The National Ligament Registry

The Fifth Annual Report (2019)

NATIONAL LIGAMENT REGISTRY

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1 Chairman's Statement

''On behalf of the steering group of the National Ligament Registry, I would like to thank everyone for their participation of this comprehensive data collection registry. Understanding outcomes of what we do continues to be extremely important, especially in this age where we are expected to – and should – provide information for patients to make informed choices about their treatment. With the data we can start to see trends in outcomes and in use and when we combine our resource with the international registries, we will be able to create a powerful message. In the meantime, with BASK, the BOA and other registries, we continue to work to improve the platform, the functionality and ensuring consent is appropriate for safe and comprehensive data entry and analysis. Feedback is always welcome, and volunteers are welcome to become involved."

Tim Spalding
Chairman

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2 Steering Group Introduction

The UK National Ligament Registry (NLR) has been set up to collect and store outcome data relating to anterior cruciate ligament reconstruction surgery. It was launched at the BASK annual scientific meeting in 2013.

Any data collection system must be established to answer clear questions. Simple questions need robust systems to provide valid answers. For this very reason, we have concentrated on a single procedure, primary anterior cruciate ligament (ACL) reconstruction, and we are confident that the results will benefit surgeons and patients alike. When established, it will ease the journey to develop similar pathways for the revision of ACL procedures, other ligament reconstructions and non-arthroplasty knee interventions. The NLR could also be used to look at the outcome for patients who are managed non-operatively.

The NLR will only succeed if all partners (patients, surgeons and industry) are involved, feel valued and benefit. We need surgeon support to ensure we achieve a critical number of surgeons and procedures. The Registry is established as a surgeon led entity without the involvement of governmental agencies. This approach therefore requires external financial support and we have received sponsorship from eight companies involved in ACL reconstruction as well as a 'priming' grant from BASK. In return the companies will be provided with information on the performance of their particular products, but will not be able to access competitor data.

Registry data provides a substantial amount of information directed towards answering questions and raising overall standards of care, for the benefit of patients, clinicians, the NHS and industry. With the NLR, surgeons should strive to achieve the primary aim of a (complete) database of the 'functional' outcome of ACL reconstruction in the UK — it will then enable some secondary gains that could include uses in surgeon revalidation and the establishment of a platform to allow the controlled introduction of new products.

We are pleased to publish the fifth annual report of the National Ligament Registry. The NLR continues to grow both in terms of patient numbers and in terms of its reach and popularity. We have received great support from the British Association for Surgery for the Knee, the International Registries Consortium and of course from industry who help fund this initiative. At this point we have 777 registered users and 12,558 pathways entered. These continue to increase at a rapid rate. We are keen to continue to provide a resource for all new surgeons and all patients who suffer ACL injuries. We hope ultimately to capture every ACL injury sustained in the UK, to look at both those treated operatively and non-operatively, and to develop a robust dataset with short and medium term outcomes.

We continue to work with Amplitude and to evolve their offering. We have received support in that regard from the TORUS Group at the BOA and from Julia Trusler in particular. The Steering Group has expanded. John Fairclough, Steve Bollen and Andy Price have moved on to other projects and initiatives; Sean O'Leary has served his term as chairman and has now stood down from that role. Tim Spalding, the new NLR Chair, and Fares Haddad continue from the original group and have been joined by James Robinson and Mike McNicholas who will particularly focus on website and industry relations, and by William Hage as treasurer. We continue to look for surgeon champions and enthusiasts and are very grateful to our regional coordinators.

We hope the material in this report is of interest and that you will continue to help us to collect more data so that we can provide feedback to our surgeons, our patients and our healthcare providers, in order to improve outcomes.

3 Aim of Registry

When understanding outcomes following ligament reconstruction, it is important to analyse all relevant factors that may have an effect. This could be anything from graft choice and surgical fixation, to patient factors and rehabilitation factors. The registry aims to:

- Collect relevant demographic data
- Identify any current or emerging trends in practice
- Identify failing techniques / devices at the earliest opportunity
- Provide functional outcome data and complication rates
- Improve the standard and quality of care in the UK as a result of all of the above

Currently, there is a lack of information regarding the number of procedures, functional outcome and complication rate following ACL reconstruction (ACLR) operations in the UK. The Registry aims to address this gap by creating one central hub of clear and concise data that will allow establishing standard of best practice. We hope this will:

- Help patients (and surgeons) understand the outcome
- Identify standards of practice
- Identify techniques / implants that do not excel
- Provide information to commissioners and to steer the genesis of high value pathways

4 Background

The UK National Ligament Registry has been designed by surgeons for the benefit of patients. It is an exciting collaborative project, aimed at understanding and optimising the outcome following anterior cruciate ligament reconstruction. At the time of writing, we have 777 registered surgeons who are defined as the enthusiasts. This is already a huge endorsement for the early phase of this project. This number should steadily increase as surgeons and orthopaedic departments see the advantage of having a readymade tool for use in governance and revalidation. Figure (1) shows the top 10 hospitals that have added patients to the registry in 2018.

Figure 1: Top 10 hospitals that have added patients to the registry in 2018

1 Royal Berkshire Hospitals, Reading
2 Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry
3 Bradford Royal Infirmary, Bradford
4 Wrightington Hospital, Wigan
5 St George's Hospital, London
6 Nuffield Health Tunbridge Wells Hospital, Tunbridge Wells
7 Royal United Hospital, Bath
8 Royal Devon & Exeter Hospital, Exeter
9 Chelsea and Westminster Hospital, London
10 Hospital of St Cross, Rugby

The Registry is a user-friendly web-based platform that collects various outcome data from ACL reconstruction operations. The Registry platform is easily accessible via computer and tablet, simplifying the process for clinicians and patients. The 'registry route' is simple, requiring small contributions from both surgeon and patient at different stages. It also automatically prompts patients to fill in their information at scheduled times throughout their treatment and rehabilitation, taking the hassle and stress out of clinical data collection for clinicians.

Bluespier was selected as the company to collect and host the data utilising their newly developed Amplitude system. With their help, we have established a new model for this Registry which involves automated online (paperless) data entry. It enables surgeons, patients and support staff to access and register online in a straightforward manner with easy access guidelines.

The population undergoing ACL reconstructions are typically younger, mobile and busy. This makes them difficult to trace and track which is why two of the key elements of information are the NHS number and an email address. This is the electronic age and email and text communication is the norm and must be acknowledged. It will take some effort and vigilance to enter patients, but with automated follow up the process is simple and appealing.

In understanding outcome following ligament reconstruction it is important to analyse all relevant factors that may be considered to affect outcome including graft choice, surgical/fixation techniques, patient factors and rehabilitation factors. The outcome measures chosen are the knee injury and osteoarthritis outcome score (KOOS), subjective International Knee Documentation Committee (IKDC), Euroqol (EQ5D) and the Tegner activity score. These scores allow comparison and communication with existing Registries as well as allowing potential 'generic health benefit' comparisons to other non-Orthopaedic procedures.

The data from the NLR is managed by the surgeons who input their patients. Backed by industry partner support, it will be overseen by the NLR steering group, producing an independent annual report. There will also be a research subcommittee appointed through the NLR steering group, with responsibility for deciding the direction of research and managing data requests from external parties. The program is run and technically supported by Amplitude, experts in collecting clinical outcomes data.

5 Results from Current data

A total of 12558 patients with ACL injury were registered in the national ligament registry between the first of December 2012 and the 31st of December 2018. Of these, 9794 patients (78%) underwent ACLR surgery. The remaining 2764 patients (22%) are either waiting for surgery or have no operative data entered on the registry (Table.1). A total of 2733 patients were added to the registry between 1st of January 2018 and 31st of December 2018. Of these, 1831 patients (67%) underwent ACLR procedure and are the main focus of this report. The remaining 902 patients (33%) are still waiting for surgery or have no operative data entered on the registry. We have noticed that the number of ACLR procedures recorded in 2018 was less than the last year. This could be attributed to the strict rules on consenting patients as all the patients added to the registry need to have a valid consent form in order to legally store their information on the NLR. We are also aware that information governance departments at some trusts have restricted surgeons from adding their patients on the registry.

5.1 Age at Surgery

The average age for patients undergoing ACLR between 2013 and 2018 was 29. 18% of patients who underwent ACLR surgery were over the age of 40. This could be attributed to the increased sports participation in this age group with patients performing athletic activities later in life that predispose them to ACL injury. Figures (3) & (4) demonstrate the number of patients who had ACLR surgery in different age groups. Figure (5) demonstrates the number and percentage of patients in different age groups over the last 6 years. In 2018, there were more patients above the age of 40 and fewer patients under the age of 20 undergoing ACLR compared to 2017.

