ICRS
International Cartilage Regeneration & Joint Preservation Society

ICRS PATIENT REGISTRY

Annual Report 2023

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Letter from Chair

Dear Registry Friends and Stakeholders,

We are pleased to share the 2023 Patient Registry Annual Data Report. This year's report is similar to prior reports as it continues demonstrating improved outcomes for people with cartilage injuries on a population level and the number of annual new users remains consistent. What differs this year, is that towards the end of the report we are sharing the first steps in our evolution to co-develop our joint preservation registry with stakeholders and opportunities for you to get involved. We know that what doesn't get measured, doesn't get managed and the 2023-2025 steering committee is committed to increasing awareness, use and quality via improved partnerships with all - clinicians/health care providers/health technology assessors/patients/regulators/sponsors/surgeons/etc. We want future reports to provide you and our many stakeholders with actionable insights to help and support decision-making on management strategy.

We have been including patient reported outcome measures since the inception of the Registry, yet solely improving outcomes doesn't guarantee patient access. The time to act and integrate patient and public involvement is now. Health technology assessors (HTAs) and regulators are increasingly using patient experience data when making decisions on what interventions are made available to patients; we have only just begun partnering with patients and providers to provide richer data insights into the patient experience across the full spectrum of cartilage injury and joint preservation. This is a call to action, rather than a letter. Don't miss out, and be certain your data/perspective is included in the Registry. Participate in current collaborative opportunities and/or reach out to present your bespoke collaboration/partnership program proposal to help us ensure access to the most optimal interventions, personalised for each patient.

This is a transformative period aimed at eliciting actionable insights for healthcare decision-making that is not possible without your continued involvement and support in increasing awareness and use of the Registry, so together we can demonstrate impact. We look forward to your partnership as we move forward increasing/improving engagement with all stakeholders. We extend sincere gratitude to each of you who contribute to the Registry's success, most notably the individuals with cartilage injuries who graciously agree to input and share their data as well as their health care team. We are incredibly grateful to the ICRS Executive Board, staff, professional members, patients and sponsors who join us in our efforts to advance joint preservation and cartilage health for all. Importantly, we also very much appreciate the dedicated, diligent efforts of our Registry Manager, Gwenllian Tawy, throughout the year and especially for her hard work getting our annual report content created, formatted and published almost entirely alone!

On behalf of the Steering Committee, thank you all for your collaboration and your commitment to the ICRS joint preservation community!

Angie Botto-van Bemden,
Patient Ambassador

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ICRS Patient Registry Information

The ICRS Patient Registry is the first global multilanguage database for the clinical outcomes of cartilage repair and joint preservation treatments. We aim to be the primary source of information for our patients, and ourselves as scientists and clinicians working to help those living with pain and disability associated with articular cartilage lesions. We are passionate about inclusivity for our clinicians and patients, and currently offer the Registry in thirteen languages. With expansion and wider use, additional languages may be added to the Registry.

The Registry was established in 2016 at the ICRS Meeting in Sorrento. It is guided by a Steering Committee comprised of orthopaedic surgeons, clinician scientists, and research scientists.

The Registry can monitor the progress of patients who have been diagnosed with pathologies of the articular cartilage, subchondral bone, or other soft tissues within the knee. It can allow a study of the natural history of such lesions, whether the cartilage damage itself is treated surgically or conservatively (non-surgically). The response of patients to injury and to joint preservation or cartilage repair treatments can be variable. It is thus vital that patient progress is monitored, particularly as treatments at the forefront of medical advances may be expensive.

Clinicians may monitor their own patients' progress through the Registry, as all users have direct access to their own data and can export their data at any time. To monitor the progress of all patients in the Registry, the ICRS pool together large numbers of anonymized patient results and analyse these. This gives us the most accurate picture of which techniques are working best for which patients. Ultimately, this will help future patients with similar injuries, and rapidly identify treatments that are showing great benefit, or those that may not be performing as well as hoped. Including the EQ-5D score in the Registry will also enable cost effectiveness and health economic analysis of the data. Irrespective of the health care location in which you practice, recording this data is increasingly required for continued service provision. We therefore encourage you to start taking advantage of this free resource today.

Registry Mission

The ICRS Patient Registry mission is to create a global source of unbiased outcomes data for treatments of articular cartilage lesions. This is paramount for the improvement of existing and discovery of new cartilage repair strategies, which have the potential to be beneficial for millions of patients worldwide.

Annual Report Disclaimer

Please note that the data presented in this Annual Report have been manually input by clinicians and patients. As such, all data rely on patient and clinician motivation and reliability. These confounders and biases should be considered when interpreting the data presented in this Report.

1. ICRS Patient Registry

1.1 Registry Updates

There have been some changes to the Registry since the publication of the last Annual Report in 2022. Over the last year we have dedicated more of our time to optimising the patient portal. Not only have we added two new languages to the portal (Arabic and Lithuanian), but we have hosted two focus groups with patient users of the ICRS Registry to learn more about how the portal can be improved for patients. Further information about these events are published in this Annual Report.

We have also been focusing on clinician engagement with the ICRS Registry. In February 2023 we ran a successful online workshop on the Registry to help clinicians learn how best to access, use, and export data from the Registry. Over the last 12 months, we have also responded to feedback from clinicians on the clinician portal. We have thus added and amended some buttons to improve the efficiency and accuracy of data entry, updated outdated terminology, and added new questions on the subchondral bone.

Importantly, we are now prioritising answering important research questions from the data in our growing Registry. This year, we wrote our first three manuscripts for publication in a peer-reviewed journal. Links to these articles will be shared with our membership as soon as they are made available online. Publications are important, as they will increase the impact of our Registry and contribute to our understanding of how musculoskeletal injuries impact patients, and help us understand how successful cartilage repair and joint preservation treatments are.

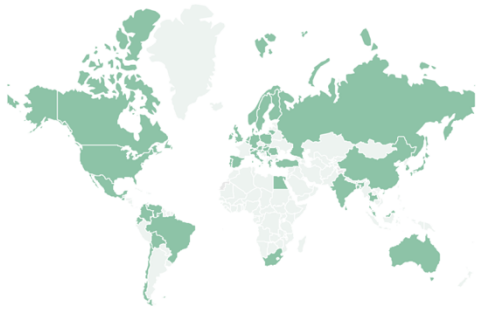

Figure 1: Map of ICRS Registry users.

1.2 Language Translations

The Registry is now live in Arabic, Chinese, Dutch, English, German, Greek, Italian, Japanese, Lithuanian, Polish, Portuguese, Spanish, and Swedish.

