Systematic Review With Video Illustrations

Meniscal Repair Versus Partial Meniscectomy: A Systematic Review Comparing Reoperation Rates and Clinical Outcomes

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Purpose: The aim of this investigation was to compare reoperation rates and clinical outcomes after meniscal repair and partial meniscectomy. **Methods:** A systematic literature review was performed to identify outcome studies of arthroscopic meniscal repair (inside-out, outside-in, and all-inside techniques) or partial meniscectomy in patients with traumatic meniscal tears. The studies included patients with no previous injuries or operations. **Results:** At short- and long-term follow-up, partial meniscectomy had a lower reoperation rate (1.4% [2 of 143] and 3.9% [52 of 1,319], respectively) than isolated meniscal repair (16.5% [47 of 284] and 20.7% [30 of 145], respectively). There was a slightly higher reoperation rate after partial lateral meniscectomy compared with partial medial meniscectomy. Repairs of the medial meniscus resulted in higher reoperation rates than repairs of the lateral meniscus. Meniscal repairs at the time of anterior cruciate ligament reconstruction had a lower failure rate than isolated repairs. In the limited number of studies with long-term clinical outcome scores, meniscal repair was associated with higher Lysholm scores and less radiologic degeneration than partial meniscectomy. **Conclusions:** Whereas meniscal repairs have a higher reoperation rate than partial meniscectomies, they are associated with better long-term outcomes. **Level of Evidence:** Level IV, systematic review of Level I–IV studies.

The meniscus functions as a load-bearing[1] and shock-absorbing[2] part of the tibiofemoral joint that increases the surface area for load transmission.[3-9] The meniscus also acts as a secondary anterior-posterior stabilizer of the knee joint,[10-15] aids in proprioception,[16] and contributes to the lubrication[17] and nutrition[18] of the articular cartilage. Clinical studies comparing total and partial meniscectomy have documented the beneficial effects of meniscus preservation. Significantly more knee degeneration and osteoarthritis have been illustrated in knees with total meniscectomy in comparison to partial meniscectomy.[19,20] An inverse relation has been shown between function of the knee and amount of meniscal tissue resected.[21] The recognition of the protective function of the meniscus has led to efforts to preserve as much meniscal tissue as possible.

Meniscal surgeries are the most commonly performed procedures in orthopaedics.[22,23] The current primary options for arthroscopic meniscal surgery are partial meniscectomy or meniscal repair (Videos 1 and 2, online only, available at www.arthroscopyjournal.org). Multiple meniscal repair techniques have been developed. An inside-out or outside-in suturing technique has historically been the most common technique of repair. More recently, numerous all-inside devices have been developed to facilitate meniscal repair performed entirely from within the joint. It has been hypothesized that preservation of more meniscal tissue leads to a better long-term outcome. Few studies, however, have directly compared the effectiveness of partial meniscectomy with that of meniscal repair.

The purpose of this study was to review the published short- and long-term outcomes of meniscal

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repair and partial meniscectomy and to compare reoperation rates and clinical outcomes when possible. A secondary aim was to compare the effectiveness of the various approaches with meniscal repair. Finally, differences in failure rates between isolated meniscal repairs and those accompanied by anterior cruciate ligament reconstruction (ACLR) were reviewed.

METHODS

We performed a systematic literature review to compare the short- and long-term outcomes between meniscal repair and partial meniscectomy in patients with a traumatic meniscal tear. We only included studies of patients with no previous knee injury or surgery. Studies with patients who underwent meniscal surgery in the setting of an ACLR were included as a separate subpopulation from the cases of isolated meniscal tears. The meniscal operation had to be arthroscopic, and the meniscal repair techniques included inside-out and outside-in suturing techniques, as well as any all-inside devices. Whereas studies directly comparing the 2 interventions were preferred, all that met the previously mentioned criteria were included.

A review of the literature with use of the Medline database was performed involving searches for the keywords "meniscus," "meniscal," "menisci," and "meniscectomy." The studies were limited to human research and to publications published between January 1, 1989, and April 1, 2010. This search strategy yielded 5,053 hits. A first-stage screening was performed on the titles and abstracts identified with our criteria. Full-text articles for the studies meeting the previously designed inclusion criteria were then reviewed. Bibliographies of the studies identified through this search method were manually searched for additional studies that had not been previously identified. All data were extracted from selected articles through a standardized electronic form. The form recorded information pertaining to the patient population, tear characteristics, follow-up period, failure rates, tear healing rates (meniscal repair only), radiographic joint changes, and subjective outcome scores. Failure was defined as the need for any revision meniscal surgery in the study's follow-up period. For the subjective outcome scores, we evaluated the frequency of use of each scale, and the most frequently used measure was then used to compare the procedures. All results were then reviewed by 2 independent investigators (E.S.P. and R.H.B.).

RESULTS

From the search, we found 95 studies that met the criteria, a vast majority of which were case series. Only 4 studies were found that directly compared meniscal repair and partial meniscectomy.[24-27] Of these 4 direct comparisons, one study reported the results of the 2 procedures in patients without an accompanying ACLR.[26] This study had a mean follow-up of 26.5 months and compared 10 meniscal repairs with 11 partial meniscectomies. No significant radiologic difference was found between the 2 groups.

Seventy studies of meniscal repair (Table 1) and twenty-one of partial meniscectomy (Table 2) were case series. The level of evidence for these studies is low, with only 3 Level I studies compared with 79 Level IV studies (Table 3). Of the Level IV studies, 75% (59 of 79) were retrospective in nature.

