

Day surgery for anterior cruciate ligament reconstruction in children: a prospective study on feasibility and satisfaction

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Abstract

Purpose To evaluate the feasibility of day surgery anterior cruciate ligament reconstruction (ACLR) in children. Our hypothesis was that proper patient selection, adequate information and a streamlined clinical pathway would allow for a safe and satisfactory procedure.

Methods A total of 20 patients, seven girls and 13 boys, who underwent outpatient ACLR at mean age of 14 years (8 to 16) were included in this single institution prospective case series. Surgery took place under simple general anesthesia while analgesia protocol combined local anesthesia, oral analgesics for the postoperative period and compressive cryotherapy. The main failure criterion was the inability to return home the day of surgery or the need for rehospitalization during the first week after discharge. Secondary evaluation parameters were the rate of postoperative complications, postoperative pain, quality of life (QOL) and patients' satisfaction outcome questionnaire (PSOQ) at postoperative day 1, 7 and 31.

Results Of the 20 patients included, only one failed the ambulatory mode. The mean PSOQ score was, respectively for children and parents, 91.4% and 90.7% at day 7 and 94.6% and 95.7% at one month. Postoperative QOL at day 7 was very satisfying for all patients. Two minor early complications were reported. Both of the late complications, which included one partial wound dehiscence and one persistent knee swelling, resolved spontaneously.

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Conclusion This study indicates that, in a targeted and well-informed population, day surgery for children ACLR yields high level of patient and family satisfaction in a safely manner.

Level of evidence IV, prospective case series.

Cite this article: Barbier D, N'Dele D, Bennis M, Thevenin-Lemoine C, Sales De Gauzy J, Accadbled F. Day surgery for anterior cruciate ligament reconstruction in children: a prospective study on feasibility and satisfaction. *J Child Orthop* 2019;13:100-106. DOI 10.1302/1863-2548.13.180064

Keywords: ACL reconstruction; children; outpatient; safety; satisfaction

Introduction

The diagnosis of an anterior cruciate ligament (ACL) tear in children and adolescents has markedly increased over the last two decades. This is partially due to a higher participation in sport activities with heightened physical demands. Another explanation for this propensity is the increased availability of advanced imaging tool such as MRI. An increasing interest amongst paediatric orthopaedic surgeons in arthroscopic handling of the ACL reconstruction (ACLR) has also contributed to the rising numbers of this procedure in children. Actual trends show that ACLR in paediatric and adolescent patients significantly outpaces the increase of the same procedure in adult population.¹

Day surgery appears to be beneficial, both for the patient in terms of nosocomial infection² and for the French healthcare system as a cost reduction measure, while enhancing the efficiency of the healthcare setting.³ Indeed, it has been shown that for equal procedures day surgery reduces expenditures from 17% to 68% compared with a traditional admission.^{4,5} In 2012, Hulet et al⁶ reviewed the economic impact on the French healthcare system of ambulatory surgery. On ACLR specifically, they reported a 34% cost overrun for the system when the patient was admitted for one night compared with an outpatient setting. A French national survey conducted in 2013⁷ highlighted the low ratio of outpatient ACLR, i.e. 3% of the registered 40000 procedures (adult and children). In comparison, rates of day surgery ACLR reached 80% in Sweden and were above 90% in the United States.

The purpose of this study was to evaluate the feasibility, in France, of the outpatient arthroscopic ACLR in children. The authors' hypothesis was that proper patient selection combined with comprehensive information and a streamlined clinical pathway would allow for a safe and satisfactory procedure.

Materials and methods

A prospective, Institutional Review Board approved (# 41-0713), consecutive case series study was conducted at our institution from January 2015 to January 2016. Following the confirmed diagnosis of an ACL tear through clinical exam and MRI, eligibility for enrolment was assessed for each patient. Patient selection was based upon the criteria for day surgery established by the French National Authority for Health (Haute Autorité de Santé, HAS).⁸ These criteria include a good comprehension of the different information, the ability for the parents to follow instructions, appropriate household hygiene, the necessity for a parent or a guardian to be present at home during the first postoperative week, being able to reach the hospital within two hours from home, a residence furnished with a telephone line and finally the patient having to fit in either class I, II or stabilized III of the American Society of Anesthesiologists (ASA) physical status classification system.⁹ Failure to meet any of the above-mentioned criteria was considered as a reason for exclusion. Other medical exclusion criteria were: multiple-ligament injuries of the knee or a prior homolateral ACLR. Meniscus involvement was not considered as exclusive.