Please contact us if you feel any additional languages would benefit you and your patients.

1.3 Registry Profile

1.3.1 User Locations

The Registry is comprised of clinician users and delegate users from 50 countries across the globe. The map illustrates the international reach of the Registry. Darkly coloured countries denote institutions or hospitals that are known to be using the Registry in that country (Figure 1).

The Registry is in use across the world. The largest data entry in the Registry from our clinicial members is from the United Kingdom (Figure 2). Our other main contributing clinicians are from India, Brazil, Japan, Poland, and the United States. Engagement from other countries is increasing, and interest from new institutes and hospitals is growing, as evidenced by the presence of clinicians from new countries at our online Workshop in February 2023. We hope to further our engagement with clinicians at new sites and in new countries in the coming year.

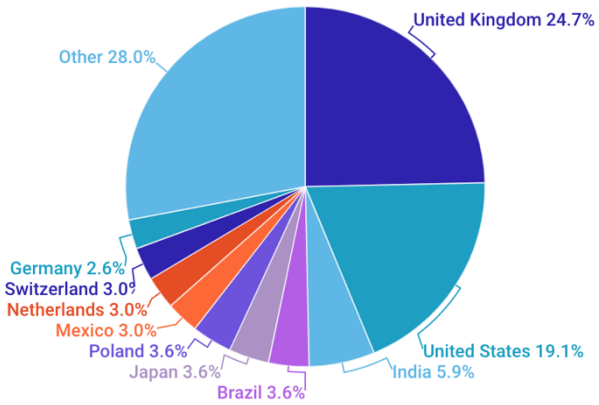

Figure 2: Graphical illustration of percentage contribution per country to the ICRS Patient Registry between 2017 and the end of 2022.

1.3.2 Pathway Volume

At the end of 2022 a total of 2,398 patient care pathways for 2,192 patients had been created in the ICRS Patient Registry: an increase of 29.5% pathways since 2021.

The reason there are more pathways than patients is because some patients have undergone multiple treatment pathways (Figure 3). In 4 cases, patients were not allocated a pathway. Data from patients who are not allocated to a pathway are not included in the Registry. Thus, the total number of patients included in this review is 2,188. It is important that users of the Registry check their data entries and remove those rare patients who change plans for whatever reason and do not set out on their planned treatment pathway.

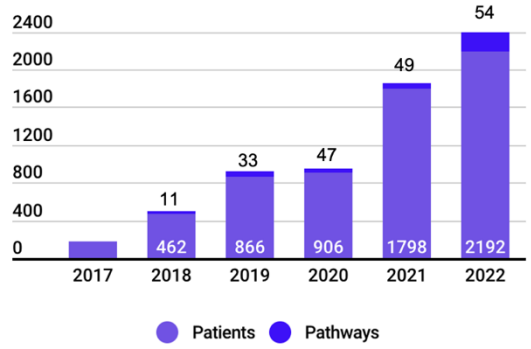

Figure 3: The annual growth of patients and pathways in the ICRS Patient Registry between 2017 and the end of 2022.

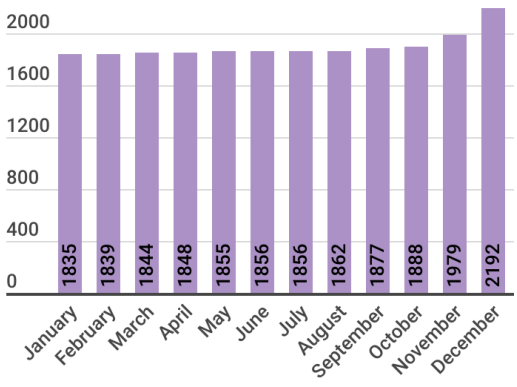

Figure 4: The monthly growth of the patients and pathways in the ICRS Patient Registry in 2022.

2. Registry Patients

2.1 Patient Demographics

The Registry captures data on sex, age, body mass index (BMI), affected limb and smoking status of enrolled patients.

A summary of the demographics is shown here, with further detail provided in the subsections.

- 54% of all pathways were male.
- Males were taller and heavier than females, as anticipated.
- The average age at intervention was 42±18 years old.
- Patients treated with an injection were almost twice as old as patients who were treated surgically (64.2±14.2 years compared to 33.8±12.4 years).
- Analyses of age categories showed females were older than males at time of treatment.

2.1.1 Sex

Sex was reported in 99.9% of patient pathways. 53.9% of patients were Male, 45.9% were Female, 0.1% (n = 3) had their sex listed as 'unknown' and 0.04% (n = 1) were listed as Intersex.

2.1.2 Age

The age range on the day of intervention ranged from 10 years old to 97. On average, patients were 42±18 years old (median age of 39 years). Data on age was available for 99.7% of patient pathways.

Patients treated with an injection were older than patients surgically treated, as depicted in Figure 5.

The distribution of age is represented as a burst with larger age frequencies covering a larger surface area. The average age of patients who had an injection was 64.2±14.2 years, whereas the average patient undergoing primary surgery was half the age at 33.5±12.3 years. Patients undergoing a revision surgery were slightly older at 37.4±12.1 years old.

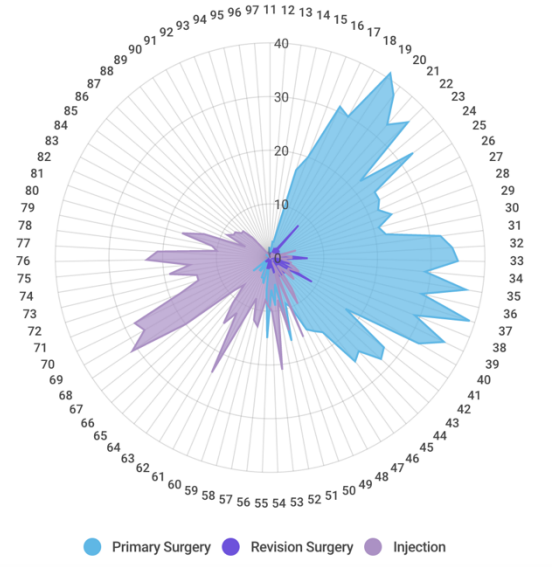

Figure 5: Radar chart of the ages at which patients received an injection or underwent primary or revision surgery. The age is depicted on the circumference of the chart, whilst the frequency is depicted within the chart.

When the data for males and females were analysed individually it was found that females were on average 7 years older than males at the time of intervention (Table 1).

Table 1: Independent ages of different sexes at the date of intervention.