The most frequently reported subjective outcome measure used was the Lysholm scale. However, this was used in just over half of the studies. The vast majority failed to report the individual patient scores or a divisional breakdown of the scores and only included mean scores of the entire cohort. Only 2 meniscectomy studies[28,29] and 1 meniscal repair study[30] reported a detailed distribution of Lysholm score outcomes.

Reoperation Rate: Meniscal Repair Versus Partial Meniscectomy

In the short-term follow-up period (0 to 4 years), isolated partial meniscectomies had a reoperation rate of 1.4% (2 of 143) whereas meniscal repairs were reoperated on in 16.5% of cases (47 of 284) (Fig 1). Over the long-term follow-up period (>10 years), partial meniscectomies required a reoperation in only 3.9% of cases (52 of 1,319) whereas meniscal repair had a reoperation rate of 20.7% (30 of 145).

With regard to tear location, partial meniscectomy had lower reoperation rates across all time periods, regardless of whether the tear was in the medial (Fig 2) or lateral (Fig 3) meniscus. Meniscal repairs of the lateral meniscus had fewer reoperations than repairs on the medial side. Conversely, partial meniscectomy was more likely to require a reoperation when performed for a lateral meniscal tear compared with a medial tear. Both lateral and medial meniscal repairs performed at the time of ACLR had a lower reoperation rate than isolated meniscal repairs in the same compartment.

TABLE 1. *Summary of Meniscal Repair Study Outcomes*

Device	Author	Year	No. of Repairs	Mean Age (yr)	ACLR (%)	Mean Follow-up (mo)	Lost to Follow-up (%)	Subjective Outcome Scales	Type of Study	Level of Evidence
Inside-out	Choi et al.[45]	2009	34	27.7	100.0	36	0.0	Lysholm, Tegner, Lachman	Cohort study	II
	Logan et al.[46]	2009	45	23.2	82.2	102	0.0	Lysholm	Retrospective case series	IV
	Feng et al.[47]	2008	67	25.0	100.0	26	0.0	—	Retrospective case series	IV
	Haklar et al.[48]	2008	5	28.6	0.0	31	0.0	Lysholm	Prospective case series	IV
	Krych et al.[49]	2008	17	15.8	0.0	70	—	IKDC, Tegner	Retrospective case series	IV
	Bryant et al.[50]	2007	49	25.7	63.3	28	12.5	—	RCT	I
	Hantes et al.[51]	2006	20	28.0	65.0	22	0.0	IKDC	Prospective randomized study	II
	Tuckman et al.[52]	2006	12	30.1	54.1	62	15.0	—	Retrospective case series	IV
	Barber et al.[53]	2005	29	27.0	82.8	27	14.0	Lysholm, Tegner, Cincinnati, IKDC	Prospective comparative study	II
	Soejima et al.[54]	2005	17	24.0	0.0	9	0.0	—	Retrospective case series	IV
	Steenbrugge et al.[55]	2005	2	34.5	100.0	113	0.0	HSS	Retrospective case series	IV
	Steenbrugge et al.[55]	2005	10	37.2	0.0	110	0.0	HSS	Retrospective case series	IV
	Kimura et al.[30]	2004	28	22.9	71.4	122	28.2	Lysholm	Retrospective case series	IV
	Steenbrugge et al.[56]	2004	14	33.5	7.1	158	0.0	HSS	Retrospective comparative study	III
	Papachristou et al.[57]	2003	10	21.0	0.0	36	50.0	—	Prospective case series	IV
	Spindler et al.[58]	2003	40	24.4	100.0	68	14.9	Lysholm, IKDC, KOOS	Prospective case series	IV
	Noyes and Barber-Westin[59]	2002	71	16.0	66.2	51	4.7	Cincinnati	Prospective case series	IV
	Steenbrugge et al.[60]	2002	7	35.5	14.3	158	50.0	HSS	Prospective case series	IV
	Noyes and Barber-Westin[61]	2000	30	45.0	73.3	34	3.3	Cincinnati	Prospective case series	IV
	Albrecht-Olsen et al.[62]	1999	34	25.5	55.9	4	0.0	—	RCT	I
	Johnson et al.[63]	1999	38	20.2	0.0	129	47.1	—	Retrospective case series	IV
	Asahina et al.[64]	1998	63	22.0	100.0	48	13.7	Lysholm, Tegner	Retrospective case series	IV
	Barrett et al.[65]	1998	31	44.2	58.1	27	0.0	—	Prospective case series	IV
	Rubman et al.[66]	1998	198	28.0	64.6	42	9.2	—	Retrospective case series	IV
	Asahina et al.[67]	1996	98	23.2	100.0	16	19.0	—	Retrospective case series	IV
	Horibe et al.[68]	1996	36	24.0	0.0	5	45.3	—	Retrospective case series	IV
	Horibe et al.[68]	1996	36	24.0	0.0	42	45.3	—	Retrospective case series	IV
	Perdue et al.[69]	1996	45	29.6	100.0	27	50.5	Lysholm, Tegner	Retrospective case series	IV
	Horibe et al.[70]	1995	132	22.0	68.9	8	0.0	—	Retrospective case series	IV
	Jensen et al.[71]	1994	34	28.0	20.6	54	0.0	Lysholm, Tegner	Retrospective case series	IV
	Tenuta and Arciero[35]	1994	54	22.0	74.1	11	16.4	—	Retrospective case series	IV
	Albrecht-Olsen and Bak[72]	1993	27	28.0	0.0	36	6.9	Lysholm	Retrospective case series	IV
	Cannon and Vittori[36]	1992	68	27.0	100.0	10	15.9	—	Retrospective case series	IV
	Cannon and Vittori[36]	1992	22	27.0	0.0	7	12.0	—	Retrospective case series	IV