Informed consent was obtained from both the patient and their family. In this regard each child was provided with an illustrated and age-adapted step-by-step care map (Supplemental Material). Details on the injury and its related surgery, pre- and postoperative instructions, postoperative physiotherapy guidelines and emergency contact numbers were topics covered by the care map.

A total of 20 patients, 13 boys and seven girls, with a mean age of 14 years (8.8 to 16.4) presenting with an isolated ACL tear were included (Table 1).

The surgical technique was consistent in all patients and performed by two senior surgeons (FA and CTL). A transphyseal reconstruction with a four-stranded closed loop semitendinous autograft (short graft) was carried out. Femoral and tibial tunnels, which consisted of intraepiphyseal sockets, were drilled independently. Implants used for graft fixation were the ToggleLoc Ziploop DTz4 devices (Zimmer Biomet, Warsaw, Indiana). It consisted of a suspensory button on the femoral side and an attachable button on the tibial end (Fig. 1). When a meniscal tear was observed, it was systematically addressed prior to ACLR. Posterior horn tears were repaired using an all-inside technique with the Fastfix device (Smith & Nephew,

Table 1 Patient demographics

Case number	Sex	Age at operation (year/month)
1	Male	14.0
2	Female	14.5
3	Male	15.5
4	Male	8.8
5	Male	14.5
6	Male	15.4
7	Male	16.3
8	Female	15.7
9	Male	14.2
10	Female	14.1
11	Male	14.5
12	Female	13.8
13	Male	10.2
14	Male	15.9
15	Female	13.5
16	Female	14.7
17	Male	13.9
18	Female	16.4
19	Male	12.5
20	Male	12.2

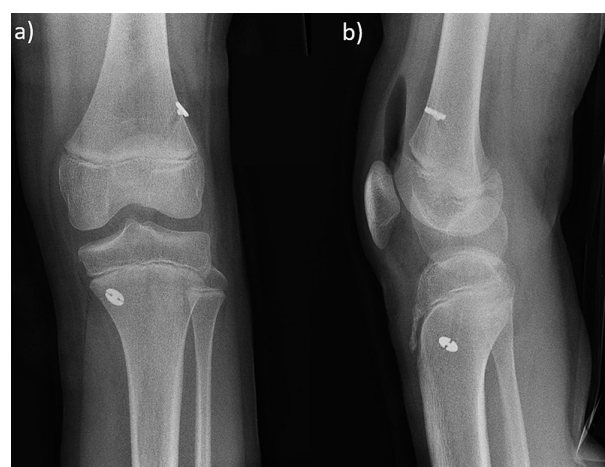


Fig. 1 Postoperative anteroposterior (a) and lateral (b) radiographs showing tunnels position and graft fixation devices.

London, United Kingdom). Hybrid repair was chosen for extended lesions, using the aforementioned technique for the posterior horn and an outside-in procedure for the mid-/anterior portion.

All surgeries were performed under general anesthesia. No patient received peripheral nerve blocks. Antibiotic prophylaxis was systematically administered (Cefazolin 30mg/kg iv) at induction of anesthesia as well as dexamethasone (0.15mg/kg iv) to prevent postoperative nausea and vomiting.

Analgesia was monitored and adapted at each step of the process. Intraoperatively, it combined a step 1 analgesic (paracetamol 15mg/kg), a non-steroidal anti-inflammatory drug (ketoprofen 1mg/kg), a bolus of ketamin (0.15 mg/kg) and an intraarticular injection of ropivacaine (20 ml, 0.2%). At the end of surgery, a knee icing system by means of a compressive long-leg brace was set up. If the patient remained painful (visual analogue scale (VAS) > 3),¹⁰ in the post-anesthesia care unit (PACU), a step 2

analgesic (tramadol 1mg/kg) was given through an IV route. In case of persistent pain morphine IV was titrated (bolus of 0.1 mg/kg then 0.025 mg/kg/min). If the patient presented with nausea, an antiemetic treatment was started (ondansetron, 0.05mg/kg).

