcomes include inferior patient-based outcomes, increased laxity, higher graft failure rate, meniscal degeneration, and chondral lesions.

A number of reasons for the poorer outcome rate have been proposed, including compromised tunnel location, pathologic abnormalities untreated during the primary reconstruction, and greater reliance on allografts for revisions.[6,14,27] To evaluate the contributions of these and other factors to outcome, large numbers of patients who are undergoing revisions must be identified and followed prospectively. Because of the relative infrequency of revision ACL reconstructions in any one center, a large multicenter, multisurgeon study is necessary to accumulate enough subjects over a reasonable time to allow multivariable analyses with a large number of predictor variables. The eventual goal of this project is to identify clinically useful (ie, modifiable) predictors of outcome that may inform practice decisions and improve revision ACL reconstruction outcomes.

The purposes of this article are to (1) describe the rationale for and development of a specialty society–organized,

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multicenter study to evaluate predictors of outcome following revision ACL reconstruction, (2) document the feasibility of collecting a large sample of relatively low-volume surgical cases in a short period of time using this study strategy, and (3) present preliminary baseline data from this study to characterize the cohort.

METHODS

Study Design

A prospective longitudinal cohort design with multiple sites and multiple surgeons was chosen to determine modifiable predictors of outcome. This study design permits the establishment of both high-level evidence on prognosis to better counsel patients and, more importantly, to discover predictors (risk factors) of these outcomes. This cohort study was designed to recruit and retain enough subjects with longitudinal follow-up to allow multivariable analyses of factors affecting outcome.

In keeping with the National Institutes of Health roadmap to revamp clinical research, practice-based research networks are recognized as a critical component of clinical research. These partnerships with private practice physicians are part of the Clinical and Translational Science Awards.[28] Moreover, there have been calls for orthopaedic specialty societies to play a leading role in conducting multicenter clinical trials. The AOSSM has over 2000 members, including private practice and academic physicians from predominantly the United States and Canada; that group was the most practical venue to construct a large-scale research network involving revision ACL reconstruction surgery. All AOSSM members were notified regarding this society-level multicenter study and were given the opportunity to participate. Interested parties were required to attend 1 of 4 surgeon training sessions held in 2006–2008. At each session the manual of operating procedures was reviewed and items for data collection were discussed and revised based on group consensus. To establish standardization and uniformity among the group, all study-related forms were reviewed in detail and all questions were answered regarding how to appropriately complete them. Meniscal and articular cartilage arthroscopy videos were also reviewed, independently graded by each physician, and then discussed by the group to clarify any ambiguity in the classification of meniscal and articular cartilage injury. These videos were identical to the ones used in previous interobserver reliability studies evaluating meniscal and articular cartilage lesions.[7,15]

After the training sessions the surgeons were required to review the final manual of operating procedures, obtain institutional review board approval, complete a trial surgeon form, and sign a surgeon's agreement to follow the manual of operating procedures before beginning patient enrollment. Since these training sessions, the MARS Study coordinators (L.J.H. and A.K.H.) have been available to address individual questions and concerns from surgeons and research assistants by e-mail and phone. Patient enrollment began May 1, 2006. The current study includes enrollment through March 31, 2009.

Participants

Inclusion criteria for patients enrolled in the study include all patients with ACL deficiency evaluated at the clinic between the ages of 12 and 65 years who are scheduled to have a revision ACL reconstruction by a participating (MARS study group) surgeon. All participants must have undergone an ACL reconstruction in the past, and are currently identified as having experienced failure of their ACL reconstruction, as defined by the surgeon by either MRI, knee laxity (>5 mm side-to-side difference on arthrometer testing), a positive pivot shift or Lachman test, functional instability, and/or by arthroscopic confirmation. Patients with concomitant injuries to the medial and lateral collateral ligaments, posterior cruciate ligament, or posterolateral complex are also included. Exclusion criteria for patients for the study were patients with graft failure secondary to prior intra-articular infection, arthrofibrosis, or complex regional pain syndrome. Patients unwilling or unable to complete their repeat questionnaire 2 years after their initial visit are also excluded. Surgeon enrollment logs demonstrate that 75% of eligible patients agreed to participate.