TABLE 1. *Continued*

Device	Author	Year	No. of Repairs	Mean Age (yr)	ACLR (%)	Mean Follow-up (mo)	Lost to Follow-up (%)	Subjective Outcome Scales	Type of Study	Level of Evidence
	Hanks et al.[73]	1991	45	24.0	46.7	50	0.0	—	Retrospective case series	IV
	Stone et al.[74]	1990	27	28.5	63.0	48	76.3	HSS	Retrospective case series	IV
	Krych et al.[49]	2008	15	15.8	0.0	70	—	IKDC, Tegner	Retrospective case series	IV
Mensicus arrow (Bionx, Blue Bell, PA)	Bryant et al.[50]	2007	51	25.1	66.7	28	12.1	—	RCT	I
Biofix arrow fixation technique (Bionx Implants, Ltd, Tampere, Finland)	Gifstad et al.[75]	2007	120	26.0	24.2	56	4.0	Lysholm	Retrospective case series	IV
Meniscus arrow (Bionx Implants, Blue Bell, PA)	Siebold et al.[76]	2007	95	30.0	66.0	72	15.9	Lysholm, Cincinnati	Retrospective case series	IV
	Koukoulias et al.[77]	2007	62	23.7	72.6	73	7.5	Lysholm, IKDC, Tegner	Retrospective case series	IV
	Tuckman et al.[52]	2006	64	30.1	54.1	62	15.0	—	Retrospective case series	IV
Meniscus arrow (Bionx Implants, Malvern, PA)	Kurzweil et al.[78]	2005	57	27.0	78.9	54	0.0	—	Retrospective case series	IV
Meniscus arrow (Bionx Implants Ltd, Tampere, Finland)	Sarimo et al.[79]	2005	21	26.0	57.1	26	0.0	Lysholm	Prospective case series	IV
Meniscal arrow (Biofix; Bioscience, Tampere, Finland)	Steenbrugge et al.[56]	2004	22	37.5	13.6	77	31.3	HSS	Retrospective comparative study	III
Bionx arrows	Spindler et al.[58]	2003	85	23.4	100.0	27	13.3	Lysholm, IKDC, KOOS	Prospective case series	IV
Biofix meniscus arrow (Bioscience)	Al-Othman[80]	2002	32	29.4	34.4	25	0.0	Marshall	Retrospective case series	IV
Meniscus arrow (Bionx Implants, Blue Bell, PA)	Ellermann et al.[81]	2002	105	29.9	71.4	33	7.1	Lysholm, Cincinnati	Retrospective case series	IV
Meniscus arrow (Bionx, Malvern, PA)	Jones et al.[82]	2002	39	29.9	53.8	30	0.0	Lysholm	Retrospective case series	IV
Meniscus arrows (Bionx, Blue Bell, PA)	Petsche et al.[83]	2002	27	29.0	92.6	24	3.6	Lysholm, Tegner	Retrospective case series	IV
Meniscal arrows (Biofix)	Venkatachalam et al.[84]	2001	23	28.0	50.0	21	—	—	Retrospective case series	IV
Meniscal arrows (Biofix)	Hürel et al.[85]	2000	26	31.6	34.6	17	30.6	—	Retrospective comparative study	III
Biofix meniscus arrow (Bioscience)	Albrecht-Olsen et al.[62]	1999	34	26.5	55.9	4	0.0	—	RCT	I
Outside-in	Abdelkafy et al.[86]	2007	41	26.5	39.0	141	55.9	Lysholm, IKDC, SF-36	Retrospective case series	IV
	Hantes et al.[51]	2006	17	28.5	58.8	23	0.0	IKDC	Prospective randomized study	II
	Majewski et al.[87]	2006	88	29.8	0.0	120	24.1	Lysholm, Tegner	Retrospective case series	IV
	Tuckman et al.[52]	2006	10	30.1	54.1	62	15.0	—	Retrospective case series	IV
	Marinescu et al.[88]	2003	68	27.6	36.8	60		Lysholm	Prospective case series	IV
	Venkatachalam et al.[84]	2001	14	28.0	50.0	21	—	—	Retrospective case series	IV
	Plasschaert et al.[89]	1998	41	25.4	82.9	42	14.6	Lysholm	Retrospective case series	IV
	van Trommel et al.[90]	1998	51	28.0	68.6	15	45.7	—	Retrospective case series	IV
	Morgan et al.[91]	1991	28	26.0	85.7	8	90.9	—	Retrospective case series	IV
T-Fix (Smith and Nephew Endoscopy, Andover, MA)	Kalliakmanis et al.[92]	2008	89	30.4	100.0	25	0.0	Lysholm, IKDC	Retrospective comparative study	III
	Tuckman et al.[52]	2006	17	30.1	54.1	62	15.0	—	Retrospective case series	IV
	Kocabey et al.[93]	2004	55	26.7	58.2	10	0.0	—	Retrospective case series	IV
	Asik et al.[94]	2002	47	27.0	23.4	26	0.0	—	Prospective case series	IV

