Original article

Incidence, management and outcome assessment of post operative infection following single bundle and double bundle acl reconstruction

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ARTICLE INFO

Article history:

Received 19 July 2016

Received in revised form 8 September 2017

Accepted 28 September 2017

Available online 29 September 2017

Keywords:

Post-operative infection

Single bundle ACL

Double bundle ACL

Septic arthritis

Arthrofibrosis

ABSTRACT

Introduction: Post-operative infection is a dreadful complication of ACL reconstruction with gray zone over management guidelines. We aimed to establish commonest etiology, assess incidence of infection and effect on outcome, individually for single and double bundle ACL reconstruction techniques, so as to formulate appropriate management guidelines.

Methods: Our prospective study involved 1152 patients operated for ACL reconstruction (437– DBACL, 715– SBACL) from 2010–2013. Post-operative infection was diagnosed clinically supported by positive gram stain/ culture and increased cell count in knee aspirate. All patients were started on empirical antibiotics and arthroscopic lavage and debridement was done. Graft was retained if it was stable and intact. Data recorded at follow up was analysed statistically.

Results: In SBACL infection rate was 0.84% while in DBACL it was 2.52%. All patients with infection presented with pain, effusion, fever and increased WBC, ESR & CRP. Average time of presentation after the surgery was 2.27 weeks for DBACL and 2.16 weeks for SBACL. In both groups, *S.aureus* followed by *S. epidermidis* were commonest isolates. Patients were given IV antibiotics for 2 weeks and oral for further 4 weeks.

Discussion: Incidence of infection is higher with the double bundle technique, however, the functional outcome is not affected (p value 0.231). Joint aspirate is the gold standard diagnostic test for infection. CRP and ESR are the next dependable tests with high sensitivity but their specificity is low. A thorough debridement is necessary apart from recommended antibiotic cover of 2 weeks IV followed by 4 weeks oral antibiotics.

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1. Introduction

The anterior cruciate ligament (ACL) is one of the most commonly injured ligament in the knee.¹ Presently arthroscopic reconstruction is the most preferred method for ACL tear. There have been a lot of controversies regarding double bundle vs single bundle technique for ACL reconstruction. Among the complications which affect the outcome after the ACL reconstruction surgery, post-operative infection is deemed to be one of the most dreadful. It not only causes chondrolysis but may also cause graft failure and arthrofibrosis of the joint. The incidence after the ACL reconstruction has been reported from 0.14% to 1.8%.² The most common organisms isolated are *Staphylococcus aureus* and

Staphylococcus epidermidis.³ However, there are no clear cut guidelines for the management and there is a lot of controversy regarding arthroscopic or open debridement, graft retention versus scarification of graft, retention versus removal of the implants, duration of intravenous or oral antibiotics.² The purpose of our study was to review (compare) the incidence, management and outcome of post-operative infection following arthroscopic single and double bundle ACL reconstruction so as to formulate an opinion regarding the common controversies. To the best of our knowledge, there is no study in literature that directly compares infection after Double bundle ACL reconstruction with Single bundle ACL reconstruction.

2. Material and methods

This was a prospective study which was conducted in a tertiary care hospital from 2010 to 2013. The study was approved by Institutional Review Board and Ethics committee. Ethical standards according to the Helsinki declaration of 1964 (and its later amendments) were conformed to. Informed consent was obtained

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from all patients. Total 1152 patients were operated for ACL reconstruction in our hospital from 2010 to 2013. Among these a double bundle ACL reconstruction (DBACL) was done in 437 patients and single bundle ACL reconstruction (SBACL) in remaining 715 patients. The double bundle technique was used in more active and athletic patients with good bone stock.

2.1. Surgical techniques: technical specifications

All cases were done under tourniquet control. In all the patients ipsilateral autogenous hamstring tendon grafts were used for ligament reconstruction. In double bundle reconstruction technique, 2 femoral and 2 tibial tunnels were made for anatomical reconstruction. In this femoral side fixation of AM bundle was done with Tight rope-RT or crosspin and PL bundle fixation was done with 1 bioscrew while tibial side fixation was done with 2 bioscrews. In single bundle technique the single femoral tunnel was fixed with Tight rope-RT or crosspin or bioscrew or RCI. Tibial fixation was done with RCI or bioscrew. Sutures were removed after 2 weeks.