We used modified Aldrete and Chung post-anesthetic scoring systems to respectively evaluate discharge from PACU and home readiness.^{11,12} In the day surgery unit, step1 and 2 oral analgesics were given associated with antiemetic treatment when necessary.

Before discharge, modalities of the oral analgesia were reexplained to the patient with conditions allowing resorting to a higher step analgesic. Prescriptions for oral analgesics (paracetamol 15 mg/kg 4 times a day; ibuprofen 10 mg/kg 3 times a day; tramadol at weight-based dosage up to 50 mg 3 times a day, as needed) and ACL-specific physiotherapy were given.

Thromboprophylaxis was judged as unnecessary since return to walk with full weight-bearing was immediate.

Rehabilitation started as soon as day 1. It consisted of a detailed self-training programme (given at preoperative visit along with the care map). Further training in physiotherapy only started at day 30.

As for patient satisfaction, it was evaluated at three different checkpoints: through a phone call at day 1, at a follow-up visit on day 7 and finally at day 31. A PSOQ score¹³ was completed at each visit. The follow-up specific to our investigation was one month.

Feasibility of outpatient ACLR used as main criterion the absence of conventional hospital stay the day of surgery or during the first following week after discharge. Secondary judgment criteria were the absence of major comorbidity, any postoperative side effect such as dizziness, nausea or vomiting and of any surgical complication which we sought at each control. The entire process from inclusion to final evaluation in summarized in Figure 2.

Results

All of the included patients had an ACLR using the same technique. Surgery included a meniscal repair in 25% of the cases (5/20 cases). Four tears confined to the posterior horn and one bucket handle tear were identified. Every patient but one was able to return home the day of the surgery. The single case of failure was attributed to insufficient pain control.

Mean VAS at rest in PACU was 2/10 (0 to 6), 1 in outpatient unit (0 to 10), 1 (0 to 9) at home at day 1 and 0 (0 to 0) at day 7. The mean VAS at mobilization was 5 (2 to 10) in PACU, 4 (0 to 10) in outpatient unit and at home at day 1 and 0.2 (0 to 5) at day 7. Walking ability and knee flexion were assessed at day 7 and 31. In all, 17 out of 20 of the patients were able to take more than 100 consecutive steps at day 7 which was considered as an unrestricted perimeter. A mean flexion of 79° (30° to 110°)