Table 1: Number of patients who had primary ACLR with completed procedure form on the NLR between 2013 and 2018

	Primary ACLR (Patients with procedure form)(%)	**Patients without procedure form (%)**	**Total (100%)**
2013	590 (89%)	73 (11%)	663
2014	1339 (88%)	175 (12%)	1514
2015	1879 (84%)	354 (16%)	2233
2016	1987 (78%)	566 (22%)	2553
2017	216. (76%)	694 (24%)	2862
2018	1831 (67%)	902 (33%)	2733
Total	**9794 (78%)**	**2764 (22%)**	**12558**

A total of 101 surgeons have entered patients on the NLR in 2018. There has been a gradual increase in the number of surgeons adding patients to the registry over the past 6 years (Fig 2).

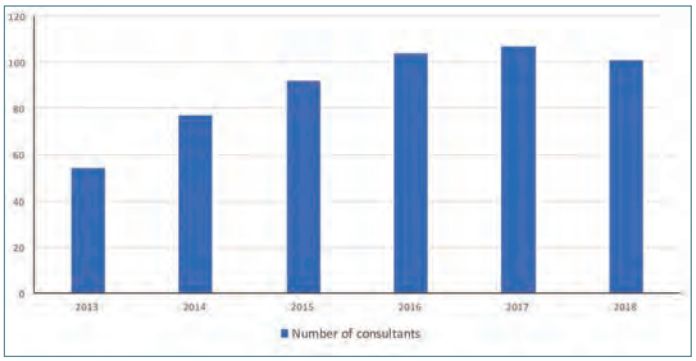

Figure 2: Number of surgeons who entered patients on the NLR between 2013 and 2018.

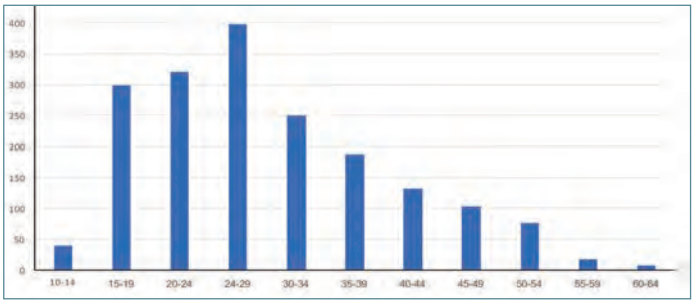

Figure 3: Number of patients who underwent primary ACLR in 2018 according to their age at time of surgery.

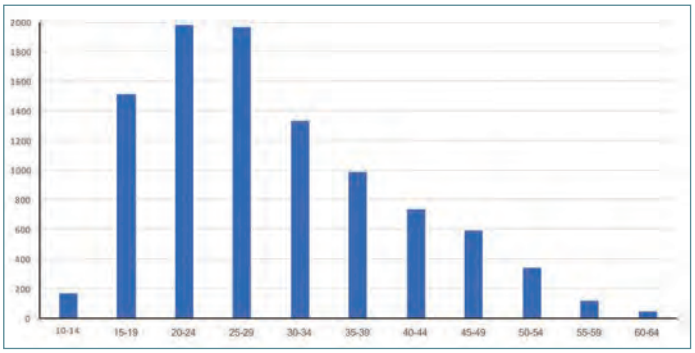

Figure 4: Number of patients on the NLR who underwent primary ACLR according to their age at time of surgery (2013-2018).

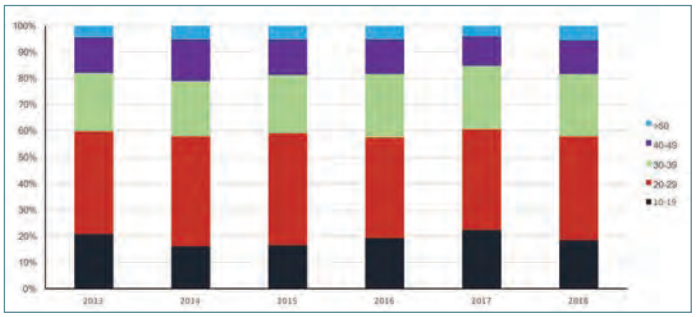

Figure 5: Percentage of patients who underwent primary ACLR according to their age groups at time of surgery between 2013 and 2018.

5.2 Gender distribution

The percentage of men and women who underwent ACLR surgery in 2018 were 72% and 28% respectively (Figure 6). These percentages have been similar every year since 2013. The average SHOULD WE USE MEAN, MEDIAN OR MODE? age for women who had ACL surgery was 32 while it was 29 in men. The distribution of male and female in different age groups is shown in figure (7).

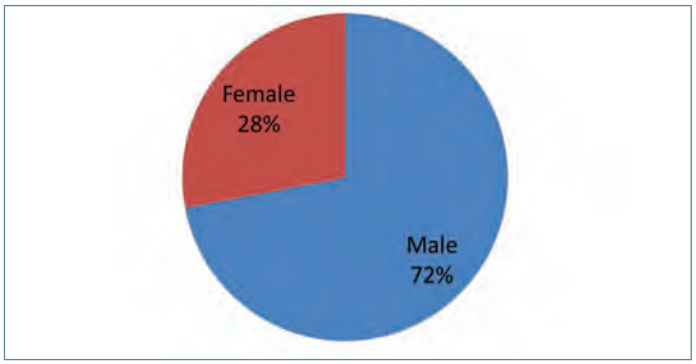

Figure 6: Percentage of male and female patients who underwent ACLR surgery in 2018.

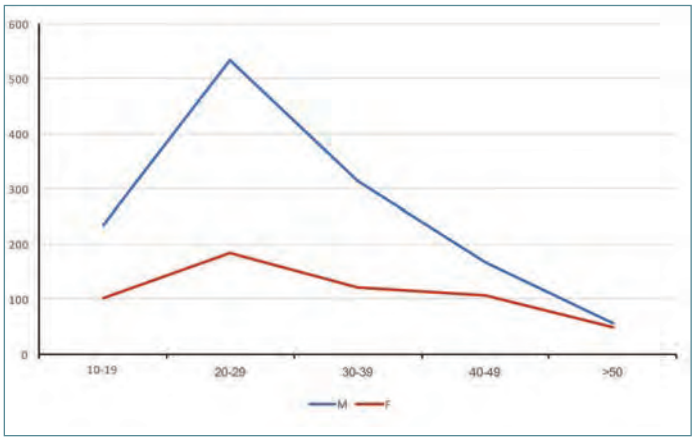

Figure 7: Distribution of male and female patients who underwent ACLR surgery in different age groups in 2018.

5.3 Operated Side

In 2018, the right knee was operated upon in 53% of patients who underwent ACLR surgery while it was the left knee in 47% of patients (Figure 8).

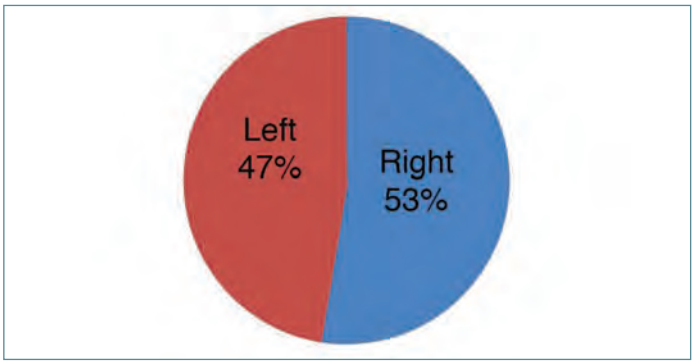

Figure 8: Operated Side.

5.4 BMI distribution

Figure (9) describes the body mass index (BMI) ranges for patients who underwent ACLR procedures in 2018. The BMI was recorded in 1796 patients. Of these, approximately 44% had BMI values between 18.5 and 25 while 3% were over 35. Figure (10) demonstrates the percentage of patients in different BMI groups over the last 6 years.