Treatment

Surgical reconstruction technique is left to the discretion of the operating surgeon. Because patients have already sustained failure of one or more ACL grafts, the surgeon is often forced to use a graft that is not his or her usual first choice. The following graft types are the only ones accepted for inclusion: (1) any autograft, including contralateral autografts; and (2) nonirradiated, fresh-frozen allografts from a single donor source (Musculoskeletal Transplant Foundation, Edison, New Jersey), including bone-patellar tendon-bone, tibialis anterior/posterior, Achilles tendon, semitendinosus, or gracilis. Required radiographs for the study include bilateral standing AP and a full-extension lateral. Recommended radiographs include bilateral 45° bent knee weightbearing Rosenberg view, patellofemoral view, and standing alignment (hip, knee, ankle).

Data Collection

After giving informed consent, subjects are provided a self-administered, 13-page patient questionnaire containing the validated outcome instruments of the Short Form-36 (version 2), Western Ontario and McMaster Osteoarthritis Index, Knee injury Osteoarthritis Outcome Score, International Knee Documentation Committee subjective form, and Marx activity scale. The surgeon questionnaire is completed at the time of surgery and includes sections on history of knee injury and/or surgery on both knees, the results of the general knee examination done under anesthesia, recording of all previous and new intra-articular

injuries and treatments to the meniscus and articular cartilage, and the surgical technique used for the revision ACL reconstruction. Classification of the general knee examination findings follows the recommendations of the updated 1999 International Knee Documentation Committee guidelines.[12,13] Surgeon documentation of articular cartilage injury is recorded on the modified Outerbridge classification[4] and is based on an interobserver agreement study.[15] Meniscal injuries are classified by size, location, and partial versus complete tears. Treatment of meniscal tears are recorded as none, repair, or extent of resection. Both of these classifications are based on a previous interrater agreement study.[7] Rehabilitation issues are recorded including the use of postoperative and functional bracing, timing of initiating weightbearing, passive motion, and active motion.

Completed data forms are mailed from the participating sites to the central data collection site (Vanderbilt University). Data from both the patient and surgeon questionnaires are scanned with TeleForm software (Cardiff Software, Inc, Vista, California) that uses optical character recognition to avoid manual data entry, and the returned data are verified and then exported to a database.[10,19] Both the patient and the surgeon questionnaire have a matched, barcoded identification number on each page to deidentify the data and to aid in database merging.

Statistical Design

Statistical power necessary to complete the MARS study could be used to calculate the sample size and duration of the proposed study, but power calculations have limitations in that they not only assume the magnitude of a single effect but also assign this single variable overriding importance. Because this study will rely on multivariable analysis to determine predictors of worse outcome, we elected to use sample size estimates based on estimating the number of variables and allowing a ratio of 10:1 for subjects to variables.[11] Hence, sample size estimates are based on model complexity where m is the effective sample and $m/10$ variables (predictors plus nonlinearities and interactions) are possible in the model. A total of 900 to 1000 patients will be enrolled to ensure adequate power with expected 80% follow-up at 2 years.

RESULTS

As of April 1, 2009, 87 surgeons had enrolled 460 patients across 52 sites in 28 states and 2 Canadian provinces. Enrollment began July 1, 2006. Academic sites represented 54% of the total versus 46% private practice. Twenty-eight percent were performed by the surgeon who had performed the primary ACL reconstruction. Median age for the cohort is 26 years (range, 12-63 years) and there are 57% male patients. Age at the time of revision differed by sex. Most commonly, female patients underwent revision in the second decade of life and men most commonly underwent revision in the third decade (Figure 1). The most common races

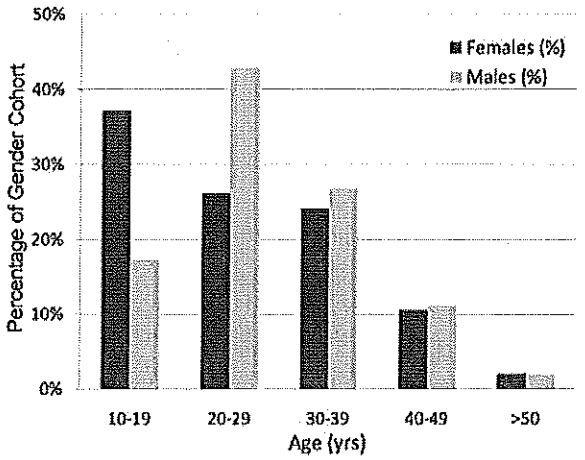

Figure 1. Age at time of revision (age range, 12-65 years).