2.2. Follow up and evaluation

Rehabilitation protocol followed was aimed at achieving full range of motion within first 6 weeks with strengthening and proprioception being the focus over next two to three months and allowing return to sport/heavy work by 6 months. Patients were followed up post operatively at 2 weeks, 6 weeks, 12 weeks and every 6 months thereafter and assessed clinically and

radiologically. Post-operative infection was diagnosed clinically (fever, wound site erythema, any wound discharge, effusion and painful knee movements out of proportion to expect according to duration since surgery) and supported by positive gram stain/culture and increased cell count in the knee aspirate. Patients with superficial infection who responded well with oral antibiotics and regular wound care were excluded from the study. Any patient who was confirmed as post-operative infection following ACL reconstruction was subjected to haematological investigations including haemogram, ESR and CRP. All these patients were started on empirical antibiotics (usually Inj. Teichoplanin 400 mg 24hrly) after the knee was aspirated. Thorough arthroscopic lavage and debridement was done and the graft was retained if it was stable and intact. A synovial biopsy was also sent at this time. The antibiotics were suitably modified as per the culture report. The intravenous (IV) antibiotics were continued for 2 weeks and oral antibiotics were given for 4 weeks. The patients were followed every 3 weeks till knee was clinically silent and ESR and CRP returned to normal and thereafter every 6 months till possible. At every follow up patients were assessed clinically with Lachman test and Anterior drawer test and KT-1000 for stability and functional status was assessed as well with IKDC and Lysholm scores.

3. Results

Patient specific details have been tabulated in [Tables 1a and 1b](#). Of the 1152 (437 double bundle & 715 single bundle) patients operated, 17 patients (incidence of 0.01%) had post-op joint

Table 1a
Details of patients who had post-operative infection after double bundle ACL reconstruction.

S. NO.	AGE	COMORBIDITY	METHOD OF RECONSTRUCTION	DURATION (MINUTES)	TIME OF PRESENTATION AFTER SURGERY (Weeks)	BLOOD PICTURE	CULTURE	NO. OF PROCEDURE AFTER INFECTION	LYSHOLM SCORE (at three successive follow ups)	KT SIDE TO SIDE DIFFERENCE
1	32	Nil	3 BIO + 1 TR	40	2	WBC-12, ESR-32, CRP-29	STAPH. AUREUS	1	35, 60, 82	3.6
2	24	Nil	3 BIO + 1 TR	44	6	WBC-14, ESR-26, CRP-46	STAPH. AUREUS	1	55, 72, 88	2.4
3	36	Nil	3 BIO + 1 TR	65	3	WBC-11, ESR-42, CRP-56	STAPH. EPIDERMIDIS	1	28, 78, 92	1.8
4	19	Old history of Chest Tuberculosis (taken ATT for 6 months)	3 BIO + 1 TR	41	4	WBC-17, ESR-31, CRP-39	STAPH. AUREUS	1	42, 57, 70	3.2
5	28	Nil	3 BIO + 1 TR	52	1	WBC-10, ESR-29, CRP-70	NO ORGANISM FOUND	2	29, 58, 85	2.9
6	25	Nil	3 BIO + 1 TR	49	2	WBC-13, ESR-56, CRP-46	STAPH. EPIDERMIDIS	1	21, 74, 91	1.6
7	39	Diabetic (Sugar controlled prior to surgery)	3 BIO + 1 TR	46	1	WBC-10, ESR-42, CRP-52	PSEUDOMONAS	1	38, 79, 82	2.5
8	31	Nil	3 BIO + 1 TR	56	1	WBC-12, ESR-29, CRP-57	STAPH. AUREUS	2	42, 59, 78	3.1
9	27	Nil	3 BIO + 1 TR	47	1	WBC-16, ESR-57, CRP-67	STAPH. AUREUS	1	57, 78, 88	1.2
10	35	Nil	3 BIO + 1 TR	54	2	WBC-13, ESR-42, CRP-87	NO ORGANISM FOUND	1	62, 76, 84	2.7
11	22	Nil	3 BIO + 1 TR	55	2	WBC-14, ESR-33, CRP-48	STAPH. EPIDERMIDIS	1	6, 56, 11, 72, 12 87	2.8

Table 1b

Details of patients who had post-operative infection after single bundle ACL reconstruction.