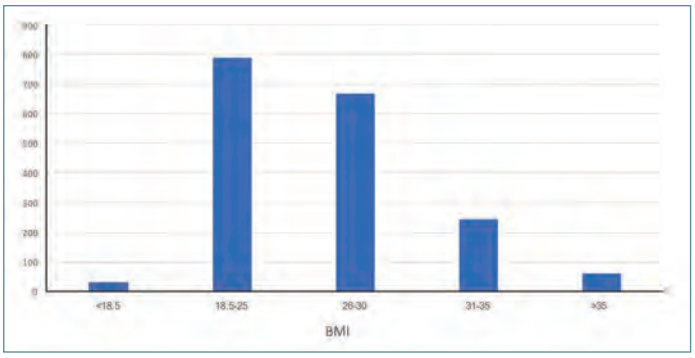

Figure 9: BMI ranges for patients who underwent ACLR procedures in 2018

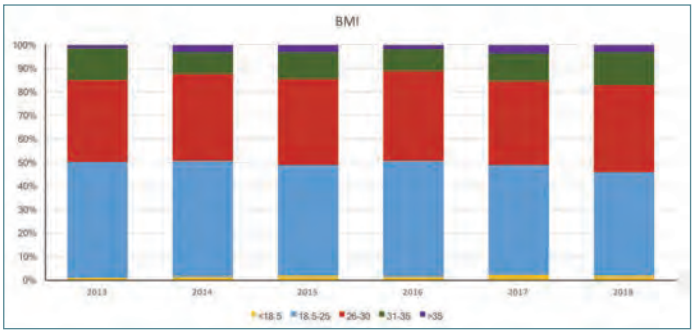

Figure 10: Percentage of patients who underwent primary ACLR according to their BMI at time of surgery between 2013 and 2018.

5.5 Activity in Association with the ACL injury

Sport injuries are the leading cause for ACL tears. ACL injury is particularly common in pivoting and cutting sports. Out of 9794 patients with ACLR on the registry, 4299 (44%) have answered the question on the activity leading to their ACL injury. 87% of those that answered sustained their ACL injury while engaged in sports activities while 13% sustained their ACL injury due to non-sport activities. Football (soccer) was the most common activity associated with an ACL injury. Among men, the second most common activity associated with ACL injury was rugby followed by snow skiing. However, snow skiing was the most common activity associated with an ACL injury in women, followed by netball. Table (2) shows the sport activities in relation to the ACL injuries in men and women. Table (3) shows the various non-sport activities that lead to ACL injury. 40% of these patients reported having a fall as the cause for their ACL injuries.

Table 2: Distribution of sport activities as the cause for ACL injuries in men and women

	Male	Female	Total	(%)
Football (Soccer)	1651	117	1768	47.4%
Rugby(Union)	434	56	490	13.1%
Snow Skiing	145	320	465	12.5%
Netball	0	184	184	4.9%
Other	118	83	201	5.4%
Rugby(League)	74	13	87	2.3%
Hockey (Field Hockey)	15	36	51	1.4%
Martial Arts	30	18	48	1.3%
Trampolining	12	41	53	1.4%
Basketball	43	11	54	1.4%
American Football	30	1	31	0.8%
Cycling (Mountain Bike)	25	5	30	0.8%
Running	18	7	25	0.7%
Hoarse riding	1	30	31	0.8%
Gaelic Games	22	4	26	0.7%
Badminton	15	9	24	4.9%
Squash	12	3	15	0.4%
Tennis	6	15	21	0.6%
Cricket	19	1	20	0.5%
Skate Boarding	16	0	16	0.4%
Gymnastics	5	11	16	0.4%
Volley Ball	11	5	16	0.4%
Boxing	6	4	10	0.3%
Cycling (Road bike)	7	3	10	0.3%
Athletics – Field	3	4	7	0.2%
Wrestling	6	0	6	0.2%
Judo	6	3	9	0.2%
Snow Boarding	3	2	5	0.1%
Hockey (Ice Hockey)	4	0	4	0.1%
Handball	1	2	3	0.1%
Roller Blading	3	0	3	0.1%
TOTAL	**2741**	**988**	**3729**	

Table 3: Distribution of non-sport activities as the cause for ACL injuries in men and women

	Male	Female	Total	(%)
Assault	12	4	16	3%
Dance	13	34	47	8%
Fall	124	104	228	40%
Motor Bike(Off road)	15	2	17	3%
Motor Bike(Traffic accident)	23	5	28	5%
Motor vehicle(Traffic accident)	8	6	14	2%
Other	72	72	144	25%
Work Related Injury	63	13	76	13%
Total	**330**	**240**	**570**	

5.6 Associated knee injuries with ACL tears

Of the 9794 patients who had ACLR surgery on the NLR, 50% had associated knee injuries that required surgical treatment. Medial meniscal surgery including partial menisectomy and meniscal repair were the commonest associated surgery (21%). The second most common associated procedure was lateral meniscal surgery (14%). Combined medial and lateral meniscal surgeries were undertaken in 6.7% of the patients. Table (4) shows a breakdown of patients who had knee surgery associated with ACLR procedures.

Table 4: Total number of ACLR and associated surgery.
MM= Medial Meniscus, LM= Lateral Meniscus, CL= Collateral Ligament, AC= Articular Cartilage, ALL= Anterolateral Ligament, PLC= Posterolateral Corner, PCL= Posterior cruciate Ligament

	2013	2014	2015	2016	2017	2018	Total
ACL	342	704	922	941	949	807	4665
ACL+ MM	82	267	385	457	515	406	2112
ACL+ LM	86	164	268	280	348	303	1449
ACL+ MM+ LM	34	68	129	126	169	137	663
ACL+ AC	12	30	32	30	36	34	174
ACL+ Other	0	10	15	21	18	18	82
ACL + CL	5	9	14	13	12	12	65
ACL+ Lateral tenodesis	1	3	12	24	17	17	74
ACL+ AC+ MM	5	16	7	17	15	21	81
ACL + PLC	1	13	11	4	9	4	42
ACL+ MM+ LM+ AC	5	10	7	4	12	11	49
ACL + LM+ AC	3	0	10	10	13	8	44
ACL+ LM+ lateral tenodesis	0	1	10	6	4	5	26
ACL+ MM+ lateral tenodesis	0	6	4	8	2	4	24
ACL+ MM+ other	1	3	6	6	3	2	21
ACL + ALL	0	6	4	3	5	2	20
ACL+ MM+ LM+ lateral tenodesis	0	2	6	6	3	0	17
ACL+ LM + CL	2	4	6	2	3	12	29
ACL + LM+ Other	1	1	2	7	3	3	17
ACL+ loose bodies	1	3	1	4	0	2	11
ACL+ MM+ CL	1	2	4	1	0	7	15
ACL+ MM+ Loose bodies	3	0	0	1	3	3	10
ACL+ MM+ LM+ PLC	0	1	1	0	5	0	7
ACL+ MM+ ALL	0	0	1	1	4	2	8
ACL + PLC+ CL	0	0	4	1	1	1	7
ACL+ MM+ LM+ CL	0	2	2	1	0	2	7
ACL+ PCL+ CL	1	1	2	0	1	1	6
ACL+ PCL	1	1	2	0	1	0	5
ACL+ LM+ ALL	0	0	1	1	2	1	5

	2013	2014	2015	2016	2017	2018	Total
ACL+ MM+ LM+ loose bodies	0	1	1	1	1	1	5
ACL+ LM+ PLC	0	1	1	1	1	0	4
ACL+ MM+ PLC	0	0	0	1	3	0	4
ACL+ AC+ Others	1	0	0	1	1	0	3
ACL+ MM+ AC+ other	0	1	1	0	1	1	4
ACL + PLC+ Lateral tenodesis	0	1	1	1	0	0	3
ACL+ MM+ LM+ ALL	0	0	0	1	2	0	3
ACL + CL+ Other	1	0	0	0	1	2	4
ACL+ AC+ PCL+ PLC	0	1	1	0	0	0	2
ACL+ LM+ Loose bodies	0	1	0	0	1	0	2
ACL+ MM+ LM+ AC+ loose bodies	0	1	0	0	1	0	2
ACL+ MM+ PCL	0	0	0	0	2	0	2
ACL+ Lateral tenodesis+ Other	0	2	0	0	0	0	2
ACL+ LM+ PCL+ Lateral tenodesis	0	1	1	0	0	0	2
ACL+ AC+ loose bodies	0	0	1	1	0	1	3
ACL+ AC+ CL + Loose bodies	1	0	0	0	0	0	1
ACL+ MM+ LM+ CL+ ALL	0	0	0	1	0	0	1
ACL + LM+ AC+ Other	0	1	0	0	0	0	1
ACL+ MM+ AC+ ALL	0	1	0	0	0	0	1
ACL+ AC+ CL	0	0	1	0	0	0	1
ACL+ AC+ MM+ lateral tenodesis	0	0	1	0	0	0	1
ACL+ MM+ PCL+ CL	0	0	1	0	0	0	1
ACL+ MM+ PCL+ PLC	0	0	1	0	0	0	1
ACL+ MM+ PLC+ ALL	0	0	0	1	0	0	1
ACL + PLC+ PCL	0	0	0	1	0	1	2
ACL+ LM+ PCL+ PLC	0	0	0	1	0	0	1
ACL + PLC+ PCL+ Lateral tenodesis	0	0	0	1	0	0	1
ACL+ PCL+ ALL	0	0	0	0	1	0	1
Total	**590**	**1339**	**1879**	**1987**	**2168**	**1831**	**9794**

5.7 Funding Sources

The source of funding was recorded in 2264 patients (23%) out 9794 patients who had ACLR between 2013 and 2018. The NHS funded 80% of these patients while 20% were independently funded. Figure 11 shows the breakdown for funding sources over the last 6 years.

