

Table 1. Database Analysis

Patient	Site/Sex	Age (yrs.)	Time Onset (day)	Signs/ Causes	Micro-organism	Type of Surgery	Reoperation	Complications	Lachman (+, -)/ KT difference, mm
1	L/F	28	5	Bursitis tibia site	NA	STG/DB	Debridement, tibial screw removal	None	- / 0
2	R/M	30	22	Tibial wound infection	NA	PT	Fastlok removal, debridement	ROM reduction (3°-115°)	+ / 2
3	L/M	24	7	Tibial wound infection	NA	ST/SB	Lavage debridement	None	- / 1
4	L/M	34	20	Fever, knee swelling	<i>S. epidermidis</i>	STG/DB	Lavage debridement	ROM reduction (0°-120°)	- / 1
5	L/M	25	6	Tibial wound infection	<i>S. aureus</i>	STG/DB	Wound debridement	None	- / 0
6	R/M	36	4	Tibial wound infection	NA	ST/SB	Fastlok removal	Instability, ROM reduction (2°-120°)	+ / 3
7	R/M	39	5	Tibial wound infection	NA	ST/SB	Lavage debridement	None	+ / 2

DB, double bundle; F, female; KT difference, mean KT-1000 Arthrometer difference; L, left knee; M, male; PT, patellar tendon; R, right knee; ROM, range of motion; SB, single bundle; ST, semitendinosus; STG semitendinosus and gracilis; NA, not applicable.

Table 2. Characteristics, Data, Incidence, and Graft-Specific Incidence

Study	Authors	Year	Level of Evidence	Period (yrs.)	ACLR, n	Infection n (%)	Mean Age (yrs.) ^a	M/F, % ^a	Allograft/Hamstring/BPTB %	H/B
1	Abdel-Aziz et al ¹	2014	2	NA	2560	24 (0.94)	NA	NA	NA	NA
2	Torres-Claramunt et al ²⁴	2013	4	4	810	15 (1.8)	33.5	76/24	0/80/20	NA
3	Maletis et al ¹⁴	2013	2	5	10,626	51(0.48)	29.5	64/36	41/31/28	8.2
4	Sonnery-Cottet et al ²³	2011	3	5	1957	12 (0.61)	24	100/0	0/34/58	NA
5	Monaco et al ¹⁶	2010	3	9	1232	12 (0.97)	NA	NA	NA	NA
6	Barker et al ³	2010	3	5	3126	18 (0.58)	34.1	78/22	0.44/1.44/0.49*	3.34
7	Wang et al ²⁷	2009	4	11	4068	21 (0.52)	28.6	86/14	1.11/0.57/0*	2.5
8	Katz et al ¹²	2008	3	5	801	6 (0.75)	29	NA	1.2/0.6/0*	NA
9	Schulz et al ²²	2007	4	10	1872	24 (0.78)	32.5	79/21	0/29/50	NA
10	Van Tongel et al ²⁵	2007	4	9	1736	15 (0.51)	31	93/7	0/100/0	NA
11	Binnnet amd Başasrir ⁴	2007	3	8	1231	6 (0.48)	24.5	100/0	NA/0.64/0.29 ^b	NA
12	Judd et al ¹¹	2006	4	8	1615	11 (2.6)	28	72/28	0/100/0	NA
13	Fong and Tan ⁶	2004	4	3	472	7 (1.0)	23	100/0	0/100/0	NA
14	Burks et al ⁵	2003	4	11	1918	8 (0.42)	27	75/25	0/88/12	NA
15	Schollin-Borg et al ²¹	2003	3	3	575	10 (1.7)	28.3	80/20	0/40/60	NA
16	Indelli et al ¹⁰	2002	4	6	3500	6 (0.14)	32.5	83/17	NA	NA

BPTB, bone–patellar tendon–bone graft; H/B, Ratio of infection in Hamstrings and BPTB grafts; NA, not available; n, number.

^a Among patients with post-ACLR infection.

^b No allografts used.

* Incidence of Infection in Allograft/Hamstring/BPTB grafts.