S. NO.	AGE	COMORBIDITY	METHOD OF RECONSTRUCTION	DURATION (MINUTES)	TIME OF PRESENTATION AFTER SURGERY (Weeks)	BLOOD PICTURE	CULTURE	NO. OF PROCEDURE AFTER INFECTION	LYSHOLM SCORE (at three successive follow ups)	KT SIDE TO SIDE DIFFERENCE
1	46	Nil	TR + BIO	32	1	WBC-15, ESR-45, CRP-49	NO ORGANISM FOUND	1	47, 79, 82	2.4
2	35	Nil	TR + BIO	40	2	WBC-11, ESR-32, CRP-35	STAPH. AUREUS	1	63, 71, 86	2.6
3	28	Known case of Inflammatory bowel disease	BIO + BIO	26	3	WBC-10, ESR-41, CRP-72	STAPH. EPIDERMIDIS	3	32, 46, 68	3.6
4	51	Nil	TRANSFIX + BIO	29	1	WBC-12, ESR-72, CRP-63	STAPH. AUREUS	1	64, 71, 87	2.1
5	21	Nil	TRANSFIX + RCI	35	5	WBC-13, ESR-39, CRP-58	NO ORGANISM FOUND	1	71, 82, 94	1.3
6	48	Nil	TR + BIO	28	1	WBC-16, ESR-46, CRP-46	STAPH. AUREUS	1	68, 88, 90	1.8

infection. Of them 11 were double bundle reconstruction and 6 were single bundle reconstruction. In single bundle arthroscopic reconstruction infection rate was 0.84% & in double bundle it was 2.52%. Amongst infected cases, in DBACL reconstruction group all patients were males while there were 2 female and 4 male patients in infected SBACL reconstruction group. The median age was 27.2 years in DBACL and 38.2 in SBACL reconstruction. Average tourniquet time for DBACL reconstruction was 50.82 min & for SBACL it was 31.67 min. All patients with post operative infection presented with pain, effusion and fever. The average time of presentation after the surgery was 2.27 weeks for DBACL and 2.16 weeks for SBACL. Maximum time was 6 weeks for DBACL & 5 weeks for SBACL. The haematological examination showed increased ESR & CRP in all the cases. The average ESR was 38.1 in DBACL & 45.8 in SBACL while the average CRP was 54.27 in DBACL and 53.83 in SBACL group. WBC count was above 10000 in every case; the average was 129000 in DBACL and 12800 in SBACL.

In all infected cases, the knee was thoroughly debrided arthroscopically. The graft was stable in all the cases. There were fibrin clots and inflamed synovium in all the cases. Thorough irrigation was done during debridement. Postoperatively Inj. Teicoplanin 400 mg 24 hourly IV with Inj. Amikacin 500 mg 12 hourly was started. The antibiotics were started in accordance with the sensitivity report obtained from routine OT cultures that are sent every month. In DBACL reconstruction the culture showed *staphylococcus aureus* in 5 patients (45.4%), *staphylococcus epidermidis* in 3 (27.2%), *pseudomonas aeruginosa* in 1 patient (9%) and no organism was found in 2 patients (18.2%). In SBACL reconstruction *staphylococcus aureus* was found in 2 patients (50%), *staphylococcus epidermidis* in 1 (17%) and no organism was found in 2 patients (33%). The antibiotics were changed or added according to the sensitivity of the organism. The patients were kept on IV antibiotics for 2 weeks and oral antibiotics for further 4 weeks (total 6 weeks). All patients responded to this treatment except three. Of them 2 were DBACL and 1 SBACL. In these 2 DBACL patients 2nd procedure was done after 3 days. And in 1 SBACL patient debridement was done two more times after every 72 h. In all these three patients further course was uneventful. All patients recovered symptomatically and had normal laboratory parameters such as WBC count, CRP and ESR by final follow up.

The rehabilitation program was altered and was focused to achieve full range of motion but there was a loss of flexion of 11° in DBACL & 9° in SBACL. On KT-1000 there was a side to side

difference of 2.53 mm in DBACL and 2.73 mm in SBACL. The average Lysholm score in DBACL was 42.27 at six months that increased to 84.27 at two year follow up. In SBACL reconstruction the initial Lysholm score was 57.5 at 6 months that increased to 84.5 at two years. All the patients had no symptom of instability and had no problems with day to day activities at two years follow up. Two patients from DBACL reconstruction group were participating in the state level competitive sports activities and had achieved their previous activity level by final follow up.

4. Discussion

Infection after arthroscopic ACL reconstruction is uncommon & has been reported to be 0.14–1.8% in various studies (Fig 1). In our study also the infection rate after SBACL reconstruction was 0.84%, comparing favorably with the literature while for DBACL reconstruction the same was slightly higher being 2.52%. The incidence of infection is generally higher with the double bundle technique attributable to the longer surgical time involved, greater number of fixation implants used, more debris produced due to more number of bony tunnels, more suture materials used to hold graft, slightly longer surgical wound incision over proximal tibia to accommodate two tibial tunnels and increased tourniquet time owing to longer procedure.^{4–7} However, despite a slightly higher incidence of infection in DBACL group in our study, the functional outcome was not affected. Average Lysholm score was similar in SBACL reconstruction (84.5) and DBACL reconstruction group (84.27) after 2 years follow up. Knee stability evaluation was done by KT-1000 that showed average side to side difference of 2.53 mm in DBACL reconstruction and 2.73 mm in SBACL reconstruction group with the difference being statistically insignificant (p value 0.231). Other studies in literature^{2,4,7–10} also mention similar results with average Lysholm scores ranging from 65.6–93.2 and average side to side KT difference ranging from 1.6 mm to 7 mm. Moreover, on applying regression analysis (where WBC count, ESR and CRP values were considered to be dependent variables for infection) to ascertain if at all the increased surgical time spent during DB ACL reconstruction is a risk factor for infection, the correlation (pearson's coefficient: –0.17, –0.3 and 0.1 respectively) obtained turned out to be negative.