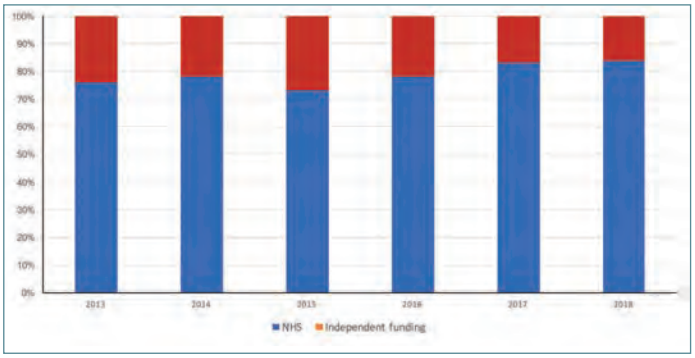

Figure 11: Funding sources for ACLR procedures (A total of 2264 patients were available for analysis)

5.8 Time to surgery

In 2018, the average time between ACL injury and surgical reconstruction was 164 days (Figure 12). Although this might appear as a long period between injury and surgery, it is similar to what has been reported by the Scandinavian registries. The reason for such a long period is unknown. Possible explanations include delayed diagnosis, long surgical waiting lists, prehabilitation and lengthy rehabilitation programs for patients who were initially managed non-operatively.

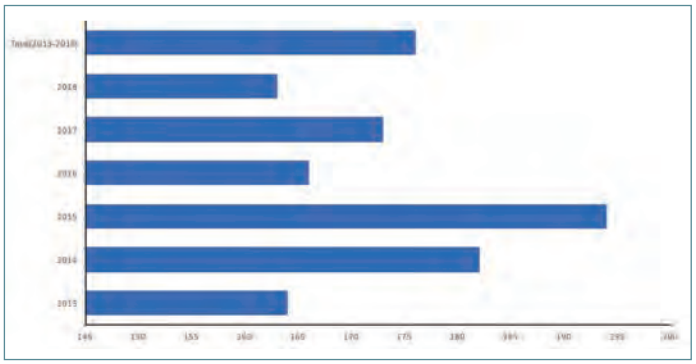

Figure 12: Average time from injury to ACLR surgery (days) over the last 6 years

5.9 Surgeons' Profile

In 2018, 101 surgeons have registered their patients on the NLR. Forty-one surgeons performed 10 or less ACLR surgery while only one surgeon performed over 90 ACLR procedures. Figure (13) demonstrates the number of surgeons in relation to the total ACLRs procedure they have performed between 2013 and 2018. Figure (14) shows the grade of operating surgeons who performed the ACLR surgery. In 2018, there was a noticeable increase in ACL procedure performed by trainees and fellows compared to previous years. Approximately 90% of ACLR procedures on the registry have been performed by consultant grade surgeons.

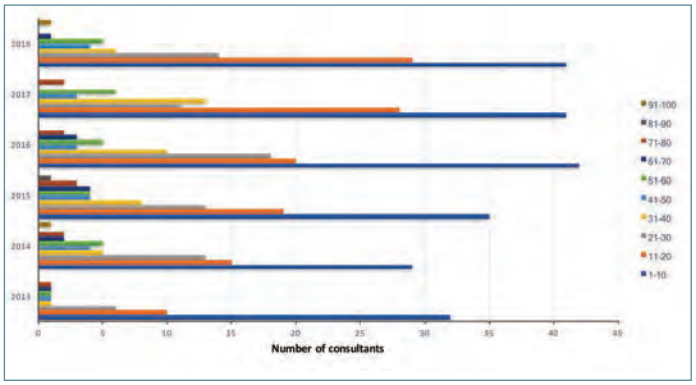

Figure 13: Number of surgeons in relation to the total ACLRs procedures they performed between 2013 and 2018

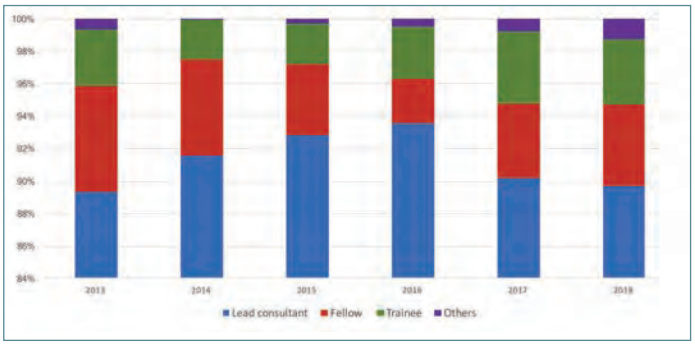

Figure 14: Grade of operating surgeons.

5.10 Thromboprophylaxis

Perioperative thromboprophylaxis strategies were recorded in 2120 patients who underwent ACLR procedure between 2013 and 2018. Of these, 38% had no thromboprophylaxis given and 30% had mechanical methods of thromboprophylaxis (Figure 15). There were no details on type of mechanical or chemical prophylaxis that were used. The indications for specific thromboprophylaxis strategy were not recorded either.

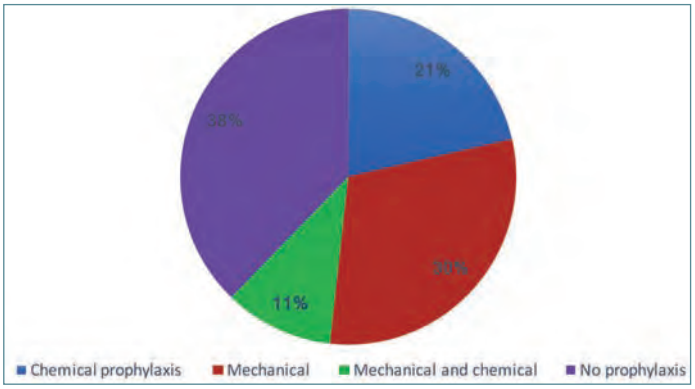

Figure 15: Percentage of different thromboprophylaxis strategies used in patients who underwent ACLR procedure.

5.11 Graft type

The type of ACL graft used was recorded in 9261 out of 9794 patients who had primary ACLR between 2013 and 2018. Autograft was the most common graft choice in ACLR procedures (98%). Allograft was used in primary ACLR surgery in 1% of the patients. A synthetic graft was used in 32 patients only. Seventeen patients underwent direct suture repair for the ACL tear instead of a reconstruction procedure (Figure 16). The outcome has only been captured for two of these patients so far.

Hamstring tendon autograft was the graft of choice in the majority of patients who underwent ACLR procedures. A doubled semitendinosus and gracilis graft was the most commonly used autograft (79%) followed by semitendinosus alone (12%) and patellar tendon (9%). Quadriceps tendon autograft was used in 26 patients only (Figure 17).

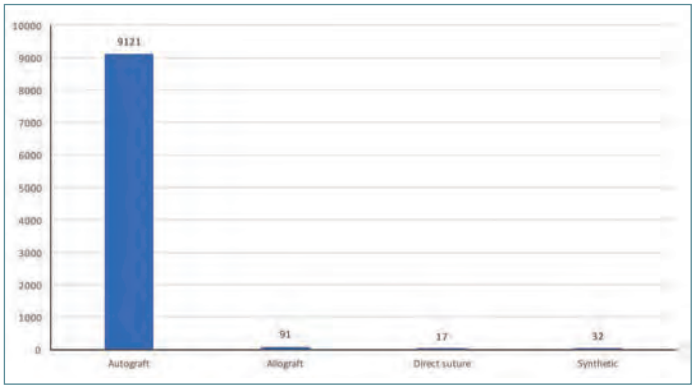

Figure 16: Type of ACL Graft. Data from 9261 patients were available for analysis.