1 **Table 3. Risk Factors and Pathogenesis**

Study	Risk factors	Pathogenesis	Causes
Azar and Arthur²	-	-	Environmental contamination of surgical equipment or hospital stuff is responsible for epidemic
Barker et al³	Hamstring graft	-	Multifilament suture used to prepare hamstring graft; graft harvest site and tunnel site coincides when hamstring tendon is used
Binnet et al⁴	Short hamstring tendon with more suture material; postoperative effusion	Grafts act as foreign body Hematoma at tibial tunnel end in subacute and late cases	Meniscal repairs/arrows or sutures in graft act as foreign material Adjacent tunnel osteomyelitis in persistent cases Persistent communication between skin and joint by sutures
Burks et al⁵	Previous knee surgery(arthroscopy or open) in 53%-75% patients	Post-infectious synovitis and inflammatory mediators causes chondrolysis	
Fong and Tan⁶	Previous knee surgery(arthroscopy or open) in 53%-75% patients Concomitant surgery in 43%-50% patients	Hematoma at tibial tunnel end in subacute and late cases	Meniscal repairs/arrows or sutures in graft act as foreign material
Indelli et al¹⁰	No risk with concomitant surgery	Grafts act as foreign body	
Judd et al¹¹	Previous knee surgery(arthroscopy or open) in 53%-75% patients Different implants increases risk by 3.2-4.5 times	Grafts act as foreign body Hematoma at tibial tunnel end in subacute and late cases Post-infectious synovitis and inflammatory mediators causes chondrolysis	If normal skin flora cultured, then inoculation must have occurred at the time of surgery or shortly thereafter through femoral or tibial site Meniscal repairs/arrows or sutures in graft act as foreign material
Maletis et al¹⁴	Hamstring graft High BMI		Multifilament suture used to prepare hamstring graft; graft harvest site and tunnel site coincides when hamstring tendon is used
Mouzopoulos et al¹⁷	Subcutaneous fixation material (position of the metallic post/washer/braided suture construct)		
Parada et al¹⁹	Previous knee surgery(arthroscopy or open) in 53%-75% patients		
Plante et al²⁰	Hamstring graft		Multifilament suture used to prepare hamstring graft; graft harvest site and tunnel site coincides when hamstring tendon is used
Schollin-Borg et al²¹	Concomitant surgery in 43%-50% patients Arthroscopy combined with the use of	Hematoma at tibial tunnel end in subacute and late cases	Meniscal repairs/arrows or sutures in graft act as foreign material Metal part and the rubber membranes on the suture clamps cannot be

	intraoperative, intra-articular steroids	sterilized satisfactorily despite sterilization performed in certified autoclaves
Torres- Claramunt et al²⁴	Hamstring graft	Multifilament suture used to prepare hamstring graft; graft harvest site and tunnel site coincides when hamstring tendon is used
Van Tongel et al²⁵	No risk with concomitant surgery	-

2 BMI, body mass index.

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5 **Table 4.** Clinical Presentation and Laboratory Values

Study	Clinical Presentation	MTO (range in days)	Mean Investigation Values at Time of Diagnosis (range)^a	Micro-organism Cultured, n (%)
1 (Abdel-Aziz et al¹)	Classic Features ^{5,6,10,27} -Acutely swollen painful joint	12 (5-45)	NA	CNS: 7 (29) MSSA: 7 (29) OS: 7 (30) NG: 3 (12)
2 (Torres- Claramunt et al²⁴)	-Limited range of motion -Sudden increase of pulsatile knee pain	24 (7-35)	NA	CNS: 10 (66) MSSA: 2 (19) MRSA: 1 (7) P: 1 (7)
3 (Maletis et al¹⁴)	-Rapidly increased and persistent effusion -Incision drainage -Local erythema -Warmth -Intermittent fever usually over 38°C	20 (12-30)	NA	Deep- CNS: 11 (32) SA: 8 (24) NG: 9 (26) OS: 6 (18) Superficial- SA: 10 (59) CNS: 1 (6) OS: 5 (30) NG: 2 (12)
4 (Sonnerly-Cottet et al²³)	-Hyperemic with serous or purulent discharge ⁴	15 (2-37)	NA	CNS: 11 (92) P: 1 (8)
5 (Monaco et al¹⁶)		NA	ESR: 76	CNS: 11 (92)