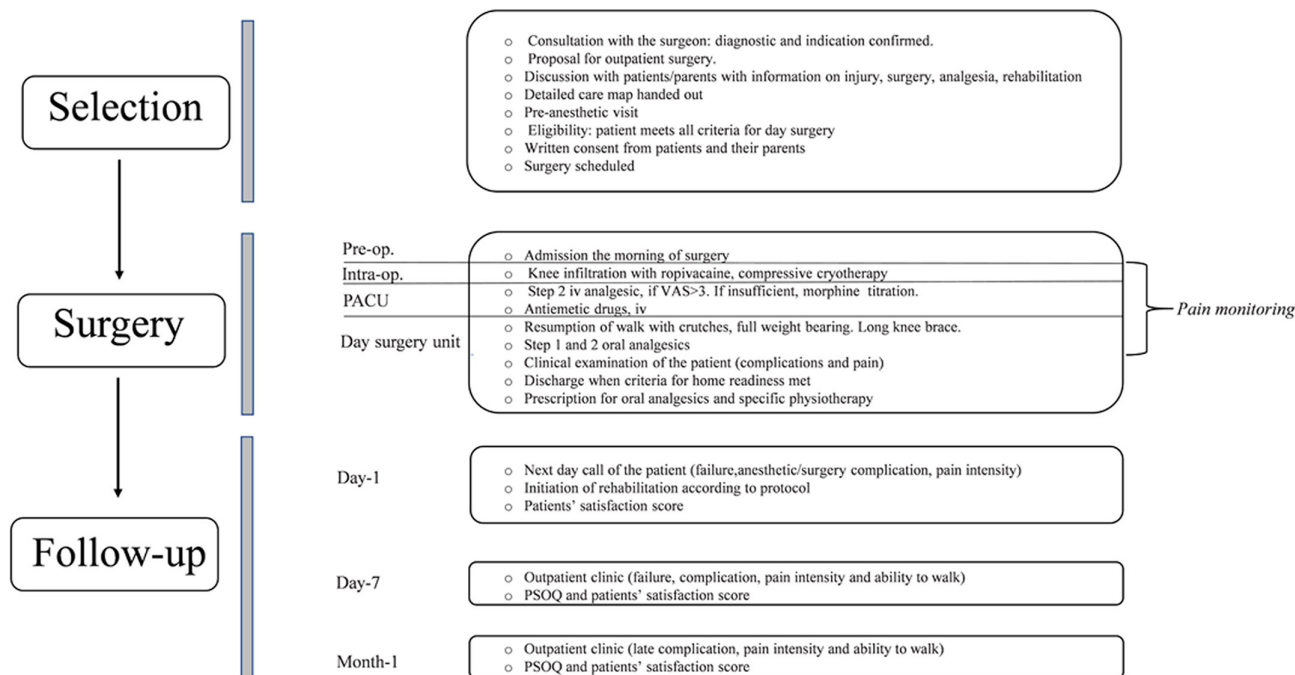


Fig. 2 Flow chart of patient's itinerary through day surgery anterior cruciate ligament reconstruction (PACU, post-anaesthesia care unit; VAS, visual analogue scale; PSOQ, patient satisfaction outcome questionnaire). FIG. 2 Flow chart of patient's itinerary through day surgery anterior cruciate ligament reconstruction (PACU, post-anaesthesia care unit; VAS, visual analogue scale; PSOQ, patient satisfaction outcome questionnaire).

was observed then. At day 31, all patients were able walk in an unlimited way. Mean flexion was measured at 111° (80° to 145°).

Concerning complications, three episodes of dizziness in recovery room and two similar episodes with one vomiting at day 1 were reported. Of note, there were two early surgical complications, two minimal bleedings in the outpatient unit which solely required a dressing replacement followed by a few hours of surveillance before discharge. Two late surgical complications were reported at one month. They were minor ones and consisted of a partial superficial wound dehiscence on the graft donor site and one persistent knee swelling. Both complications resolved spontaneously.

Quality of life on the seventh postoperative day was very satisfying for all patients with a mean score of 5.7/6.

The overall mean PSOQ scores for children and parents were 91.4% and 91.1%, respectively at day 7 (see Table 2 for details). At one month, average scores were 95% and 94.5%, respectively.

Finally, no rehospitalization was reported.

Discussion

To our knowledge this is the first European study to address the topic of day surgery ACLR in a paediatric population and the only study to investigate its feasibility. The main findings of the study were the great satisfaction of the patients and their family; at day 7 they all scored above 90% on the PSOQ items. Scores improved at one month to reach 95% for patients and 94.5% for parents.

Table 2 Patient satisfaction outcome questionnaire (PSOQ) scores for children and parents at day 7 and day 31

Case number	PSOQ scores (%)			
	Children: day 7	Parent: day 7	Children: day 31	Parent: day 31
1	92.0	93.0	92.0	93.0
2	87.8	86.1	90.6	86.1
3	95.0	96.0	99.0	100.0
4	98.9	90.6	95.0	91.7
5	94.4	97.2	99.4	94.4
6	91.7	90.6	93.3	93.9
7	97.8	97.2	96.1	96.1
8	86.1	86.1	93.9	93.9
9	96.5	97.1	95.0	97.2
10	97.2	98.3	97.2	98.3
11	72.2	68.3	72.2	68.3
12	93.3	92.8	99.4	99.4
13	95.0	97.2	98.9	99.4
14	87.2	91.7	98.3	98.3
15	96.7	98.9	96.7	98.9
16	94.7	93.5	100.0	100.0
17	93.9	94.4	96.1	95.0
18	88.7	81.2	N/A	N/A
19	98.2	98.1	97.8	97.8
20	80.6	73.9	93.9	93.9
Mean PSOQ (%)	91.4	91.1	95.0	94.5