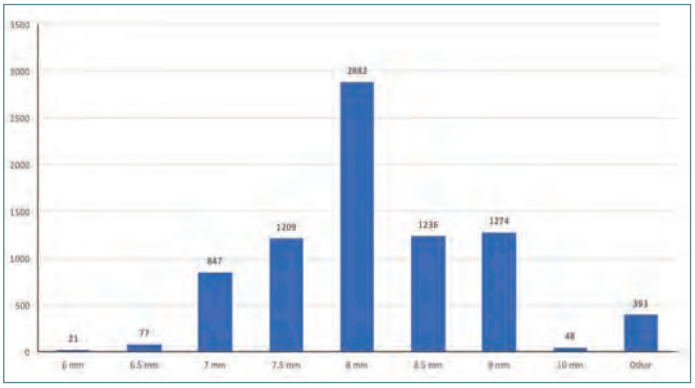

Figure 19: Graft diameter. Data from a total of 7987 patients were available for analysis.

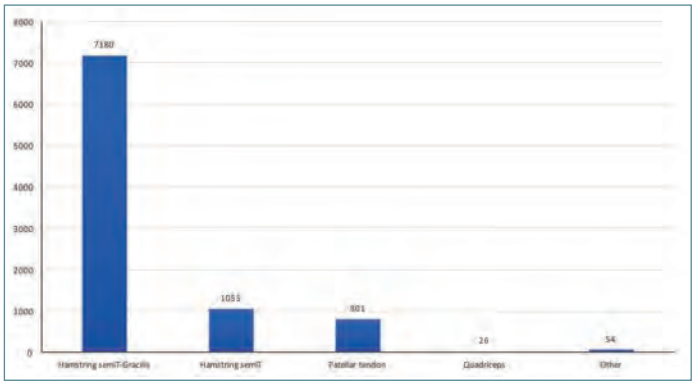

Figure 17: Types of ACL autograft.

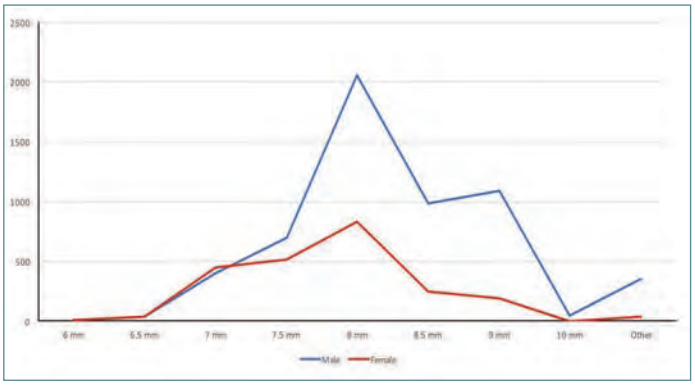

Figure 20: Graft diameter among men and women.

The hamstring tendon autograft can be used in a single- or multi-strand configuration. Four-strand configuration was the most common (81%) followed by five-strand configuration (9.5%). Single-strand configuration was used in 48 patients (Figure 18).

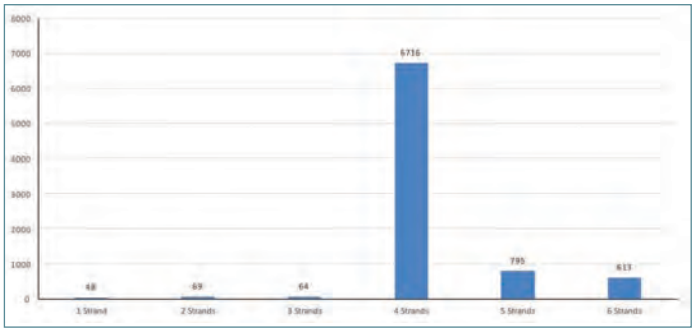

Figure 18: Hamstring tendon autograft doubling configurations.

5.12 Graft diameter

The most common hamstring autograft diameter was 8 mm (36%). 21 patients had a graft diameter of 6 mm while 48 patients had a graft diameter of 10 mm (Figure 19). Figure 20 shows the graft diameters among men and women.

5.13 Femoral and tibial tunnels drilling

Anteromedial portal (AM) was the most common portal for femoral tunnel drilling (Figure 21). The second common portal was through the all-inside technique. The transtibial technique was least common technique for femoral tunnel drilling. Figure 22 shows the percentages for different femoral tunnel drilling technique over the last 6 years. This shows a change in the trends in femoral tunnel drilling with the transtibial technique seems to be falling out of favour while there is an increase in the use of the all-inside technique. The outside-in technique was the predominant technique for tibial tunnels drilling (Figure 23). Figure 24 shows gradual increase in the use of the all-inside technique for tibial tunnel drilling over the last 6 years.

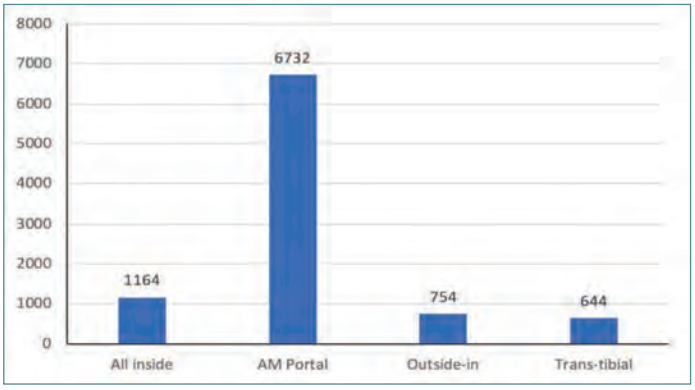

Figure 21: Femoral Tunnel Drilling Techniques between 2013 and 2018.

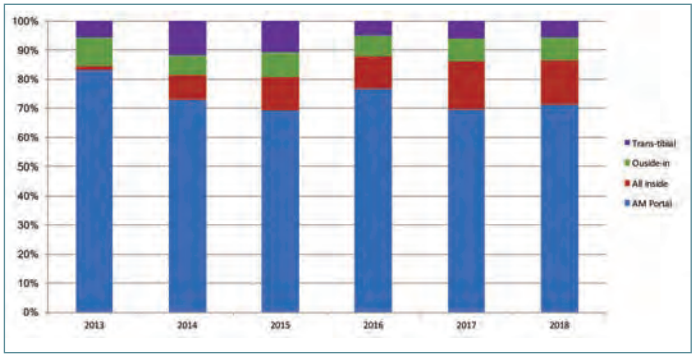

Figure 22: Percentages of different femoral tunnel drilling techniques between 2013 and 2018.

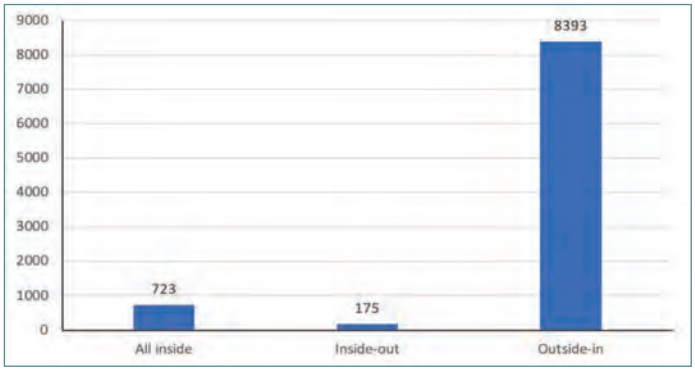

Figure 23: Tibial Tunnel Drilling Techniques.

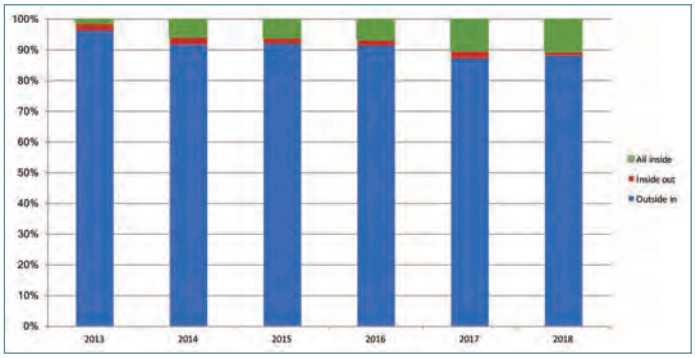

Figure 24: Percentages of different tibial tunnel drilling techniques between 2013 and 2018.

5.14 Femoral and tibial tunnels fixation

Figure (25) shows the percentage of different fixation devices for the ACL graft in the femoral tunnel. Endobutton suspensory mechanism was the most common fixation method followed by interference screw fixation.

For tibial tunnel fixation, interference screws were used in 87% of all ACLR procedures on the NLR (Figure 26). Metal was the most common material used for femoral and tibial tunnels interference screws, although there is growing increase in the use of PEEK screws over the last 6 years for tibial tunnel fixation (Figure 27 and 28).