TABLE 1. *Continued*

Device	Author	Year	No. of Repairs	Mean Age (yr)	ACLR (%)	Mean Follow-up (mo)	Lost to Follow-up (%)	Subjective Outcome Scales	Type of Study	Level of Evidence
	Venkatachalam et al.[84]	2001	7	28.0	50.0	21	—	—	Retrospective case series	IV
	Barrett et al.[65]	1998	6	44.2	66.7	27	0.0	—	Prospective case series	IV
	Barrett et al.[95]	1997	21	25.2	100.0	17	0.0	—	Prospective case series	IV
	Escalas et al.[96]	1997	20	29.0	5.0	6	0.0	—	Prospective case series	IV
FasT-Fix (Smith & Nephew Endoscopy, Andover, MA)	DeHaan et al.[97]	2009	27	31.0	100.0	37	0.0	Lysholm	Retrospective case series	IV
	Barber et al.[98]	2008	41	28.0	70.7	31	0.0	Lysholm, Tegner	Prospective case series	IV
	Kalliakmanis et al.[92]	2008	99	29.1	100.0	24	0.0	Lysholm, IKDC	Retrospective comparative study	III
	Kotsovolos et al.[99]	2006	61	32.6	63.9	18	3.3	Lysholm	Prospective case series	IV
	Tuckman et al.[52]	2006	10	30.1	54.1	62	15.0	—	Retrospective case series	IV
	Haas et al.[100]	2005	42	27.0	59.5	24	0.0	Lysholm, IKDC	Prospective case series	IV
Clearfix meniscus screws (Innovasive Devices, Marlborough, MA)	Tuckman et al.[52]	2006	3	30.1	54.1	62	15.0	—	Retrospective case series	IV
Clearfix meniscal screws (Mitek, Norderstedt, Germany)	Frosch et al.[101]	2005	40	27.7	67.5	18	5.4	Lysholm, Tegner	Retrospective case series	IV
	Hantes et al.[102]	2005	48	32.7	81.3	19	4.0	OAK	Prospective case series	IV
Clearfix (Mitek Products, Norwood, MA)	Tsai et al.[103]	2004	18	28.8	50.0	24	28.0	Lysholm, Tegner	Retrospective case series	IV
Clearfix meniscal screw (Mitek, Westwood, MA)	Bohnsack et al.[104]	2003	64	30.0	53.1	18	7.7	Lysholm, Tegner	Retrospective case series	IV
RapidLoc (Mitek, Norwood, MA)	Kalliakmanis et al.[92]	2008	92	26.0	100.0	25	0.0	Lysholm, IKDC	Retrospective comparative study	III
	Barber et al.[105]	2006	32	30.0	71.9	31	8.6	Lysholm, Tegner, Cincinnati	Prospective case series	IV
	Hantes et al.[51]	2006	20	25.0	25.0	22	0.0	IKDC	Prospective randomized study	II
	Quinby et al.[106]	2006	54	25.8	100.0	35	14.8	IKDC	Retrospective case series	IV
	Tuckman et al.[52]	2006	3	30.1	54.1	62	15.0	—	Retrospective case series	IV
BioStinger (Linvatec, Largo, FL)	Barber and Coons[107]	2006	41	29.8	85.4	39	14.6	—	Retrospective case series	IV
	Barber et al.[53]	2005	47	27.0	87.2	27	14.0	Lysholm, Tegner, Cincinnati, IKDC	Prospective comparative study	II
All-inside Biofix suture system	Steenbrugge et al.[55]	2005	17	36.5	23.5	111	0.0	HSS	Retrospective case series	IV
All-inside suture	Ahn et al.[108]	2004	39	32.0	100.0	20	0.0	—	Retrospective case series	IV
Combination of FasT-Fix and outside-in	Pujol et al.[109]	2008	50	25.0	56.0	12	5.7	IKDC	Prospective case series	IV
Combination of inside-out and all-inside	Toman et al.[110]	2009	77	25.0	100.0	24	6.1	—	Retrospective case series	IV
Combination of inside-out and T-Fix	Mintzer et al.[111]	1998	29	15.3	51.7	60		Lysholm	Retrospective case series	IV
Meniscus dart (Arthrex, Naples, FL)	Tuckman et al.[52]	2006	5	30.1	54.1	62	15.0	—	Retrospective case series	IV
Mitek meniscal repair system (Mitek, Ethicon, Norderstedt, Germany)	Laprell et al.[112]	2002	37	27.3	45.9	12	0.0	Lysholm	Prospective case series	IV
Meniscal stapler (USS Sports Medicine, Norwalk, CT)	Oberlander and Chisar[113]	2005	11	35.6	—	30	31.3	Lysholm	Retrospective case series	IV

Abbreviations: HSS, Hospital for Special Surgery; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; RCT, randomized controlled trial; SF-36, Short Form 36; OAK, Orthopaedische Arbeitsgemeinschaft Knie.