When asked, at day 31, if they had to repeat the surgery, would they do it under the same conditions, 94% of the patients answered positively. All of them were very satisfied at day 7 regarding quality of life. In terms of function we observed that 85% (17/20) of the patients were able to walk in an unlimited way at day 7 and 100% had an unrestricted perimeter at day 31. Knee mobility was also satisfying with a mean flexion of 79° at day 7 and 111° at one month. Maximal pain at rest did not exceed 5/10 in all but one patient who presented with an intensity of 6/10 in PACU and 9/10 at day 1. In all, 95% of our ACLRs were performed in an ambulatory way. Finally, no major postoperative complications were noted in this study. Thus, our results tend to indicate that outpatient ACLR in children, in a proper setting, is both feasible and safe. We believe that mandatory presence of a parent or a guardian at home during the first week following surgery and maximum two hours travel time between home and the hospital with a round-the-clock availability of a surgeon play a key role in achieving this surgery in an ambulatory mode. Day surgery can also be beneficial for the health-care system through lower expenditures. Outpatient ACLR in adult population has been the general rule of thumb for about 20 years now in various countries. On this aspect, France has suffered a delay in implanting an economic valorization of short-term stay for such surgeries as ACLR. New legislation on reimbursement policy emerged on 01 March 2014. Specialized centres in adult ACLR declare an increase from 15% to 80% in day surgery ACLR.¹⁴ However, until today paediatric ACLR in France is seldom done as a day surgery. At an international level, there is a clear lack of supportive literature in paediatric same day surgery ACLR. Hitherto, only one North American study specifically addresses this issue.³

By contrast, analgesic modalities related to ACLR are well documented in the literature. Cryotherapy has long been used to relieve acute pain and to also facilitate rehabilitation.

In 1989, Cohn et al¹⁵ carried out a prospective study on flow controlled cold therapy in 54 ACLRs and they observed a reduction in analgesics intake in the postoperative period. In 1994, Ho et al¹⁶ established that cold therapy considerably reduces arterial blood flow as well as subcutaneous tissue perfusion and bone metabolism. In 2008, HAS established new recommendations about the use of cryotherapy in adult ACLR as both an inflammation and knee swelling reducing measure.⁸ Martimbianco et al¹⁷ in 2014, carried out a meta-analysis including 573 patients and compared two groups, one with and one without cold therapy. They observed, in the cryotherapy group, 48 hours after ACLR, a significant decline in pain without additional complications. Concerning the potential side-effects of cryotherapy, Melnyk et al¹⁸ in 2006, pointed out the absence of consequence on hamstrings nervous

conduction and noticed neither any increase in latency nor altered amplitude in electromyography responses after 20 minutes of cryotherapy. They found no negative effect of cold therapy on knee stability after studying tibial translation. In 2014, Koyonos et al¹⁹ questioned the indication for intraoperative cryotherapy and found a significant reduction in pain and analgesic intake. Several studies also showed the advantage of compressive therapy combined with cryotherapy. Waterman et al²⁰ in 2012, noted a significant reduction in pain and opioid intake after using cold therapy combined with compression three times daily and this compared with cryotherapy alone after ACLR. In 2014, Murgier and Cassard²¹ also reported that dynamic compression in association with cryotherapy allows for a lessened analgesic need and improves range of movement as opposed to continued compression alone.