TABLE 1
Number of Subjects Enrolled, Stratified by Gender and Race

Racial Categories	Females	Males	Total
American Indian/Alaska Native	1	0	1
Asian	1	8	9
Native Hawaiian or other Pacific Islander	2	2	4
Black or African American	11	13	24
White	164	217	381
Other	6	7	13
More than one race	5	6	11
Unknown or not reported	9	8	17
Racial categories: Total of all subjects	199	261	460

reported were white (83%) and black or African American (5%) (Table 1). The educational level completed ranged from sixth grade through 20 years of education (Table 2). Most adults had completed high school. The majority of the cohort reported that their injury was in a noncontact setting (71%; 31% of the total cohort reported that they were jumping at the time of injury, and 40% were cutting or changing direction). Eighty-three percent reported hearing a "pop" at the time of injury; 76% of the cohort reported that they were injured while playing a sport. Of this subgroup, subjects reinjured their ACL most commonly playing either soccer or basketball (Table 3).

This was the first revision for 89% of the patients, second for 9%, third for 2%, fourth for less than 1%, and not recorded for less than 1%. The time from last reconstruction was less than 1 year in 15% of patients, between 1 and 2 years for 22%, greater than 2 years for 62%, and unknown for less than 1%. Mode of failure as deemed by the revising surgeon was traumatic for 32% (148); technical, 24%; biologic, 7%; combination, 37% (surgeons marked all that applied); infection, less than 1%, and no response, less than 1% (Figure 2). Biologic failure is not well defined in the literature despite its use in previous studies. By

TABLE 2
Completed Education Level, Stratified by Gender

Years of School Completed[a]	Gender		
	Females	Males	Total
6th grade	1	1	2
7th grade	1	0	1
8th grade	3	3	6
9th grade	9	2	11
10th grade	9	8	17
11th grade	16	12	28
12th grade	25	48	73
13	24	26	50
14	21	29	50
15	8	17	25
16	42	64	106
17	11	17	28
18	15	20	35
19	2	3	5
20	11	8	19
Unknown or not reported	1	3	4
Total	199	261	460

[a]For example, 12 = high school senior; 16 = college graduate.

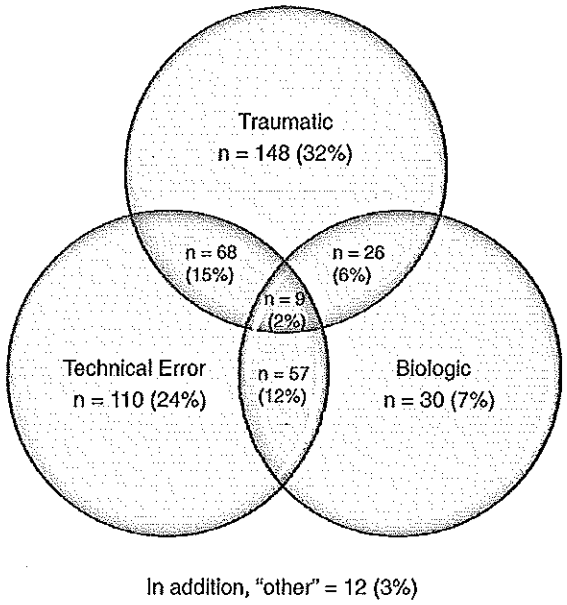

Figure 2. Mode of failure.

TABLE 3
Activity at the Time of Reinjury[a]

Activity	No. (%)
Nonsport (ie, ADL)	112 (24)
Sport	348 (79)
Soccer	83 (18%)
Basketball	74 (16%)
Football	56 (12%)
Other	58 (13%)
Skiing	39 (8%)
Baseball/softball	14 (3%)
Volleyball	13 (3%)
Gymnastics	7 (2%)
Blank/not reported	4 (<1%)
Total	460 (100)

[a]"Other" includes sports such as wrestling, tennis, hockey, track and field, biking, cheerleading, rugby, lacrosse, racquetball, frisbee, dancing, martial arts, roller skating, and trampolining. ADL, activities of daily living.