TABLE 2. *Summary of Partial Meniscectomy Study Outcomes*

Author	Year	Operations (n)	Mean Age (yr)	ACLR (%)	Mean Follow-up (mo)	Lost to Follow-up (%)	Subjective Outcome Scales	Type of Study	Level of Evidence
Kim et al.[114]	2009	40	38.3	0.0	25	0.0	Lysholm	Retrospective case series	IV
Mills et al.[115]	2008	25	46.8	0.0	47	0.0	—	Retrospective case-control study	III
Rodkey et al.[116]	2008	82	40.0	0.0	95	0.0	Lysholm	Prospective randomized trial	I
Shelbourne and Dickens[117]	2006	95	28.9	0.0	124	—	IKDC, Noyes	Retrospective case series	IV
Chatain et al.[118]	2003	362	38.5	0.0	132	57.3	IKDC	Retrospective comparative study	III
Chatain et al.[118]	2003	109	35.0	0.0	132	57.3	IKDC	Retrospective comparative study	III
Andersson-Molina et al.[19]	2002	18	29.0	0.0	168	0.0	—	Retrospective comparative study	III
Chatain et al.[119]	2001	317	38.0	0.0	138	64.5	—	Retrospective case series	IV
Hoser et al.[28]	2001	31	33.5	0.0	124	21.6	Lysholm	Retrospective case series	IV
Hulet et al.[120]	2001	74	36.0	0.0	144	74.2	IKDC	Retrospective case series	IV
Scheller et al.[121]	2001	46	42.5	0.0	85	0.0	Lysholm	Retrospective case-control study	III
Scheller et al.[121]	2001	29	39.9	0.0	148	0.0	Lysholm	Retrospective case-control study	III
Higuchi et al.[122]	2000	67	26.7	0.0	146	9.5	Tapper and Hoover	Retrospective case series	IV
Krüger-Franke et al.[123]	1999	100	30.3	0.0	91	32.9	Marshall	Retrospective case series	IV
Burks et al.[29]	1997	111	35.8	31.5	176	28.4	Lysholm	Retrospective case series	IV
Rockborn and Gillquist[124]	1996	63	30.0	0.0	156	0.0	Lysholm	Retrospective case series	IV
Jaureguito et al.[125]	1995	27	32.0	0.0	96	16.1	Lysholm	Retrospective case series	IV
Rangger et al.[126]	1995	284	32.0	0.0	54	34.7	—	Retrospective case series	IV
Rockborn and Gillquist[127]	1995	43	—	0.0	156	20.4	Lysholm	Retrospective case series	IV
Osti et al.[128]	1994	41	26.0	0.0	36	0.0	—	Retrospective case series	IV
Bolano and Grana[129]	1993	50	30.0	0.0	67	20.6	Lysholm	Retrospective case series	IV
Faunø and Nielsen[130]	1992	136	33.8	0.0	102	13.4	—	Prospective case series	IV
Pellacci et al.[131]	1990	37	27.8	0.0	33	0.0	—	Retrospective case series	IV

Abbreviation: IKDC, International Knee Documentation Committee.

Outcomes

Clinical Results: Lysholm Score: Clinical results in the form of the Lysholm score evaluated at 10 years or greater showed that just over half of the patients who underwent partial meniscectomy had an excellent outcome (Table 4). Specifically, 54% (77 of 142) had ex-

TABLE 3. *Level of Evidence for Meniscal Surgery Studies*

Level of Evidence	Meniscal Repair	Partial Meniscectomy	Total
I	2	1	3
II	3	0	3
III	3	4	7
IV	63	16	79

cellent outcomes, 27% (38 of 142) had good outcomes, 4% (5 of 142) had moderate outcomes, and 16% (22 of 142) had poor outcomes. There was only 1 meniscal repair study with long-term follow-up with only 8 patients, all of whom had excellent Lysholm scores.

Imaging: Radiographic and/or magnetic resonance imaging was included in 66% (4 of 6) of long-term meniscal repair studies and 100% (12 of 12) of long-term partial meniscectomy studies. Most used weight-bearing anteroposterior knee radiographs at varying degrees of flexion with controls most often from the contralateral knee, but preoperative imaging and matched control subjects were also used in some studies. The Fairbank grading system and the International Knee Documentation Committee system were the most frequently used scales for partial meniscectomies (both were used in 25% of studies [3 of 12]). The Fairbank grade was the most commonly used radiographic evaluation measure in meniscal repair studies, comparing the operative knee with the contralateral knee in 50% of these studies (3 of 6). Notably, 78% of meniscal repairs (85 of 109) had no radiographic degenerative changes compared with 64% of partial meniscectomies (66 of 104) (Table 5). One grade change or less was found in 97% of meniscal repairs (106 of 109) compared with 88% of partial meniscectomies (91 of 104).

Healing Rate: Eleven meniscal repair studies assessed the healing rate of the meniscus by second-look arthroscopy (Table 6). Overall, 61.7% of assessed menisci were completely healed, 20.9% were partially healed, and 17.4% had not healed.

Effect of Concomitant ACLR on Meniscal Repair Outcomes: Looking at the effect of concomitant ACLR on meniscal repair outcomes, the overall reoperation rate after meniscal repair was 24% (145 of 612) compared with 14% (148 of 1,044) when performed in conjunction with ACLR (Tables 7 and 8). This relation was maintained even when analyzed by specific repair methods and devices, except for T-Fix devices (Smith & Nephew, Andover, MA) during a 0- to 4-year follow-up period, for which 5% failure was reported without ACLR and 10% failure with ACLR.