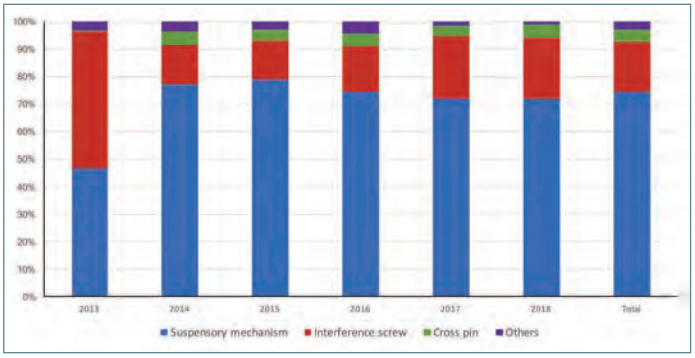

Figure 25: Femoral fixation devices.

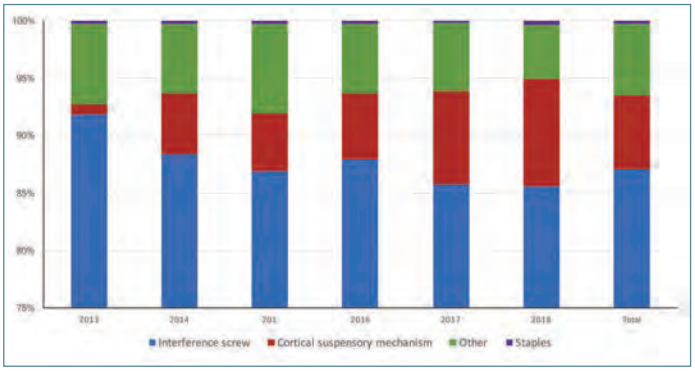

Figure 26: Tibial tunnel fixation devices.

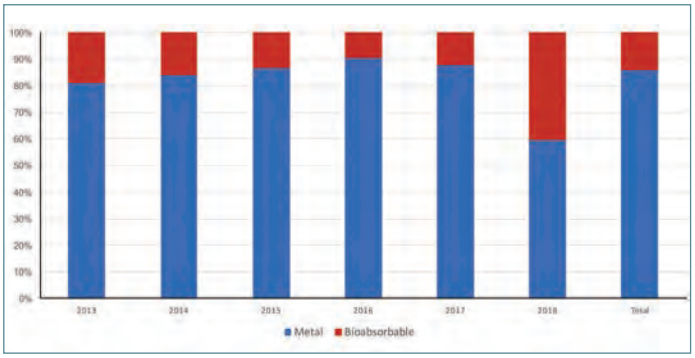

Figure 27: Materials used for femoral tunnel interference screws.

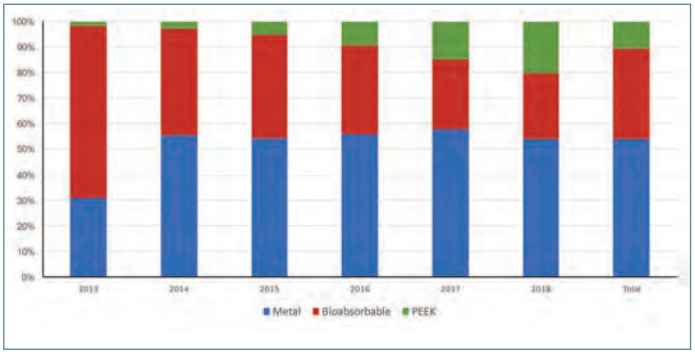

Figure 28: Materials used for tibial tunnel interference screws.

5.15 Patient reported outcome measures (PROMS)

PROMs have become an integral part for assessment of any surgical intervention. A combination of generic and disease specific outcome measure is commonly used to assess treatment outcome. The NLR collect PROMS from patients preoperatively then at 6 months, 1 year, 2 years and 5 years postoperatively. The collected PROMs are EQ-5D, IKDC subjective, Tegner and KOOS scores. The results below are for all the patients registered on the NLR between 1st of December 2012 and 31st of December 2018.

5.16 EQ-5D

The EQ-5D is a simple generic measure of health for clinical and economic appraisal. It allows description of general health status along five domains. The results are presented as an index, a quality of life weighting between 0 (death) and 1 (complete health). The EQ VAS records the respondent's self-rated health on a 0 to 100 visual analogue scale with endpoints labelled 'the best health you can imagine' and 'the worst health you can imagine'. Figure 29 and figure 30 show improvements in postoperative EQ5D-index and EQ5D-VAS scores at 1 year and 2 years compared to preoperative scores.

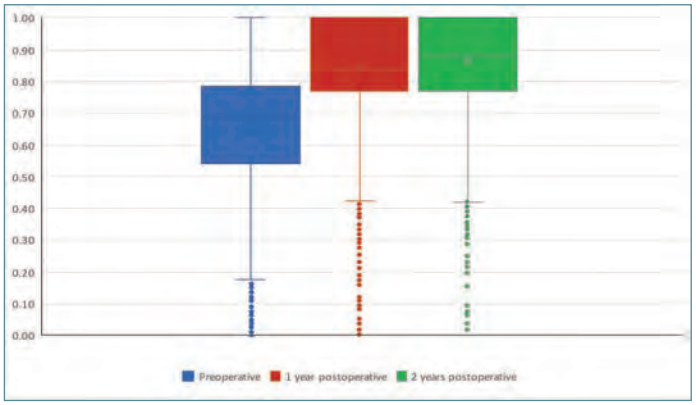

Figure 29: Preoperative, 6 months, 1 year and 2 year postoperative EQ5D-index scores for ACLR procedures.

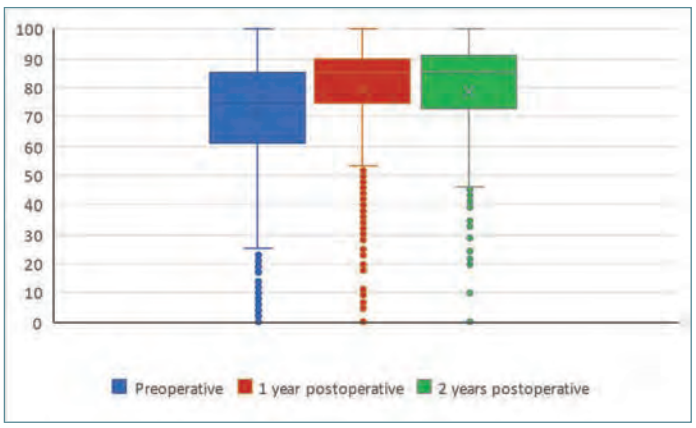

Figure 30: Preoperative, 1 year and 2 years postoperative EQ5D-VAS scores ACLR procedures.

5.17 The International Knee Documentation Committee Subjective score (IKDC)

The IKDC subjective knee questionnaire consists of 18 questions and evaluates symptoms, function, and sports activity. The raw scores are summated and transformed to a scale from 0 to 100. Figure 31 shows improvement in postoperative IKDC subjective scores at 2 years postoperatively.

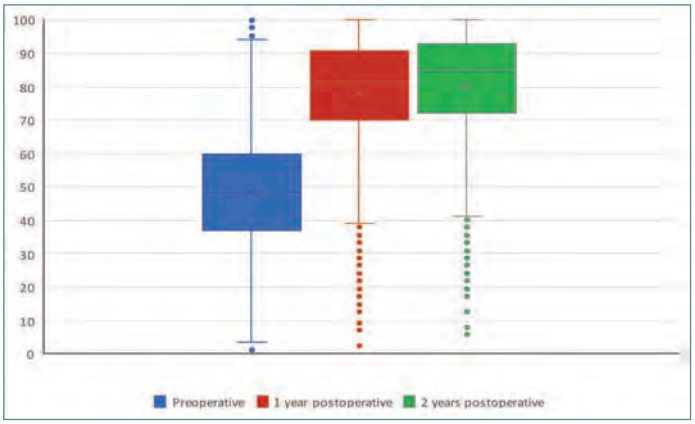

Figure 31: Preoperative, 1 year and 2 year postoperative IKDC subjective scores for ACLR procedures.

5.18 Tegner score

The Tegner activity scale was designed as a score of activity level for patients with ligamentous injuries. The instrument scores a person's activity level between 0 and 10 where 0 is defined as 'on sick leave/disability' and 10 is defined as 'participation in competitive sports'.