TABLE 4
Technical Cause of Failure[a]

Cause	No. (%)
Femoral tunnel malposition	223 (80)
Tibial tunnel malposition	104 (37)
Malalignment	12 (4)
Femoral fixation	17 (6)
Tibial fixation	3 (1)
Autograft source	4 (1)
Allograft source	20 (7)
Posteromedial laxity	6 (2)
Posterolateral laxity	4 (1)
Other	11 (4)

[a]Note the denominator is >100% because of the multiple choice option of this question (surgeons were instructed to "check all that apply").

consensus at the surgeon training sessions, biologic failure was defined as lack of incorporation of the graft as evidenced by early failure without a significant traumatic episode or obvious significant technical problems with the previous reconstruction.

The type of technical failure was determined at the time of surgery by the surgeon using all available evidence (history, physical examination, radiographs, and arthroscopic evaluation). Surgeons were allowed to indicate more than one type of technical error. Femoral tunnel malposition was rated as the most common technical failure by far (80%), followed by tibial tunnel malposition (37%) (Table 4).

Graft source for the prior reconstruction was 70% autograft, 27% allograft, 2% both allograft and autograft, and 1% unknown (Table 5). Graft choice for the current revision ACL reconstruction was 45% autograft, 54% allograft, less than 1% combination, and less than 1% no response (Table 6). The single most common graft was an allograft bone-patellar tendon-bone (27%); autograft and allograft bone-patellar tendon-bone together represented 49% of all grafts chosen for revision reconstruction in this series. Prior approach was arthroscopic single incision in 81%, arthroscopic rear entry 2-incision in 16%, traditional arthrotomy in 2%, miniarthrotomy in less than 1%, and less than 1% were not recorded. Current surgical exposure and technique is arthroscopic single-incision transtibial drilling, 48%; arthroscopic single-incision anteromedial portal drilling, 35%; arthroscopic rear entry 2-incision,

TABLE 5
Prior Graft Source

Source	Autograft, No. (%)	Allograft, No. (%)
Bone-patellar tendon-bone	205 (64)	55 (44)
Quadriceps tendon bone	3 (<1)	
Hamstring (semitendinosus [ST])	15 (5)	1 (<1)
Hamstring (ST + gracilis)	93 (29)	6 (5)
Iliotibial band	1 (<1)	
Achilles tendon		14 (11)
Tibialis anterior		24 (19)
Tibialis posterior		4 (3)
Other/unknown	3 (1)	21 (17)
Blank	1 (<1)	1 (<1)
Total	321 (70)	126 (27)

TABLE 6
Current Graft Source (Autografts and Allografts Only)

Source	Autograft, No. (%)	Allograft, No. (%)
Bone-patellar tendon-bone	102 (49)	123 (50)
Quadriceps tendon bone	11 (5)	2 (<1)
Hamstring (semitendinosus [ST])	11 (5)	5 (2)
Hamstring (ST + gracilis)	84 (40)	1 (<1)
Iliotibial band		
Achilles tendon		30 (12)
Tibialis anterior		57 (23)
Tibialis posterior		28 (11)
Other / unknown	1 (<1)	
Blank		1 (<1)
Total	209 (45)	247 (54)

TABLE 7
Meniscal and Articular Cartilage (AC) Condition

	AC Injury		
Meniscal Injury	Normal	Abnormal	Total
Normal	44 (10%)	74 (16%)	118 (26%)
Abnormal	79 (17%)	263 (57%)	342 (74%)
Total	123 (27%)	337 (73%)	460 (100%)

15%; traditional arthrotomy, less than 1%; miniarthrotomy, less than 1%; and not recorded, less than 1%. Bone grafting of dilated tunnels was performed at the time of the revision in 3% of patients for the tibia and 3% of patients for the femur. It was performed as a staged procedure before revision reconstruction in 9% of patients for the tibia and in 8% of patients for the femur.

Concomitant knee injury (meniscal and chondral) was common in this cohort (Tables 7 through 9). Current or previously treated meniscal injury was noted in 74% of patients. Articular cartilage damage grade 2 or worse

TABLE 8
Medial Versus Lateral Meniscal Tears

Current Tears	Partial Tear	Complete Tear	Total
Medial	53 (12%)	129 (28%)	182 (40%)
Lateral	66 (14%)	94 (20%)	160 (35%)
Total	119 (26%)	223 (48%)	342 (74%)

TABLE 9
Location and Frequency of Articular Cartilage Injury[a]

Location	No. (%)
Medial femoral condyle	204 (44)
Lateral femoral condyle	131 (28)
Medial tibial plateau	53 (12)
Lateral tibial plateau	86 (19)
Patella	158 (34)
Trochlea	96 (21)

[a]Grade 2 or higher, seen at the time of revision surgery.