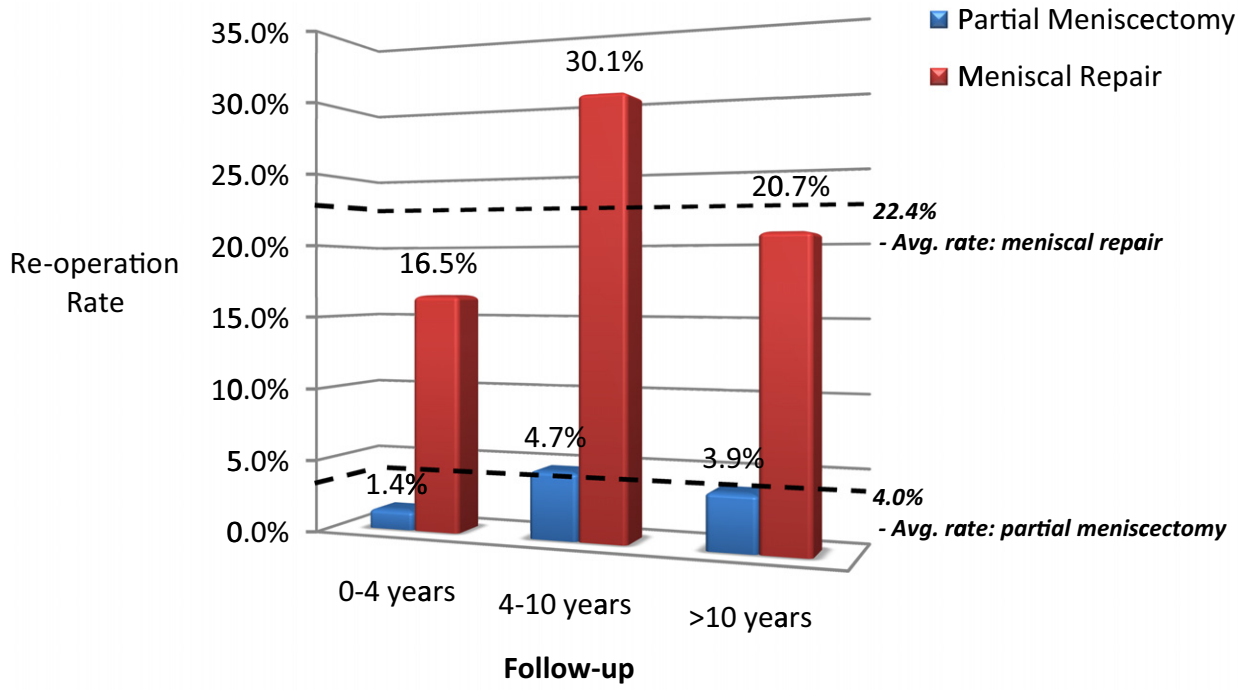

FIGURE 1. Reoperation rates after partial meniscectomy compared with meniscal repair.

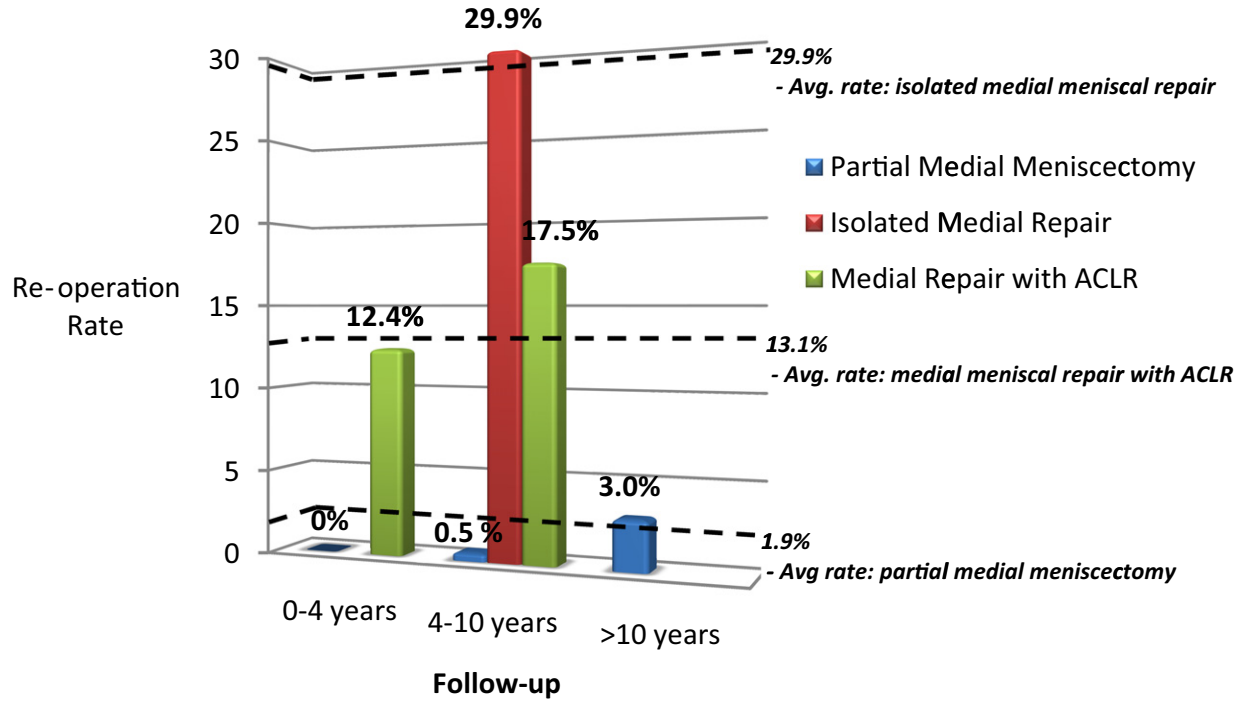

FIGURE 2. Medial meniscus reoperation rates.