Sex	Number of Patients	Mean±SD* Age at Intervention (years)	Range (years)
Male	1175	38±15	10-97
Female	1003	45±19	11-94
Intersex	1	51	-
Unknown	2	75±8	70-81

SD – Standard Deviation

When the data for males and females were further subdivided by age at intervention, it was found that the number of procedures in males consistently decreased from the age of 40 (Figure 6). Interventions in females were shown to be reduce after 40 too, but then increase once more until the age of 70. It is therefore plausible to infer from this data that males generally undergo intervention for cartilage regeneration or joint preservation between early adulthood and middle-age, whereas females tend to start and end treatments later in life.

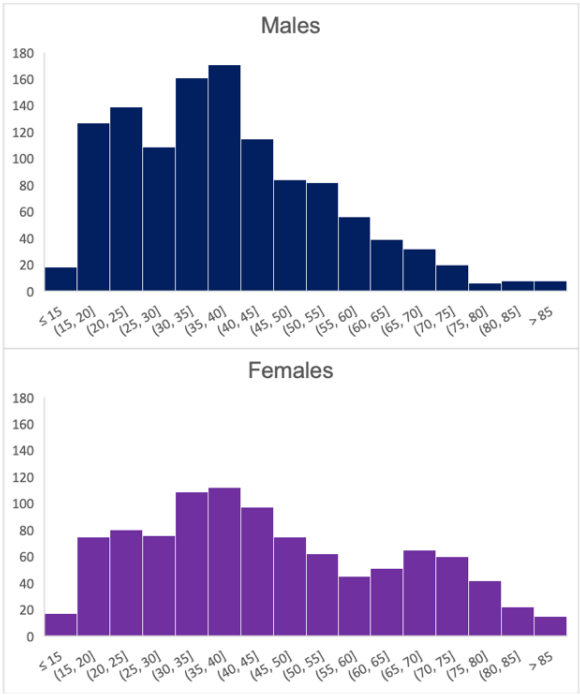

Figure 6: Histograms showing the distribution of Male (above) and Female (below) ages at intervention.

2.1.3 BMI

Users of the Registry and patients may input mass in kilograms, stones, or pounds. Thus, to calculate average mass, all entries were converted to kilograms. Males were on average heavier than females (Table 2). Data were available for 1,016 (46.4%) patients.

Table 2: Independent masses of different sexes at the date of intervention.

Sex	Number of Patients	Mean±SD Mass at Intervention (kg)
Male	610	87.1±16.7
Female	417	67.0±14.9

Like mass, height can be input into the Registry in centimetres or feet and inches. Thus, all entries were converted to centimetres to calculate the average height. Males were on average taller than females (Table 3). Data was available for 1,021 (46.7%) patients.

Table 3: Independent heights of different sexes at the date of intervention.

Sex	Number of Patients	Mean±SD Height at Intervention (cm)
Male	606	180.6±9.2
Female	415	166.9±9.0

The available data on patients' masses and heights were used to calculate the average BMI. The mass and height of an individual were reported for 1,006 (46.0%) patients. The average. The BMI was lower in females than in males (Table 4).

Table 4: Independent body mass indices of different sexes at the date of intervention.

Sex	Number of Patients	Mean±SD BMI at Intervention (kg/m^2)
Male	596	26.7±4.8
Female	410	25.3±6.8

2.1.4 Affected Limb

The limb affected was reported in 1,073 (49.0%) patients in the pre-treatment form. In the remaining pathways, the injured side was not identified. Of the patients whose data was available at this stage, 553 (51.5%) had a procedure on their right knee, and the remaining 520 (48.5%) had a procedure on the left knee.

2.1.5 Smoking Status

Data on smoking status was available for 348 (15.9%) patients. Most patients were non-smokers, and smokers were more likely to be male (Table 5).

Table 5: Smoking status of patients in the ICRS Registry.

Sex	Number of Patients	Smoker (%)	Ex-smoker (%)	Non-smoker (%)
All	348	34 (9.8)	42 (12.1)	272 (78.2)
Male	180	21 (11.7)	22 (12.2)	137 (76.1)
Female	168	13 (7.7)	20 (11.9)	135 (80.3)

3. Patient History

3.1 Baseline Patient Data

When enrolling with the Registry, patients, clinicians, and their delegates are asked to complete a questionnaire on the patients' condition at baseline. This questionnaire has been partly or fully completed for 1,223 (55.9%) patients. This seemingly low completion rate is likely because some pathways have been added to the Registry retrospectively. The data required for this questionnaire may therefore not have been available to the clinician or delegate when entering the data into the Registry. As we proceed with prospective data collection, this effect will decrease over time.

Of the data available, 79.9% of entries were made by patients (Figure 7).

As this questionnaire forms part of the enrolment process, we would recommend that all users encourage their patients to enrol themselves in the Registry. This reduces the workload on the clinician or delegate and is therefore the most efficient way to collect this data. We are all very busy in our working lives, and the Registry was purposely designed to minimise the addition of work for clinicians.

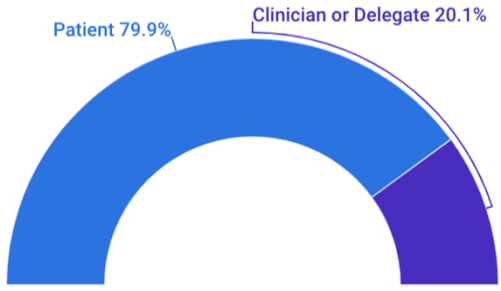

Figure 7: Percentage of patients and clinicians or delegates who have completed the baseline patient data questionnaire.

The completion rate for the questionnaire was high for both patients and clinicians (Table 6).

Table 6: Completion rate of baseline patient questionnaire.

User	Number of Individuals	Complete (%)	Incomplete (%)
All	1223	1203 (98.4)	20 (1.6)
Patients	781	764 (97.8)	17 (2.2)
Clinicians	440	439 (99.8)	1 (0.2)

3.1.1 Previous History of Injections and/or Surgery

As part of the baseline assessments, users are asked a series of mandatory and optional questions.

One of the questions asks whether the patient has undergone previous injections to their knee. An answer was provided for 367 (16.8%) pathways. Over half of these patients (n = 208; 56.7%) had not previously had an injection in the knee (Figure 8). All others reported previous injections to the knee (43.3%).

When asked whether previous surgery had been carried out on the knee, an answer was provided for 794 (36.2%) patient pathways. Thus, a third of patients in the Registry had undergone previous knee surgery before their involvement in the Registry.

Of the patients who had previously had surgery, 53 (6.7%) previously had also had an injection to their knee.