	-Indolent presentation (60%		CRP: 7.4 TLC: 8.6	OS: 1 (8)
6 (Barker et al³)	missed on first visit) ²¹ -Exclude large hematomas	32 (5-205)	ESR: 79.8(15–118) CRP:17.5(4.5–38.1) TLC: 9.5(6.0 13.8) TLC(joint):11.5	MSSA: 6 (33) MRSA: 4 (22) P: 2 (11) NG: 6 (33)
7 (Wang et al²⁷)	simulating acute symptoms; laboratory investigations needed	16 (5-32)	ESR: 59.7 (9-108) CRP: 8.3 (4.1-17.8) TLC: 9.1 (4.2-15.2)	CNS: 11 (52) SA: 2 (9) OS: 3 (14) NG: 5 (25)
8 (Katz et al¹²)	for confirmation ¹¹	16 (6-33)	ESR: 65.7(30-124) CRP: 27.7(11.2-70.1) TLC: 9.6(7.3-13-7)	CNS: 6 (75) NG: 2 (25)
9 (Schulz et al²²)		61.7 (5–196)	CRP: 4.8(0.5-17.4) TLC: 9.5 (3.3–17)	CNS: 5 (21) SA: 12 (50) OS: 3 (16) NG: 4 (17)
10 (Van Tongel et al²⁵)		10.9 (3-1y, 3 mo)	ESR: 70.6(40–110) CRP: 146.6(12.9–316.3) TLC: 8.1(6.0–12.8)	CNS: 8 (53) MSSA: 1 (7) OS: 6 (40) NG: 0 (0)
11 (Binnet et al⁴)		22 (14-35)	ESR: 51(17 to 80) CRP: 29.7(17-42) TLC: >10.	SA: 3 (50) OS: 1 (17) NG: 2 (33)
12 (Judd et al¹¹)		22.9(6-45)	ESR: 67 CRP: 14 TLC: 9.8(4.9-17.7) TLC (joint): 5.2	CNS: 8 (72) SA: 1 (9) P: 1 (8) OS: 1 (8)
13 (Fong and Tan⁶)		25(7-35)	ESR:72 (10-95) CRP: 123 (25-215) TLC: 11.7 (10-16)	SA: 4 (57) P: 3 (43)
14 (Burks et al⁵)		19	NA	NA

15 (Schollin-Borg et al²¹)		9.5(4-20)	ESR: 62.3 (22-102) CRP: 84 (10-199) TLC: 8.4 (7.4-10.6)	CNS: 6 (60) SA: 1 (10) P: 1 (10)
16 (Indelli et al¹⁰)		7.5(2-20)	NA	CNS: 2 (33) SA: 3 (50) OS: 1 (17)

- 6 CNS, coagulase-negative *Staphylococcus*; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; MRSA,
7 methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *Staphylococcus aureus*; MTO, mean time
8 of onset; NA, not available; NG, no growth; OS, other species; P, *Propionibacterium*; SA, *Staphylococcus aureus*;
9 TLC, total leucocyte count; n, number.
10 ^aESR, mm/h; CRP, mg/L; TLC, $\times 10^9/L$.

11 **Table 5a.** Arthroscopic Lavage and Graft Retention at Final Follow-up

Study ^a	Arthroscopic Lavage (Mean per Person)	Graft Retention/Removal, N (%)
1 (Abdel-Aziz et al¹)	3	24 (100)/0 (0)
2 (Torres-Claramunt et al²⁴)	1.3	14 (93)/1 (7)
5 (Monaco et al¹⁶)	NR	14 (100)/0 (0)
6 (Barker et al³)	1.5	13 (72)/5 (28)
7 (Wang et al²⁷)	1	21 (100)/0 (0)
8 (Katz et al¹²)	NR	5 (83)/1 (17)
9 (Schulz et al²²)^b	2.2	7 (29)/17 (71)
10 (Van Tongel et al²⁵)	1.9	11 (73)/4 (27)
11 (Binnet et al⁴)	2.66	6 (100)/0 (0)
12 (Judd et al¹¹)	2.4	10 (91)/1 (9)
13 (Fong and Tan⁶)	1.4	4 (100)/0 (0)
15 (Schollin-Borg et al²¹)	1	10 (100)/0 (0)
16 (Indelli et al¹⁰)	1.3	4 (66)/2 (34)

12 NR, not reported.

13 ^a Studies 3 (Burks et al⁵), 4 (Maletis et al¹⁴), and 14 (Sonnerly-Cottet et al²³) were excluded because they followed different protocols

14 ^b Complicated cases.