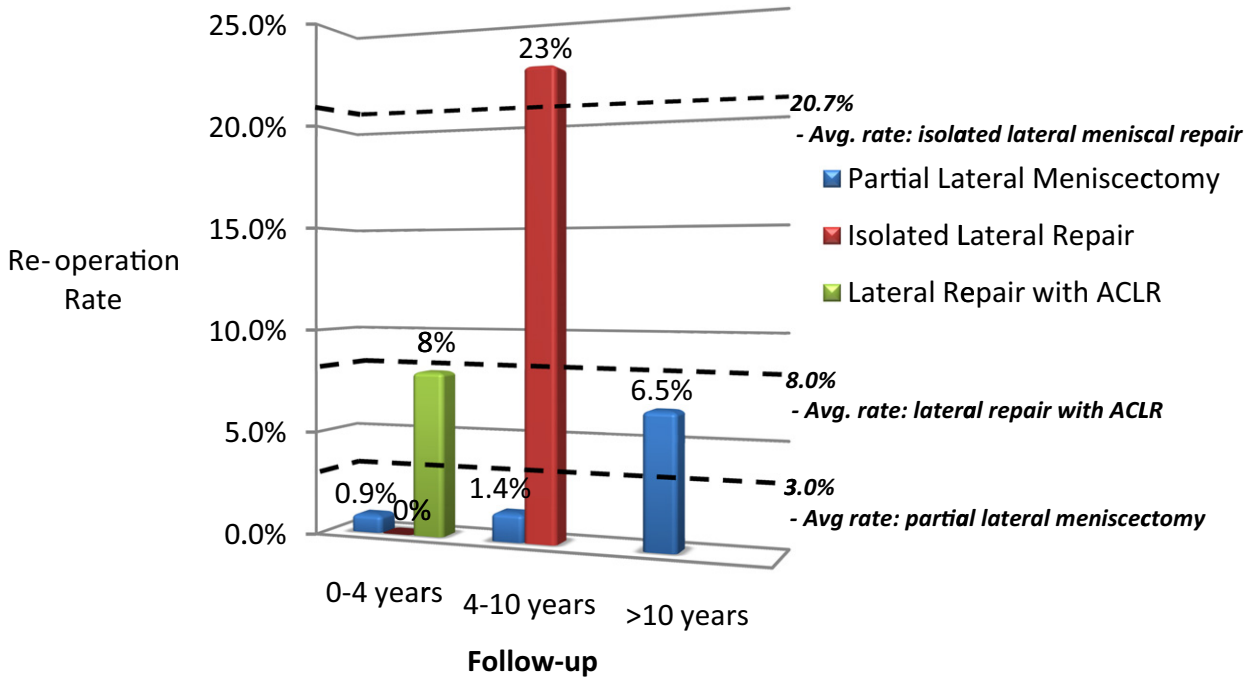

FIGURE 3. Lateral meniscus reoperation rates.

TABLE 4. *Lysholm Grades After More Than 10 Years' Follow-up*

Procedure	Studies (n)	Repairs (n)	Lysholm Grade			
			Excellent	Good	Moderate	Poor
Meniscal repair[30]	1	8	100.0%	0.0%	0.0%	0.0%
Partial meniscectomy[28,29]	2	142	54.2%	26.8%	3.5%	15.5%

DISCUSSION

Partial meniscectomy has a substantially lower reoperation rate than meniscal repair. Reoperation rates appear to be slightly higher after partial meniscectomy of the lateral meniscus compared with the medial meniscus. Repair of the lateral meniscus has a lower reoperation rate than repair of the medial meniscus. Meniscal repairs with concomitant ACLR have a lower reoperation rate than isolated meniscal repairs. Whereas it has been established that the conserved meniscal tissue of a partial meniscectomy leads to fewer osteoarthritic and degenerative changes than a total meniscectomy, meniscal repair has not been definitively shown to reduce osteoarthritic changes when compared with partial meniscectomies. However, there is some evidence that meniscal repair does lead to better radiologic and subjective outcomes over the long-term.

It is important to emphasize to patients with isolated meniscal tears that an attempted repair has a significant risk of needing a reoperation. Patients can be advised that the reoperation rate is lower with concomitant ACLR and perhaps in lateral meniscal tears compared with medial meniscal tears, even though the medial meniscus has a greater blood supply.[31] Patients should understand that the theoretic benefits of meniscal repair have not been proven, although the limited data available to date are at least weakly supportive of this notion.

Potential reasons for a higher reoperation rate after repair of the medial meniscus include the fact that the medial side of the meniscus is anchored more tightly to the tibial plateau and that the medial side sees higher biomechanical loads.[32] If there is residual laxity after ACLR, the medial meniscus may see greater stress because it is a secondary stabilizer to anterior tibial translation.[33] This may put a repaired medial meniscus under more stress, potentially contributing to more failures. Comparisons between medial and lateral meniscal repairs are limited, and future studies are needed to determine whether similar tears on the medial and lateral sides show any differences in reoperation rates and/or outcomes.