Table 7 outlines the relationship between previous histories of injections and surgery, where the data is available in the Registry. The results suggest that a previous history of injections was more common in patients who had not had previous surgery, converse to our previous annual report. The type of injection reported in patients who had no previous history of surgery were mostly unknown. Because of the unknown injections, the percentages presented in Table 7 may not be an accurate representation of the way in which injections are prescribed to patients with varying degrees of cartilage defects.

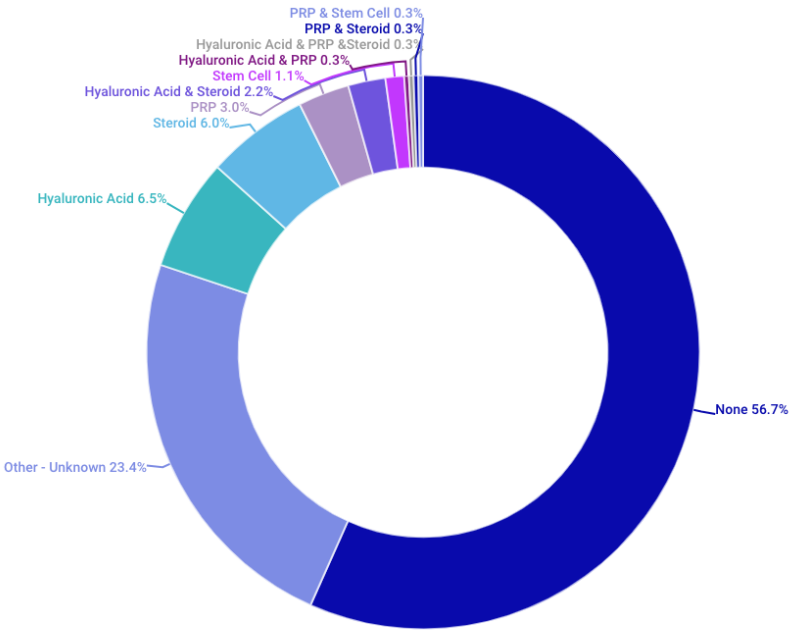

Figure 8: Types of injections reported by patients prior to their involvement in the Registry.

Table 7: Numbers and percentages of patients who have reported previous injections and/or surgery in their knee.

Type of Injection	History of injections and surgery (%)	History of injections but no surgery (%)
Hyaluronic Acid	19 (35.8)	5 (4.3)
Steroid	16 (30.2)	7 (6.1)
Hyaluronic Acid & Steroid	7 (12.2)	3 (2.6)
PRP	4 (7.5)	8 (7.0)
Cultured Stem Cell	3 (5.7)	3 (2.6)
Hyaluronic Acid & PRP	1 (1.9)	0 (0.0)
Hyaluronic Acid & PRP & Steroid	1 (1.9)	0 (0.0)
PRP & Steroid	1 (1.9)	1 (0.9)
PRP & Stem Cell	1 (1.9)	1 (0.9)
Other – Unknown	0 (0.0)	86 (75.4)
Total (number)	53 (100.0)	114 (100.0)

Of the 794 patients with data on their history of knee surgery, the total number of procedures each patient had undergone was known for 150 (18.9%) patients. Over half of these patients (56.0%) had undergone more than one surgical procedure (Figure 9). However, it was most common for patients to have undergone one or two procedures previously.

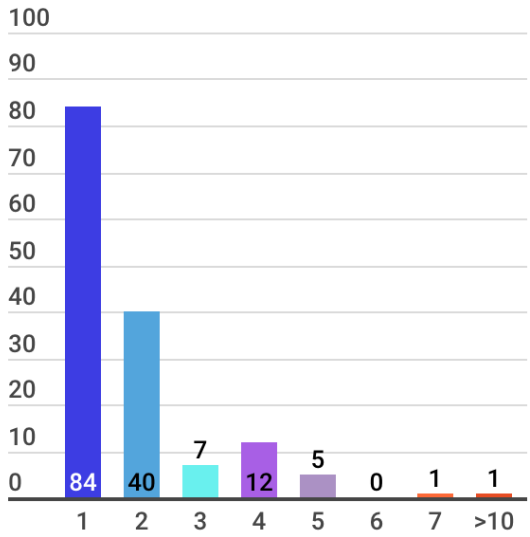

Figure 9: Known number of previous surgeries per patient when enrolled with the ICRS Patient Registry.

Patients reported having previously undergone various procedures in numerous combinations (Table A, Appendix A). The most commonly reported previous surgery was a debridement of the cartilage injury (36.3%), while subchondral marrow stimulation with a debridement was the second most common procedure (14.8%). 12.4% of patients had not previously had a cartilage procedure on their knee. All other combinations of cartilage treatment were less common (<10%).

Over one-quarter of all patients in the Registry are also known to have undergone other knee surgery that was not specific to the knee's cartilage prior to their enrolment in the Registry (26.5%). The most common non-cartilage procedure was meniscal surgery, while the second-most common procedure was loose body removal (Table B, Appendix A). All other treatments and combination of treatments were uncommon (<10%).

The sheer variety of previous treatments patients have had for their knee evidences the importance of tailoring treatments to patients' needs.

Users of the Registry can add more detail on previous surgery their patients have had on the knee before their enrolment in the Registry. The following information summarises the data currently available on the previous surgeries.
While the data in Table B, Appendix A shows that 265 patients are known to have undergone a surgery on their meniscus

prior to their involvement (12.1%), some patients had multiple procedures on their menisci. 486 meniscal surgeries were reported prior to the patients' involvement in the Registry. Of these, 31.7% (n = 154) surgeries were on the lateral meniscus, 52.9% (n = 257) were on the medial meniscus, while the remaining 15.4% (n = 75) were on both menisci simultaneously. Table C in Appendix A outlines further details on the previous meniscal surgery. Partial meniscectomies were generally the most common meniscal procedure.

In a similar nature to meniscal surgery, the Registry data reports that 68 patients had previously undergone surgery on one of the ligaments in their knee alone or in combination with another procedure (Table B, Appendix A). Figure 10 outlines the kinds of ligamentous surgery patients had undergone before enrolling in the Registry.

Figure 10: Types of ligamentous surgery patients are known to have undergone prior to their enrolment in the ICRS Patient Registry.

Most previous ligamentous surgeries were ACL reconstructions (61.8%) alone or in combination with another procedure (Figure 10).

Additional information on previous extensor mechanism surgery was available for 9 patients, despite it being reported in 67 patients (Table B, Appendix A). The mechanisms used varied, but MPFL reconstruction was the most common (44.4%).