TABLE 10
Baseline Outcome Instrument Scores

Validated Outcome Instrument	Scale	Baseline (T_0)
Marx activity level	0–16	11 (4,16)
IKDC	0–100	46 (34,57)
KOOS	0–100	
Symptoms		68 (54,82)
Pain		75 (61,86)
ADL		87 (71,96)
Sports/recreation		45 (25,65)
Knee-related quality of life		31 (19,44)
WOMAC	0–100	
Stiffness		75 (50,88)
Pain		85 (70,95)
ADL		87 (71,96)

[a]Median (25%, 75% quartile). IKDC, International Knee Documentation Committee "subjective" form. KOOS, Knee injury Osteoarthritis Outcome Score; WOMAC, Western Ontario and McMaster Osteoarthritis Index; ADL, activities of daily living.

using the modified Outerbridge classification system was noted in 73%. Both meniscal and articular cartilage damage was seen in 57%. Only 10% of the cohort had neither meniscal nor articular cartilage damage. Baseline time zero patient-based outcome measures were recorded (Table 10).

DISCUSSION

The primary purposes of this report were to describe the development of a large specialty society, multicenter study and to document the feasibility of collecting data rapidly on large numbers of relatively low-volume surgical cases

using this strategy. Using this approach, MARS has been able to enroll over 400 ACL revision patients in the space of 2 years. This represents the largest multisurgeon, multicenter group assembled to investigate revision ACL reconstruction outcomes, and the cohort has reported here the largest series of revision patients reported in the literature. The strength of MARS lies in its society-wide, multicenter cohort design, the collective expertise of the group, and the establishment of the infrastructure. The study's novelty is drawn from the unique combination of large numbers of both academic and private practice physician groups. Thus, the results become generalizable. The multisurgeon, multicenter sampling scheme has allowed rapid accumulation of a high number of patients that could not otherwise be achieved given the relative infrequency of revision ACL reconstructions in most surgeons' practice. The prospective nature of the study ensures consistency in data collection, and the clinical study design uses multivariable analysis to determine the most important predictors of prognosis. Finally, the support of AOSSM ensures the ability of the findings to be widely and rapidly adopted by the sports medicine community.

A secondary purpose of this report was to provide representative demographic and clinical data from the cohort of patients enrolled in the initial 2 years of the study, as has been done for other large multicenter orthopaedic studies.[31] These data will form the basis of our predictive analysis of patient outcomes. A prospective longitudinal cohort is the study design most useful for determining modifiable predictors of outcome. The Framingham study is the classic example of this type of study design to establish both high-level evidence on prognosis for outcome to counsel patients, and, more importantly, to discover independent predictors (risk factors) of these outcomes.[5] Identifying these predictors will allow us to further investigate targeted subpopulations with poor outcome in future interventional trials. Similar to the Framingham study, our cohort is designed to collect enough subjects followed over time to allow multivariable analyses of the factors affecting outcome. Identification of these modifiable predictors will allow improved counseling of surgeons and patients and allow the focus of research resources toward improvement of revision ACL reconstruction outcomes.

The most common mode of failure was determined to be traumatic reinjury in this early report of the cohort. A combination of factors (technical, traumatic, and/or biologic) was overall believed to be the most common reason for failure. This is in contradistinction to some previous studies that have determined technical considerations to be the most common cause of failure of ACL reconstruction. In fact, previous studies have proposed that more than 50% of the failures were due to technical considerations.[2,6,14,27] Carson et al[2] in a review of 90 revision ACL reconstructions noted that 47 of 90 were due to technical considerations and 22 of 90 were traumatic reinjuries. Our numbers, while similar to those of Salmon et al,[21] may differ from previous studies because of the inclusion of a "combination" category that likely decreases the numbers of both traumatic reinjuries and technical failures. Noyes and Barber-Westin[16] demonstrated that multiple factors contributed to ACL graft rupture in 15 of 32 of their patient's previous ACL reconstructions. This combination category in our cohort constitutes 170 of 460 (37%), which was larger than the technical failure group.