Nervous blocks are also frequently used in orthopaedic surgery to shorten hospital stay and initiate early rehabilitation.^{22,23} Nonetheless these recent studies report complications from femoral blocks. Luo et al,²⁴ in 2015, in 124 paediatric ACLRs, identified the persistence of a significant deficit in quadriceps function at six months after surgery in the femoral block group (n = 62) with a significantly delayed return to sport (odds ratio = 4.37, p = 0.002) compared with the control group (n = 62). Moreover, nervous blocks delay the onset of pain and leave the child and their family on their own to confront pain in an outpatient setting, usually the same night after surgery.²⁵ Intra-articular local anesthetic injections combined with cryotherapy have proven to be efficient in ACL surgery. In 1996, Brandsson et al²⁶ compared three randomized groups receiving a different postoperative treatment after ACLR. Group I was treated with cooling therapy and an injection of physiological saline at the completion of surgery; in group II, the cooling system was combined with an intra-articular injection of bupivacaine and morphine at the end of the procedure; while group III (placebo group) only received an intra-articular injection of physiological saline. A greater satisfaction amongst patient in cooling therapy groups was observed (80% versus 90% versus 30%), along with a significant pain downscaling and a lower amount of analgesics consumption.

In our study, we opted for step 1 and 2 oral analgesics combined with a perioperative intraarticular injection of ropivacaine and cryotherapy with compressive knee bracing. Nerve blockage is an alternative we did not consider, therefore avoiding a sensitive or motor deficit at home which could lead to a stress situation for the child and their family.

From a technical standpoint, in our hospital for ACLR we use a so-called short graft. By short graft we signify the introduction of a minimum and adequate collagen tissue bundle being press fit into a limited socket in the epiphysis at the anatomic footprints of the native ACL to obtain a

primary fixation and healing of the ligament. The rationale of its uses relies on the following substantial benefits as shown by Colette and Cassard:²⁷ bone tissue²⁸ and ligament sparing is of particular importance in a paediatric setting,²⁹ tensile strength resistance, low elongation rate when preconditioned, high stiffness and fixation with a tight 360° bone to graft contact.

We artificially report, in this study, a follow-up of one month only, congruously with the purpose of our study about feasibility of same day surgery ACLR. In fact, all our patients with ACLR are monitored until they have reach skeletal maturity aligned with the concerns of growth disturbances. When physes are closed the main concern is subsequent ACL injury. For those patients we establish a follow-up of at least two years after return to sports in accordance with Paterno et al.³⁰

There are assuredly limitations to this study. Notwithstanding the fact that no prior publication has investigated this specific topic, our study still has a small sample size with retrospectively reviewed data. It adds complexity when it comes to extrapolate these results to the entire paediatric population. Other limitations are the absence of a control group to compare the scores at the different milestones, the insufficient patient caseload to perform a power analysis and establish the minimum number of cases and above all the reported short follow-up of one month. The strong points were: the use of a single surgical technique with a short graft thus reducing morbidity on a bony and ligamentous standpoint and the delivery right from the start, through the care map, of a thorough information about each step of the process.

Conclusion

The results of our study indicate that day surgery for ACLR in children is feasible without increasing morbidity at one month and carries a high level of satisfaction.

Nonetheless, it is of paramount importance in this population to evaluate and ascertain eligibility for outpatient surgery. Preoperative information and postoperative availability are of critical importance to ensure confidence and safety. In this sense, we developed a child-adapted care map which is given to the patient in the preoperative consultation.

Received 02 June 2018; accepted after revision 15 November 2018.

COMPLIANCE WITH ETHICAL STANDARDS

FUNDING STATEMENT

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

OA LICENCE TEXT

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ETHICAL STATEMENT

Ethical approval: This research involved strictly human participants. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Institutional Review Board approval: # 41-0713.

Informed consent: Written informed consent was obtained in each case from both the patient and the parents.

ICMJE CONFLICT OF INTEREST STATEMENT

FA has an ongoing financial relationship for research with Zimmer Biomet, outside the submitted work.

None of the remaining authors have any conflict of interest to disclose.

AUTHOR CONTRIBUTIONS

Conception and design of the study: DB and FA.

Acquisition of data: DB, CTL and MB.

Analysis and interpretation of data: DB, DN, JSDG and FA.

FA and CTL performed the surgeries.

DB and DN wrote the manuscript with input from all authors.

SUPPLEMENTAL MATERIAL

Supplemental material is available for this paper at

<https://online.boneandjoint.org.uk/doi/suppl/10.1302/1863-2548.13.180064>.

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