The advantage of concomitant ACLR at the time of meniscal repair has been well documented.[34-36] This may be related to the abundance of blood and growth factors in the joint, relatively limited patient activity, and less aggressive rehabilitation after combined procedures and the intrinsic condition of the meniscus at the time of repair. As a result, previous studies have suggested augmenting isolated meniscal repair with iatrogenic trauma to the surrounding synovium,[37] a blood clot,[38,39] or microfracture in the notch.[40] The growing interest in platelet-rich plasma is an area that may be particularly applicable to enhancing the success of isolated meniscal repairs.[41]

The body of evidence reporting outcomes after partial meniscectomy and meniscal repair is still quite limited. No high-level studies directly compared the 2 procedures, and only 3 studies with Level I evidence are reported for both combined. For Level III evidence or higher, 8 studies have been published on meniscal repair and 5 on partial meniscectomy. It should be noted that these higher-level studies use widely varying outcome measures and grading. For both studies with a high level of evidence and those with a lower level of evidence, the lack of consistent endpoints and measurement scales makes it challenging to compare

TABLE 5. *Radiographic Changes After Minimum of 10 Years' Follow-up*

Procedure	Studies (n)	Repairs (n)	Fairbank Grade of Operated Knee				
			0	I	II	III	IV
Meniscal repair[30,63,87]	3	109	78%	19%	2%	1%	0%
Partial meniscectomy[19,122,124]	3	104	63%	24%	12%	1%	0%

Table 6. *Healing at Second-Look Arthroscopy After Meniscal Repair*

	Studies (n)	Repairs (n)	Tear Healing Rate		
			Complete	Incomplete	Not Healed
Device					
Inside-out[35,47,48,59,66-68,70]	8	519	62%	20%	18%
Outside-in[90,91]	2	79	56%	29%	15%
T-Fix[94]	1	18	83%	0%	17%
Total		616	61.7%	20.9%	17.4%

the numerous studies. In addition, when we compared the studies, it was not possible to account for differences such as type, location, and size of the tear and status of the adjacent articular cartilage, as well as patient factors such as body mass index and activity level.

Unfortunately, there are not enough long-term data comparing the 2 techniques, and the available long-term data are too heterogeneous to draw definitive conclusions. Summarizing the few studies reporting comparable outcomes, we found that meniscal repair leads to no radiographic changes in 78% of patients and Fairbank grade 0 or 1 changes in 97% of patients after 10 years. This compares favorably with the results after partial meniscectomy. Rockborn and Messner[42] (study not included in this review because it compared open meniscal repair and arthroscopic partial meniscectomy) found a statistically significant difference in radiographic findings at 7 years, but this difference was not seen at the final follow-up of 13 years. Of repair patients, 34% had some degenerative changes (Fairbank grade 1 or 2) compared with 50% of meniscectomy patients, whereas only 4% of patients with a successful repair had Fairbank grade 2 changes compared with 27% of meniscectomy patients. This study may have been underpowered to find a long-term difference in radiographic changes.

A recent systematic review found similar results when evaluating the impact of meniscal damage on the development of degenerative changes after ACLR.[43] This study found patients with a partial meniscectomy to be 5 times more likely to exhibit radiographic findings when compared with patients with intact menisci. The results of patients with repaired menisci were more heterogeneous but also showed a trend toward the repaired meniscus behaving like an intact meniscus.

A population in whom the appearance of differences between these 2 techniques might be accelerated or more readily apparent is high-level athletes. A recent case-control study showed that a history of partial meniscectomy shortened the professional football career of elite college athletes.[44] Unfortunately, there were not enough meniscal repairs in the study population to assess whether outcomes would be different. However, this suggests that focusing clinical research efforts on such groups could provide more useful data after shorter intervals compared with studies in the population at large.

Limitations of this study include the heterogeneous nature of the studies looking at meniscal surgery, including the patient population, the type of meniscal injury, the treatment administered, and the length and type of follow-up. Despite these shortcomings, review

Table 7. *Reoperation Rates for Isolated Meniscal Repairs With Inside-out Technique Compared With All-Inside Devices*

	0-4 yr	4-10 yr	>10 yr	Total
Device				
Inside-out	19% (9/47)	19% (12/62)	16% (9/57)	18%
Meniscus arrow	17% (12/71)	38% (60/157)		32%
Outside-in	29% (4/14)		24% (21/88)	25%
T-Fix	5% (2/39)			5%
FasT-Fix	23% (5/22)			23%
Meniscus screw	23% (7/31)			23%
RapidLoc	17% (4/24)			17%
Total	17% (43/248)	33% (72/219)	21% (30/145)	24%

TABLE 8. *Reoperation Rates for Inside-out Technique Compared With All-Inside Devices With Concomitant ACLR*

	0-4 yr	4-10 yr	>10 yr	Total
Device				
Inside-out	0% (0/58)	17% (11/63)	0% (0/2)	9%
Meniscus Arrow	10% (21/217)	30% (37/125)		17%
Outside-in	25% (11/44)			25%
T-Fix	10% (14/143)			10%
FasT-Fix	11% (20/177)			11%
Meniscus Screw	13% (10/75)			13%
RapidLoc	14% (24/174)			14%
Total	11% (100/888)	26% (48/188)	0% (0/2)	14%

of surgical treatment for meniscal tears is helpful to expose the inadequacies of the current literature and to document overall trends. Whereas the combined reoperation rate after a partial meniscectomy is quite low, at 4%, the relatively high reoperation rate of almost 23% after meniscal repair may be acceptable if there is a potential long-term benefit to the joint. The lower reoperation rate of 14% after meniscus repair at the time of ACLR is even more likely to be acceptable assuming long-term benefit can be shown.

CONCLUSIONS

Whereas meniscal repairs have a higher reoperation rate than partial meniscectomies, they likely result in better long-term outcomes. Meniscal repair at the time of ACLR has a lower reported failure rate than isolated meniscal repair. Tears of the medial meniscus appear to have a higher reoperation rate after repair but a lower reoperation rate after partial meniscectomy when compared with tears of the lateral meniscus. Such data have the potential to improve patient selection and counseling regarding surgical treatment of meniscal tears.

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