Ten patients had previously undergone patellofemoral surgery; all were reported to have had a soft tissue extensor mechanism realignment (Table B, Appendix A). Medial imbrication and lateral release were equally as common.

Very little additional information was available for the previous osteotomies performed on patients. Three (5.4%) patients underwent a high tibial osteotomy, one (1.8%) underwent a distal femoral osteotomy, and one (1.8%) underwent an anterior closing wedge osteotomy. The remaining 50 (90.9%) patients had no further information.

3.1.2 Associated Injuries (Concomitant Diagnoses)

When asked whether the patient suffered any associated injury at the same time as their cartilage injury, 359 (16.4%) answers were given. Three-quarters of entries had a known associated injury (Figure 11). Injury to the medial meniscus and osteochondritis dissecans were the most commonly reported associated injuries.

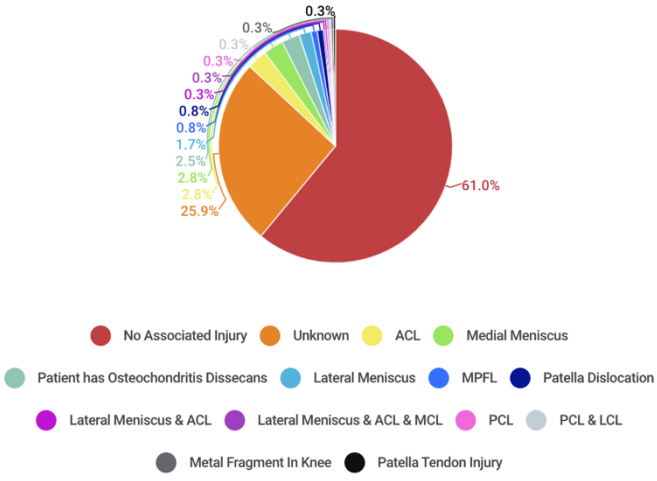

Figure 11: Available information on the associated injuries incurred at the same time as the cartilage injury.

3.1.3 Pre-Treatment Knee Alignment

Users of the Registry may also report the injured knee's alignment before treatment. This data was available for 20.1% of patients. The vast majority (91.1%) had a normal alignment (< 5º Valgus or Varus). 6.4% were reported to have excess varus alignment (>5 º Varus), and the remaining 2.5% had an excess valgus alignment (>5 º Valgus).

3.1.4 Underlying Cause of Defect (Mechanism of Injury)

The underlying cause of the cartilage defects in patients enrolled in the Registry was available for 732 (30.5%) pathways.

Table 8 outlines the leading causes of these pathways. Osteochondritis dissecans was the most reported cause, followed by a damaged chondral lesion. The lesser reported causes are shown in Appendix B.

3.1.5 Pre-Injury Status

To better understand how the patients' injuries have impacted their daily activities, patients are asked to describe their activity and functional status before their injury compared to before treatment.

Data on the level of activity was available for 590 (24.6%) pathways pre- and post-injury. Figure 12 shows how the level of activity changed over time. Most individuals were engaged in sports to some degree prior to their injury. Excluding highly competitive athletes, there was a positive trend between frequency and sporting level pre-injury. Post-injury there was a clear negative trend between frequency and sporting level, with the majority of patients claiming they were no longer participating in sports. The percentage of individuals claiming to be highly competitive athletes had also dramatically reduced from 33.1% to 3.1%.

These results highlight the impact cartilage injuries can have on an individual's activity level prior to treatment. As our data increases, it will be interesting to see how this varies by age cohort.

Table 8: The underlying causes of cartilage defects reported in the ICRS Patient Registry.

Underlying Cause	Number	Percentage (%)
Osteochondritis Dissecans (OCD)	222	30.3
Damaged Chondral Lesion (DCL)	159	21.7
Osteoarthritis	87	11.9
Traumatic Cartilage Injury (TCI)	76	10.4
Osteonecrosis / AVN	58	7.9

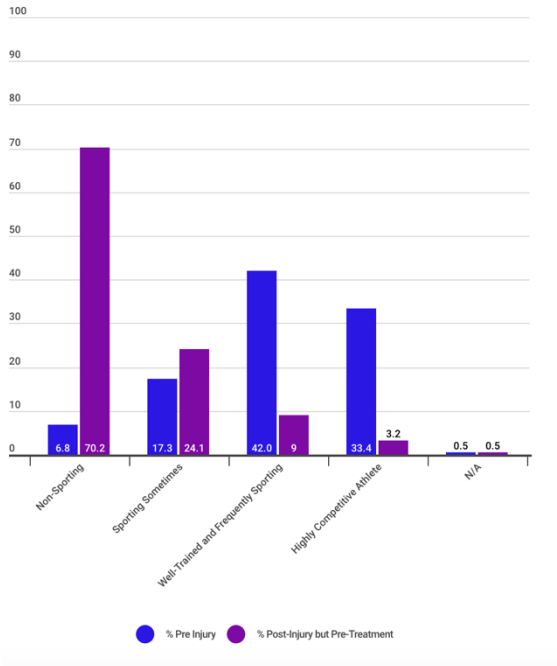

Figure 12: Level of activity of patients before injury and after injury (but prior to treatment).

A similar amount of data was available for the level of function patients felt they had in their knees. Pre-injury, there was data on 599 (25.0%) pathways; after injury there was data for 624 (26.0%) patients.

Three-quarters of patients reported no functional limitations in their knee prior to their injury (Figure 13). However, following injury, only 2.2% patients reported they could do everything they wanted with their knee. Most people could only do some things they wanted (55.1%).

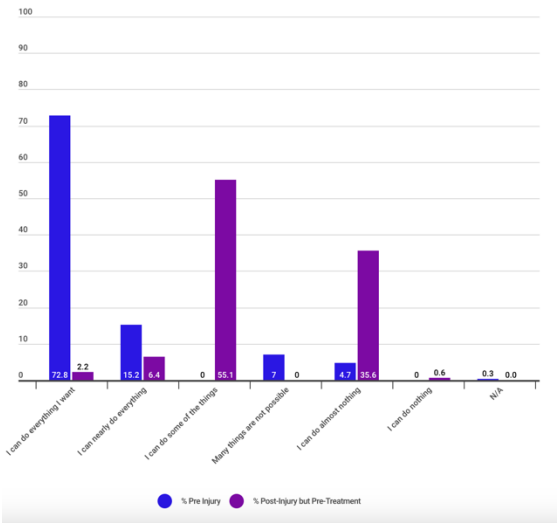

Figure 13: Patient-reported knee function before and after injury (but prior to treatment).