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24 **Table 5b.** Clinical Outcome

Study ^a	Mean Follow-up, mo	Prognosis at Final Follow-up						
		Lachman, – (%)	KT difference, mm	Lysholm		IKDC	Tegner	
				Pre-surgery	FFU		Pre-injury	FFU
1 (Abdel-Aziz et al¹)	60	91	5 in 2PT	-	-	-	7	5.5
2 (Torres-Claramunt et al²⁴)	39.3	73.3	1.3	90.7	77.7	(86.6/70.4) ^b	-	-
5 (Monaco et al¹⁶)	38	100	2.5	-	96	14 (A/B)	-	-
9 (Schulz et al²²)	66	-	-	-	65.6	8 (A/B),16 (C/D)	6.1	3.8
10 (Van Tongel et al²⁵)	58	54.5	1	-	83	9 (A/B), 2 C	NR	5.6
11 (Binnet et al⁴)	102.5	33 (66-G1)	2.7	-	81.1	-	NR	NR
12 (Judd et al¹¹)	22	-	-	-	71.6	5 (A/B), 4 (C/D)	NR	NR
13 (Fong and Tan⁶)	11.7	100	-	-	-	5 A, 2 C	7	5.14
15 (Schollin-Borg et al²¹)	36	100	1.35(2.95)	85.4	74.9	-	8.3	5.3
16 (Indelli et al¹⁰)	36	-	-	-	-	3 (A/B),1 C	NA	NA

25 FFU, final follow up; G, grade of laxity; IKDC, International Knee Documentation Committee objective scale; KT difference, mean difference by KT-1000

26 Arthrometer between infected and control group; NA, not available; NR, not reported; mo, months.

27 IKDC objective: A, normal; B, nearly normal; C, abnormal; D, severely abnormal.

28 ^aIncludes studies reporting outcomes with arthroscopic debridement and graft retention as their protocol.

29 ^bIKDC Subjective scale 86.6 (control), 70.4 (infection).