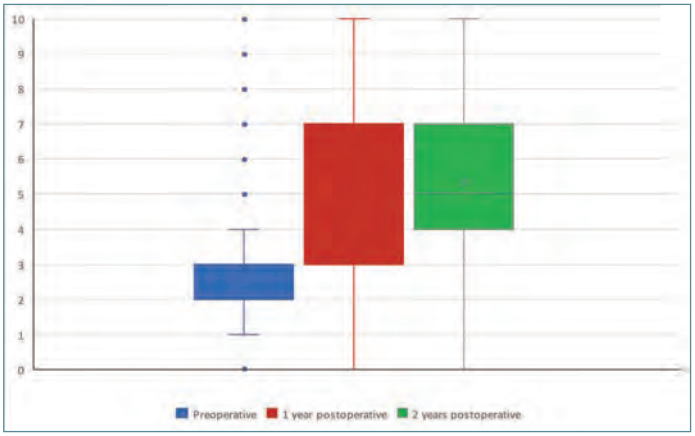

Figure 32: Preoperative, 1 year and 2 year postoperative Tegner scores for ACLR procedures

5.19 Knee Injury and Osteoarthritis Outcome Score (KOOS)

The KOOS is a knee-specific patient-reported instrument. It is used to evaluate five domains: pain, symptoms, activity of daily living, sport and recreation, as well as the knee-related quality of life in patients with knee injuries who are at risk

of OA developing (ACL, meniscus, or chondral) injury. It consists of 42-item self- administered self-explanatory questionnaire. It is intended to monitor the short- and long-term consequences (i.e., OA) of these injuries. Figure 33 demonstrates the improvement in the average KOOS scores at 6 months, 1 year and 2 years postoperatively across the 5 subscales. The quality of life subscale showed the highest increase in scores postoperative and was the most sensitive to change in the patient general health.

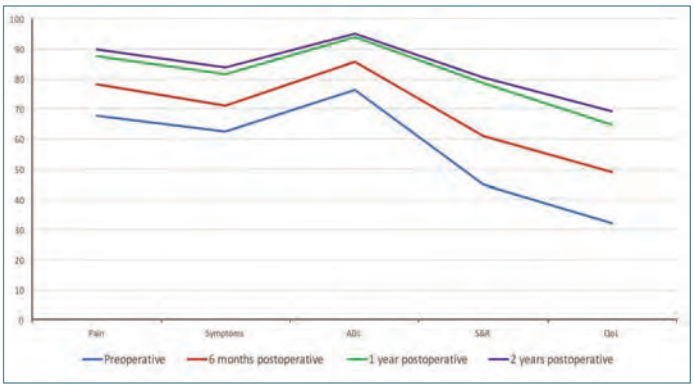

Figure 33: Preoperative, 6 months, 1 year and 2 year postoperative KOOS scores for ACLR procedures

5.20 Compliance with the personal data and compliance with PROMS

The NLR is web-based register that relies on data entered by patients and surgeons. Figure 34 demonstrates the compliance rate for filling in the basic information entered for each patient. The email address is fundamental in registering patients on the NLR as it the main contact tool with the patient. Email address was recorded for 77% of patients in 2013; that has significantly increased to approximately 100% in 2018. It is reassuring to see a gradual increase in compliance with basic patient information over the last 6 years.

Figure 35-38 shows compliance with filling in the different preoperative and postoperative PROMS questionnaires for patients who have been added between 2013 and 2018. We included all the completed PROMs for the patients on the registry who had a completed procedure form. The charts below show patients' compliance according to the year they had their operations in. The average response rate to preoperative KOOS scores was 58%. However, this drops down to approximately 37% at one year postoperatively and further down to approximately 32% at 2 years postoperatively. Interestingly, compliance rates are not the same across the various PROMs for the same time points. This indicates that patients sometimes complete some PROMs but not all four sets of PROMs.

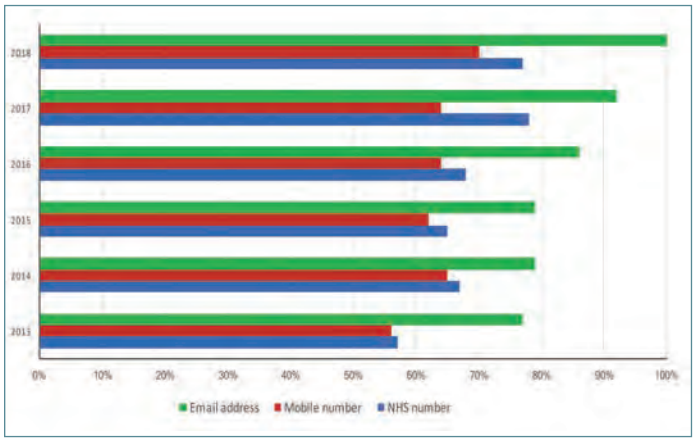

Figure 34: Compliance with basic patients information between 2013 and 2018.

It is important to appreciate that the aforementioned compliance rates are for all the patients on the NLR who had ACLR procedures. These include patients who had their dataset imported to the registry, and patients who had completed paper forms of PROMs uploaded on the system. To analyse this further, we looked at patient compliance with online collection of data. This was for patients who had a valid email address on the system for communication. We measured compliance for KOOS score only. The results showed a significant increase in compliance by using the online system only (Figure 39). The average response rate preoperatively was 76% then 46% and 38% at one-and two years postoperatively, respectively.

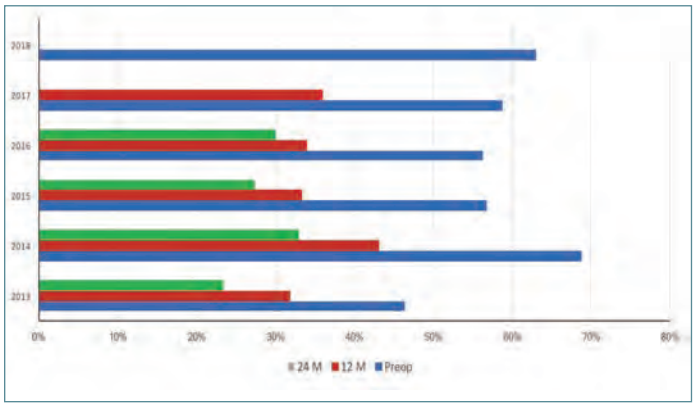

Figure 35: Response rate for preoperative and postoperative EQ5D VAS/Index scores between 2013 and 2018.

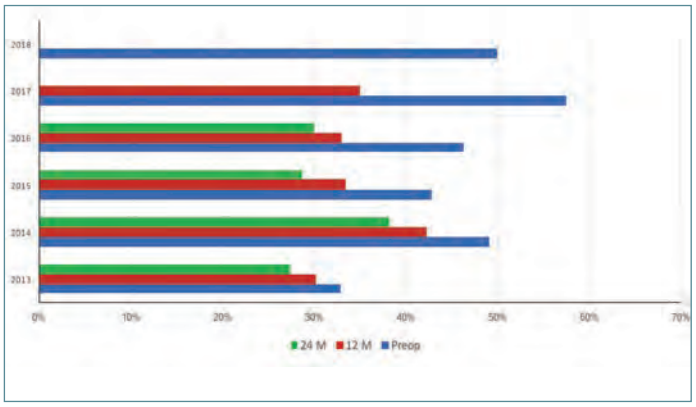

Figure 36: Response rate for preoperative and postoperative Tegner scores between 2013 and 2018.

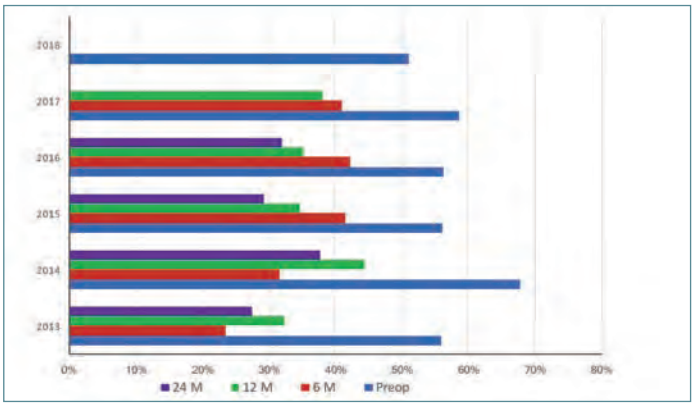

Figure 38: Response rate for preoperative and postoperative KOOS scores for all patients on NLR between 2013 and 2018.