4. Treatments

4.1 Procedure and Treatment Data

Of all 2,398 pathways in the Registry, data on the limb treated was available for 1,846 (76.9%). The remaining 552 pathways are for treatments that have not yet been performed or completed. As such, the treatment side cannot be confirmed for these cases.

Of the treatments completed to date, 50.6% (n = 934) were on the left knee and the remaining 49.4% (n = 912) were on the right.

Data on the state of the opposite knee was available for 1,433 (77.6% of performed procedures) pathways. Most patients whose data was reported had a normal contralateral knee (Figure 14).

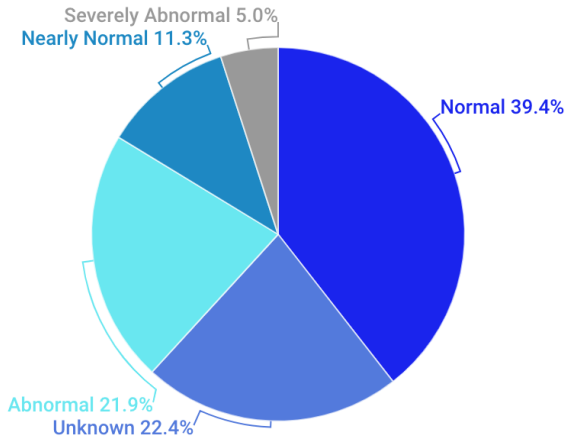

Figure 14: State of the contralateral knee.

When asked whether the procedure in question was a primary or revision, data was available for 53.7% of all pathways. Most procedures with a known classification were primary (Figure 15).

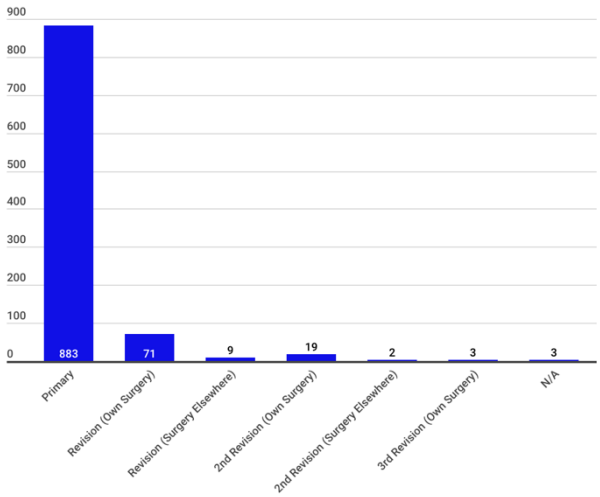

Figure 15: Type of procedure carried out on patients in Registry.

The approach used was reported in 54.4% of cases. While all injections were reported, the surgical approach was not reported for all surgical procedures (Figure 16).

Of the surgical approaches reported, open surgery was more common than arthroscopy or subchondroplasty.

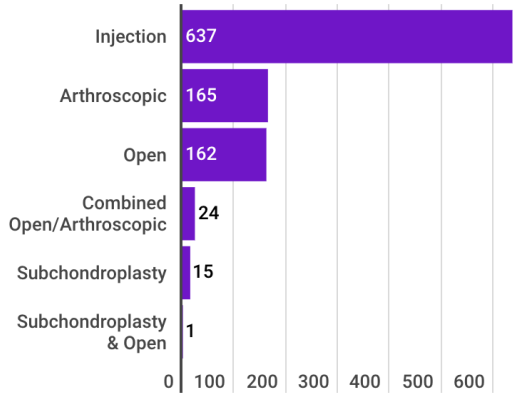

Figure 16: Data on the approaches reported in the Registry

Of the arthroscopic procedures, fifteen procedures are known to have approached the joint both medially and laterally. Six used anteromedial and standard anterolateral portals, while only one case of anteromedial as the only portal was reported. One other single case used a medial approach alone. Three additional cases used a combination of three various portals.

Patients who underwent a combined open and arthroscopic procedure generally had standard anterolateral and anteromedial portals (10/24 – 41.7%). One had an additional medial portal, while one had standard anterolateral and medial portals. A central patella tendon portal was used for one patient, while medial and lateral portals were used for two. Data on portals was not available for 9 of the patients. The open part of the procedure generally involved only one incision (45.8%). Three patients had two incisions, while one had three. The locations of the incisions varied: Lateral (4 – 16.7%), Medial Paramedial (5 – 20.8%), Medial to tibial tuberosity (1 – 4.2%), Medial and lateral (1 – 4.2%), Midline (2 – 8.3%).

Further information on incisions was available for 113 (69.7%) patients who underwent an open procedure alone. A single incision was performed in all but one procedure (99.1%). Three incisions were performed for one procedure. The location was typically in the midline – from the patella to the tibial tuberosity (65.5%). 11.5% of incisions were performed medial paramedial, while 2.6% were midline or medial curved longitudinal, and 1.8% were medial to tibial tuberosity. One incision was lateral (0.9%). The remaining incision locations were unknown.

4.1.1 State of Joint Fluid

The presence or absence of fluid in the joint during the procedure was reported for 153 patients. Approximately one third were reported to have no fluid, while the majority had clear joint effusion (Figure 17).

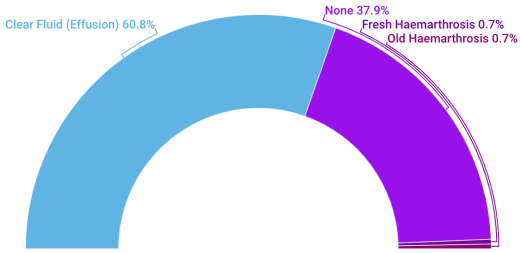

Figure 17: Reported fluid presence within the knees of patients in the Registry.

The volume of fluid present in the joint was estimated to be 10-50ml in 62 (40.5%) cases, 50-100ml in 28 (18.3%) cases, and 100-200ml in 3 (2.0%) cases.

4.1.2 State of Synovium

The state of the joint's synovium intra-operatively was also reported for 152 patients (Table 9). Roughly half of all patients had normal synovium, while half had mild proliferation. More severe proliferation was rarely reported.

Table 9: The reported state of proliferation of the synovium.