Most septic arthritis cases after ACL reconstruction can be diagnosed reliably on basis of careful history and a thorough physical examination. In our study the usual presentation was

Fig. 1. Graph depicting incidence of septic arthritis after ACL reconstruction as reported by different authors ^{1,2,6–8,10,11,14}.

pain, joint effusion, local erythema, fever and surgical wound discharge consistent with most other reports. Symptoms overlap with extra-articular infection but painful joint range of motion, joint effusion, and high grade fever strongly favor the possibility of intra-articular infection. However, a blood and joint fluid analysis must be advised to confirm the diagnosis. The joint aspirate is the gold standard diagnostic test for infection. In case the aspirate is negative, CRP and ESR are the next dependable tests with high sensitivity but their specificity is low. Their elevated levels may be due to surgical trauma in the early post-operative period. However, in our study all infected patients had an elevated ESR and CRP, correlating with most of the studies.

There are very few studies correlating the graft material used and incidence of infection. According to Burks et al.⁵ there was no statistically significant difference between total allograft and total autograft but the rate of the incidence of hamstring tendon autograft was 3.34 times higher compared with the rate of the rest of the population. Judd et al.³ also described that hamstring tendon grafts had a higher incidence of infection.

The goal of the treatment for septic arthritis is to protect articular cartilage and graft. Although clinical management guidelines remain controversial, most authors favor retention of graft if possible. Since there is presence of fixation material and avascular grafts that favor biofilm formation, antibiotics alone are never sufficient alone to control the infection in these patients. Hence, a thorough debridement is necessary apart from antibiotic cover. Most of the authors ^{11–14} favor IV antibiotics for 4–6 weeks. However, we gave IV antibiotics for 2 weeks followed by oral antibiotics for 4 weeks. SY Fong et al.⁷ also used IV antibiotics for 2

weeks (average 17.3 days) followed by 4 weeks oral antibiotics and obtained satisfactory outcome.

The most common pathogen involved in the infective process is also debatable and there are contrasting reports in literature. While some authors mention ^{13–15} *S.aureus* to be the commonest others feel it's *S.epidermidis* (Table 2). The Ahmed abdel aziz et al.² report found equal incidence by both *S.aureus* and *S.epidermidis*. In our study although *S.aureus*, followed by *S.epidermidis* (in both the SB and DB reconstruction) were encountered most frequently, we also encountered *pseudomonas* on an occasion. Hence, it is always advisable to perform culture sensitivity and prescribe antibiotics accordingly.

Table 2

Table depicting commonest causative organisms identified by different authors.^{1,7–12,15–16,15–17}

AUTHOR	COMMONEST CAUSATIVE ORGANISM IDENTIFIED
Binnet	Staph.aureus
Basarir	
Williams	
McAllister	
Indelli	
Burks	S.epidermidis
Judd	
Katz	
Schollinborg	
Alwang	
Ahmed-Abdel-Aziz	Equal incidence of S.aureus and S.epidermidis
Our Study	
	S.aureus

Septic arthritis after ACL reconstruction causes both functional compromise and financial burden on the patient and in athletic patients it may result in ending up of their sports career. Because double bundle reconstruction technique is done in younger and more active males and the infection rate is higher in this technique,¹⁶ it is essential to ensure aggressive management of infection in these patients if at all it develops. Although despite higher infection rate in DBACL group we found no difference in functional outcome, further we recommend a larger study to ascertain the facts and devise an appropriate management protocol.

5. Conclusion

Although DBACL reconstruction is associated with higher infection rates than SBACL, the functional outcome after infection is same in both the groups. Joint aspirate is the most dependable diagnostic method but in negative aspirated ESR and CRP can be depended upon. It is imperative to perform early and adequate joint debridement to ensure best outcome, however, an antibiotic cover of 2 weeks IV and 4 weeks oral should be added, based upon the culture reports as a variety of organisms can be involved.

Conflict of interest

None.

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