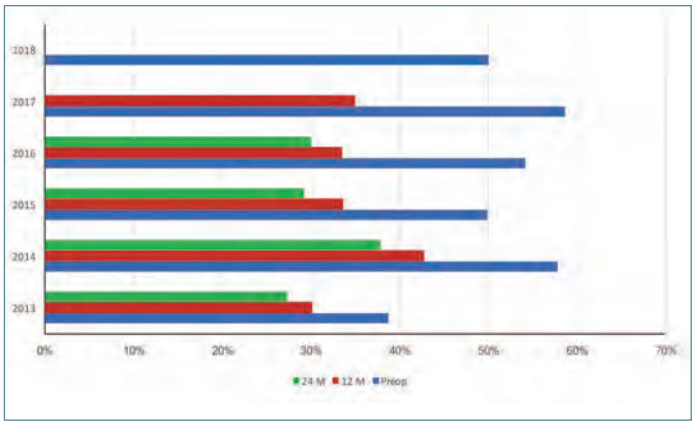

Figure 37: Response rate for preoperative and postoperative IKDC scores between 2013 and 2018.

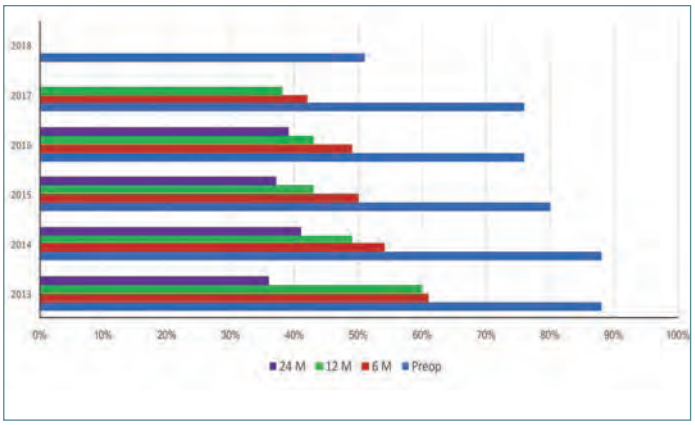

Figure 39: Compliance rate for online collection of KOOS score through email communication only between 2013 and 2018.

5.21 Complications

We are aware that not all complications have been recorded on the NLR online database (table 5). Graft failure was the most commonly recorded complication (24 cases). The second most common complication was wound infection (15 cases). All cases of wound infection required further surgical debridement, wound wash out and IV antibiotics except for two cases of superficial wound infections that were treated with oral antibiotics alone. One case had a broken guide wire in the knee joint intraoperatively that required further surgery for arthroscopic removal of the broken wire.

Table 5: Recorded complications following ACLR surgery

Complications	Number of cases	Time after ACLR
Superficial infection (Total=4)	2	< 6 weeks
	2	> 6 weeks
Deep infection (Total=10)	7	< 6 weeks
	4	> 6 weeks
Graft failure (Total=18)	2	3-6 months
	4	6-12 months
	18	>12 months
Broken guide wire	1	< 6 weeks
Arthrofibrosis	2	> 6 weeks
Wound dehiscence and serous leak	1	< 6 weeks
Peripheral neuropraxia	1	< 6 weeks
Ongoing knee pain	3	> 6 weeks
Cyclops	4	> 6 weeks
Post-menisectomy syndrome	1	> 6 weeks
Pulmonary embolism	1	< 6 weeks

6 Summary

Over the last 6 years, The NLR has provided invaluable information on the epidemiology, operative techniques and functional outcomes for patients with ACL injuries. Many observations can be drawn from the data provided in this report. We had a total of 9794 ACLR patients between December 2012 and December 2018. Men in their 20s were the predominant group of patients who underwent ACLR surgery. Sports injuries and specifically football injuries were the most common cause for ACL injury. Medial meniscus surgery was the most common associated procedure with ACLR surgery. Allograft was used in only 1% of patients who had ACLR procedures in the NLR. Four-strand hamstring tendon was the most frequently used autograft. AM portal drilling was the most common technique for femoral tunnel drilling while it was the outside-in technique for the tibial tunnel drilling. The Endobutton suspensory mechanism was the most common method for graft fixation in the femoral tunnel while interference screws predominated for tibial tunnel fixation. Patients who underwent ACLR surgery showed steady progress of their functional outcome score at six months, 1 year and 2 years postoperatively compared to their preoperative scores.

7 Future plans

7.1 Increase data capture

Increase number of registered consultants - The aim of this registry is to develop a safe and user-friendly system to record the extent and outcomes of knee ligament surgery in the UK. We remain a surgeon led Registry and endeavour to maintain this position in the future. This remains a 'development' area and we are aware that there are several reasons for surgeons not utilising the NLR. Smart phone and tablet apps can be developed to improve data collection by the clinical team. This enhances not only the ease of data input but creates a more systematic approach and could allow information to be inputted at the time of surgery or clinical review, reducing error and increasing registry compliance. There are ongoing discussions towards mandating the use of the registry in both NHS and private sectors. We are at an advanced stage of discussions with HQIP about accrediting the NLR as a 'National clinical audit' which will have significant benefits with regard to consent and data issues.

Improve data capture - The population undergoing ACL reconstructions are typically young, geographically mobile and busy. This makes them difficult to trace and track which is why two of the key elements of information are the NHS number and an email address. This is the electronic age and email and text communication is the norm and must be acknowledged. It will take some effort and vigilance to enter patients but with automated follow up the process is simple and appealing. It is very reassuring to observe a surge in the number of patients entering a valid email address in 2018 compared to when we started in 2013. Moreover, there has been a significant increase in the percentage of patients consenting to add their details to the NLR over the last 2 years. It has taken a great deal of effort to achieve such an important target and we are glad to see that we are moving in the right direction with consenting patients. The data presented in this report is for all patients that have consented to allow us to store their details legally and usefully on the registry.

Demographic data - Further analysis of the patients' profile including ethnicity and social area deprivation will be conducted. The UK has the advantage of multi-ethnicity among its population, which will enable us to have a better understanding for the epidemiology and outcome of ACL injuries. As an example, there is very little known about ACL injuries in the peripartum period. It would be interesting to collect data on the incidence and functional outcome for subject who had ACL injuries during peripartum period.

Increase information gathered/Include revision ACL surgery - To date, we have concentrated on a single procedure, primary ACLR, and we are confident that the results will benefit future surgeons and patients alike. When established it will ease the journey to develop similar pathways for the revision of ACL procedures and other ligament reconstructions.

Intra-operative data - The current operative form on NLR website doesn't have a differentiation between single and double bundle ACLR. The form also identifies collateral ligament surgery without identification whether medial or lateral. These two important surgical details need to be added to the operative form.

PROMs - Patients' compliance with completing PROMs is still a major challenge for the registry. The figures from this report show marginal improvement over the last 3 years but we still have less than 40% overall compliance with one- and two years postoperative scores. Online collection of PROMs seems to result in better compliance rates. However, this necessitates entering a valid email address for patients in order for them to respond to PROMs requests. Surgeons need to ensure patients have a valid email address when first adding them to the system. Encouragingly there has been a gradual increase in compliance with entering patients email address and hopefully this will improve compliance in the coming years. The inconsistency in the compliance among the different PROMs suggest that patients might find it time consuming to fill in all 4 scores. One option would be to consider collecting either the KOOS or IKDC score to minimise the time required to complete the questionnaires and subsequently improve compliance. Both scores cover relatively similar domains and various research studies have argued the feasibility of using one over the other. Apps could also be developed for patient data collection – allowing subjects to collect their own data at home (e.g. video capture and sensor data). While these are likely to be more subjective they would provide invaluable insight to the patient experience opening up a whole new avenue of research work.

Post-operative data - We are working to involve our physical therapists in this work to a greater degree and are planning, in connection with the replacement of IT platforms, to improve our website when it comes to follow-ups after surgery and rehabilitation. Granting access to physiotherapists to input data online during rehabilitation will enrich our register with objective assessments for ACLR patients during the rehabilitation period. Objective measures such as Lachman test and KT-1000 could be recorded online by the physiotherapists on follow up assessment.

7.2 Improved data analysis

Data analysis is the end point against which the NLR will be judged. Currently the data is analysed using simple correlations and basic statistical analysis. The world of data analysis is changing rapidly – especially with new fully validated machine learning tools – the NLR must look to these methods to truly uncover the impact of the data being collected. In conjunction with the computer science department at UCL, it is recommended to develop machine learning tools (e.g. Supervised learning, Unsupervised learning, Dimensionality Reduction, Evolutionary Optimisation) to uncover patterns in the data and build predictive surgical models – which may even be used in the future to guide people on the ideal operation based on patient demographics and injury details. This opens up a whole new field of research possibilities and uses for the NLR. It will also shed the light on new evidence that may have been missed by traditional analytical methods.

7.3 Improve Consultant Gains

Clinicians now have a framework to collect outcome data regarding their own ACLR practice, benchmarking it against practice across the NHS. The data can also be a valuable contribution towards each surgeon's annual appraisal and revalidation.

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