State of Synovium	Number (N)	Percentage (%)
Normal	70	46.0
Mild Proliferation	74	48.7
Moderate Proliferation	7	4.6
Severe Proliferation	1	0.7

The location of proliferation and type of synovitis was available for 80 (97.6%) of the reported cases. The proliferation was throughout the synovium in 68 (82.9%) cases, in the suprapatellar pouch in 8 (9.8%) cases, and in the medial gutter in the remaining 4 (4.9%) cases. All but two (97.6%) cases were reactionary. The two cases that were not reactionary were inflammatory.

4.1.3 State of Menisci

Further data on the state of the menisci of patients with chondral or osteochondral defects that required surgical intervention was available for 966 (40.2% of all pathways) patients. Basic data on the normality of the menisci were reported for 275 (11.5% of all pathways) patients. In most cases, the menisci were normal (n = 245, Figure 18).

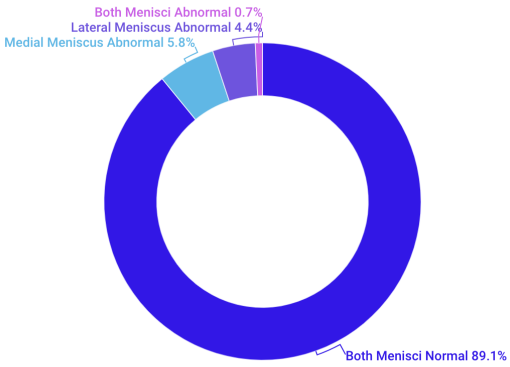

Figure 18: State of menisci in patients treated surgically for a chondral or osteochondral lesion.

This data agreed with detailed information on the menisci given elsewhere in the Registry (Table 10).

Table 10: The state of and tears reported in the menisci of patients treated surgically.

	Medial Meniscus		Lateral Meniscus	
	N	%	N	%
Intact Meniscal Horn	527	77.0	536	77.5
Anterior Horn Tear	1	0.1	0	0.0
Complex Tear	0	0.0	2	0.3
Circumferential Tear	1	0.1	0	0.0
Degenerate Horn Tear	3	0.4	2	0.3
Displaced Bucket Handle Tear	1	0.1	0	0.0
Partial Tear	120	17.5	83	12.0
Posterior Horn Tear	1	0.1	1	0.1
Radial Tear	1	0.1	1	0.1
Repair	13	0.9	16	2.3
Vertical Tear	1	0.1	1	0.1
Absent Meniscus	1	2.2	50	7.2

4.1.4 State of Ligaments

Data on the state of the ligaments in the knee was available for 838 (34.9%) patients. 154 (18.4%) were all normal, whereas the vast majority had an abnormal ACL (683, 81.5%). One patient (0.1%) was described as having abnormalities in all ligaments.

Most of the patients with abnormal ACLs had a competent ligament (Figure 19).

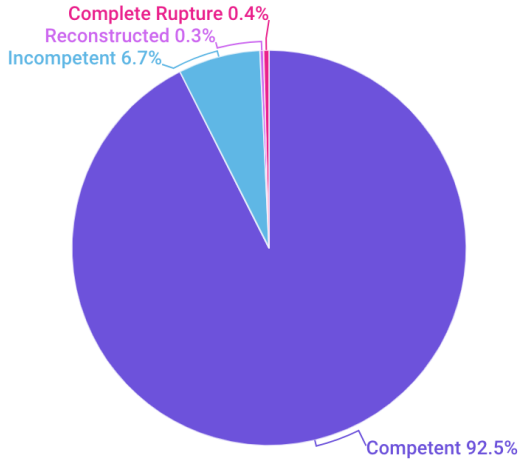

Figure 19: State of the ACL in patients with abnormal ligaments.

4.1.5 State of Cartilage

The locations of cartilage damage were reported for 667 (36.1% of all procedures) pathways, and the total size of the defect(s) per patient was available for 823 (44.6%) pathways.

The average total area of all defects in a patient across all pathways was 8.65±7.16cm^2. This figure is seemingly high as it includes patients who had multiple lesions in numerous locations. However, most pathways (66.4%) involved a single area of cartilage damage (Figure 20).

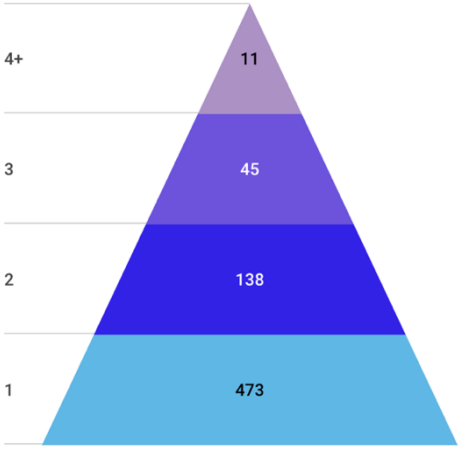

Figure 20: Number of areas reported to have cartilage damage per patient.

The patella and medial femoral condyle were the two areas most commonly affected by isolated cartilage lesions (27.9% each) (Figure 21).

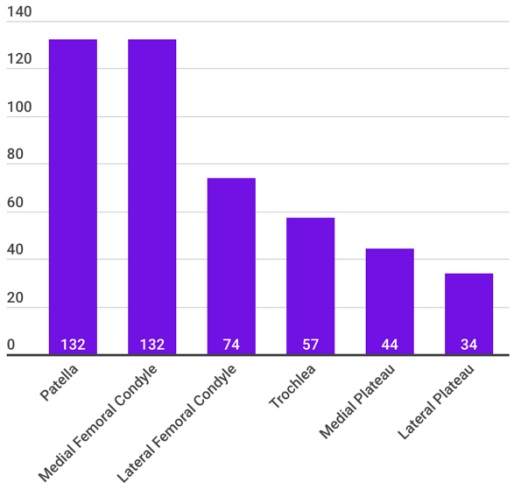

Figure 21: Number of pathways per location with isolated cartilage damage.

The total area damaged in knees with one single injured location was greatest in the trochlea, followed by the lateral femoral condyle and medial tibial plateau. The area with the smallest lesions was the patella (Figure 22).