Most studies that have examined potential causes of ACL reconstruction failure did not delineate the specific type of technical failure and only list technical failure as a broad category. The preliminary findings from the present study are in general agreement with studies that did assess specific technical errors in showing the high prevalence of femoral tunnel malposition in failed ACL reconstructions. Garofalo et al[9] demonstrated a 79% femoral tunnel and 21% tibial tunnel malposition in their revision ACL reconstruction series. Only 6 of 28 (21%) demonstrated appropriate tunnel position for both the femur and tibia. Taggart et al,[26] in a series of revision ACL reconstructions, noted 12 of 20 (60%) with any femoral tunnel malposition. The findings in these 2 studies demonstrate the frequency of femoral tunnel malposition as a cause of failure, but unfortunately, as in most revision studies, the nature of the malposition (anterior vs vertical) was not delineated. Our study asks surgeons to determine if the femoral tunnel is too vertical or too anterior, and if the tibial tunnel is too anterior, posterior, medial, or lateral.

The best graft choice for revision ACL reconstruction continues to be an area of debate. Previous studies have demonstrated use of a variety of grafts in the revision ACL reconstruction setting.[16,17,21-23] These included contralateral and ipsilateral hamstring, patellar tendon and quadriceps tendon autografts, and a variety of allografts. Graft choice is predominantly influenced by 2 factors: previous graft(s) used and surgeon preference. But it is also affected by a variety of other factors, including patient preference, tunnel dilatation, and contralateral knee status. Thus, comparison of our graft choice results with those of previous studies may be irrelevant because of the preponderance of small 1- or 2-surgeon case series in the literature. However, a few multisurgeon revision ACL reconstruction series do exist. Battaglia et al[1] recently reported a 7-surgeon series. Graft choice included 43 of 63 (68%) autografts (19 ipsilateral bone patellar tendon bone, 10 ipsilateral hamstring, 3 ipsilateral quadriceps, 1 ipsilateral bone-patellar tendon-bone reharvest, and 10 contralateral bone-patellar tendon-bone grafts) and 20 of 63 (32%) allografts (type indeterminate).

We believe our results, given the much larger surgeon sample size, are more readily generalizable to the United States sports orthopaedic surgeon's practice. The results in this study demonstrated a predilection for allograft (54%), especially bone-patellar tendon-bone grafts. Currently, graft source in general has not been determined to be a source for the worse outcomes in revision reconstructions compared with primary reconstruction. Given the large number of subjects and the near 50/50 split of autograft and allograft, we will be able to use multivariable analysis to determine if graft source is a predictor for outcome.

Limitations include the descriptive nature of this study that require further follow-up at 2 years after surgery to

assess these factors as predictors for outcome of ACL revision reconstruction. An additional weakness is the potential lack of agreement between surgeons regarding contributions to failure. This was minimized as much as possible by the required training of all participating surgeons. To further address this potential weakness, intraobserver and interobserver studies are being designed and implemented for the MARS Group. Previous case series of revision reconstructions also suffer from this by the lack of defined standards of cause of failure. We are surprised by the small number of minorities represented in our cohort (Table 1). Based on the widespread geography, practice settings, and insurance plans (including Medicaid) represented by our 52 sites, we believe this may represent the actual racial distribution of revision ACL reconstruction currently performed in North America.

Potential limitations for MARS include the feasibility of coordinating 87 investigators and obtaining greater than 80% patient 2-year follow-up. However, based on our first year, we have been able to promote a collaborative atmosphere among the participating surgeons, have assisted the sites in obtaining individual institutional review board approvals, and have been successful in subsequent subject enrollment.

We believe this first study by the MARS group demonstrates the ability of the research consortium to rapidly collect a large series of revision ACL reconstruction cases. In addition, descriptive analysis provides the background for future studies and comparison with other cohorts. The overarching goal of this group is to identify modifiable predictors of revision ACL reconstruction outcomes to improve future outcomes, counsel patients on prognosis, educate surgeons within an entire society on evidence-based medicine and clinical research, and potentially perform randomized clinical trials on the most influential predictors. Variables to evaluate include, but are not limited to, those described in the Appendices (see online Appendix 1-3 for this article at http://ajs.sagepub.com/supplemental/). We await 2-year follow-up of this cohort to allow analysis of predictors of outcome.

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