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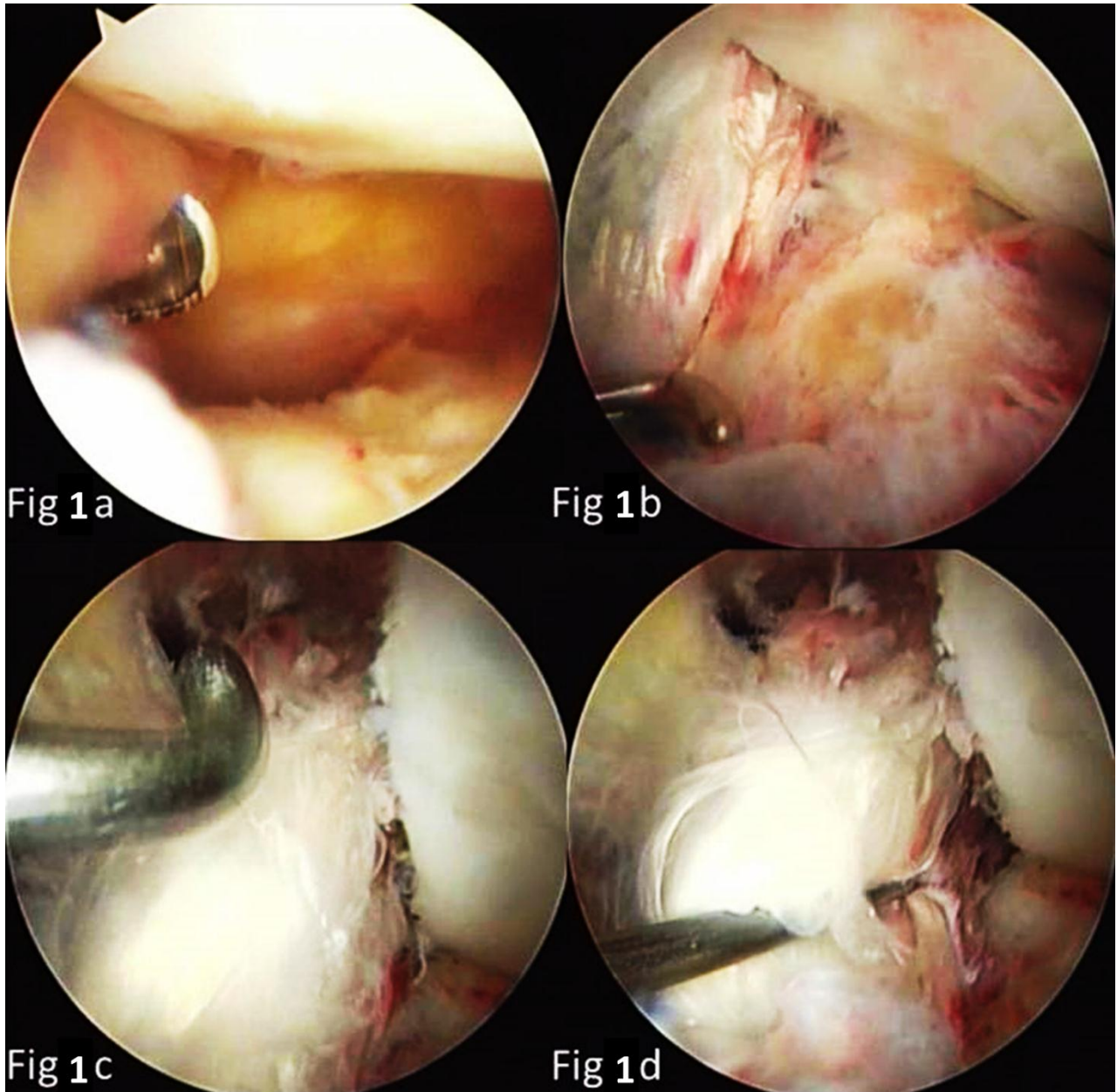
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36 **Table 5c.** Mean Duration of Antibiotics, Hospital Stay, and Complications in Included Studies

Study ^a	Mean Duration of Antibiotics	Mean Hospital Stay, d	Complications					
			Flexion Deficit, N (deg)	Extension Deficit, N (deg)	Graft Rupture	Osteoarthritis (Joint Space Narrowing or Osteophytes, Crepitus)	Graft Removal (Nonviable)	Osteomyelitis
1 (Abdel-Aziz et al¹)	NA	NA	5	0	3	2	0	0
2 (Torres-Claramunt et al²⁴)	IV: 4 wks O: 2-4 wks	NR	0	0	0	0	1	0
7 (Wang et al²⁷)	IV: 19.4 d	NR	NR	NR	NR	NR	NR	NR
9 (Schulz et al²²)	NR	NR	24 (20)	24 (3)	0	1	17	0
10 (Van Tongel et al²⁵)	IV: 24.6 d T: 3.2 mo	27.2	3 (6-15)	2 (3-5)	2	3	1	0
11 (Binnet et al⁴)	IV: 3 wks	19.5	6 (6)	0	0	1	0	1
12 (Judd et al¹¹)	IV: 4 wks O: 3-4 wks	NR	2 (20-30)	0	0	3	1	0
13 (Fong and Tan⁶)	IV: 17.3 d O: 4-6 wks	17.3	7 (20)	0	0	0	0	0
15 (Schollin-Borg et al²¹)	IV + O: 4-12 wks	NR	0	0	0	5	0	0
16 (Indelli et al¹⁰)	IV: 6 wks	NR	0	0	0	1	1	0

37 IV, intravenous; O, oral; T, total; NA, not available; NR, not reported; wks, weeks; d, days; mo, months.

38 ^aIncludes studies reporting these parameters with arthroscopic debridement and graft retention as their protocol.



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41 **Figure 1, a and b.** Subtotal synovectomy for reactive synovitis.

42 **Figure 1c.** Graft condition on first debridement at the end of fifth week post–anterior cruciate ligament
43 reconstruction.

44 **Figure 1d.** Graft viable and of proper strength on second debridement at the end of seventh week post–
45 anterior cruciate ligament reconstruction.