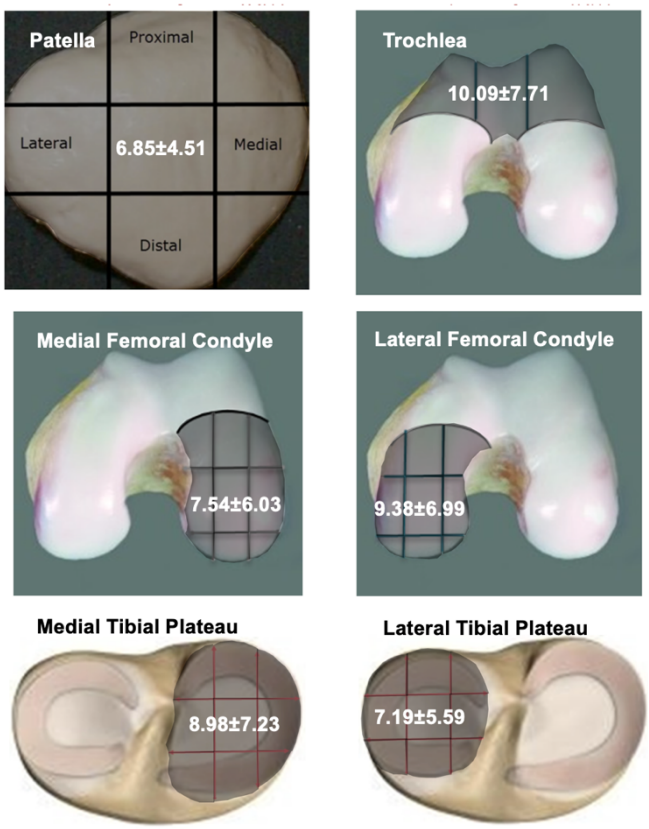

Figure 22: Mean reported area of damage in each condyle of the knee

Of the pathways with two areas of cartilage damage, trochlear damage combined with patellar damage was most common (2.2% of all surgical pathways; Figure 23).

The area of cartilage damage was reportedly greatest in the lateral tibial plateau and medial femoral condyle (Table 11).

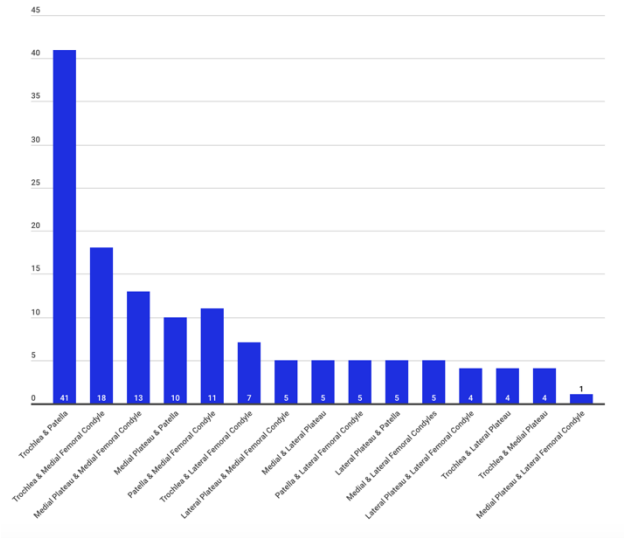

Figure 23: Number of pathways with two locations of cartilage damage.

Table 11: The average area of cartilage damage reported in pateints with two involved areas.

Locations	Average Area (mm^2)	SD (mm^2)
Lateral Plateau Medial Femoral Condyle	20.86	27.50
Medial Plateau Medial Femoral Condyle	14.02	14.86
Medial Plateau Lateral Femoral Condyle	11.88	N/A
Medial Plateau Patella	11.20	7.22
Patella Medial Femoral Condyle	10.37	5.65
Trochlea Medial Plateau	9.94	7.08
Trochlea Patella	9.73	6.53
Trochlea Medial Femoral Condyle	9.14	2.22
Trochlea Lateral Femoral Condyle	9.00	7.58
Lateral Plateau Patella	8.20	4.58
Lateral Plateau Lateral Femoral Condyle	7.83	3.40
Trochlea Lateral Plateau	7.63	2.67
Medial Plateau Lateral Plateau	7.33	5.15
Patella Lateral Femoral Condyle	6.35	4.29
Medial Femoral Condyle Lateral Femoral Condyle	No Data	No Data

Patients with three or more locations of cartilage damage were reported less frequently (Appendix B).

4.2 Patellar Defects

A patellar defect was reported in 244 (11.1% of all patients) patients, either in isolation or in combination with other defects. Further information was available for a subset of all cartilage damage reported in the patella (238/244 – 97.5%). The type of lesion was reported for 103 (48.5%). 50 (48.5%) were chondral lesions, and 53 (51.5%) were osteochondral lesions.

Most chondral and osteochondral lesions were contained and shouldered (Table 12). Osteophytes were more prevalent in osteochondral lesions. Most chondral lesions had no osteophytes (Table 12).

Chondral lesions were on average 19.1±7.7mm wide (range: 10-40mm), 15.7±5.6mm long (range: 8-30mm), and 4.5±1.8mm deep (range: 2-8mm).

Osteochondral lesions were slightly larger at 22.9±6.8mm wide (range 8-40mm), 20.1±6.1mm long (range: 7-36mm), and 4.4±2.0mm deep (range: 2-11mm).

These values are smaller than the average total size reported in Table 12, because they are calculated from a subset of all reported patellar lesions (42.2%).

The ICRS Grade of cartilage damage was more severe in the osteochondral lesions, as would be expected. Generally, the chondral lesions were described as being at least 50% greater than the cartilage depth, whereas the osteochondral lesions were described as extending through the subchondral bone plate, or worse (Figure 24).

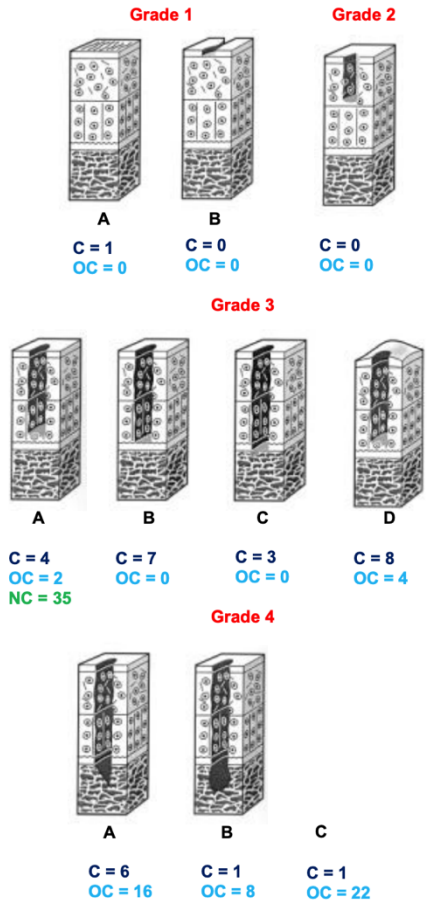

Figure 24: ICRS Grade of cartilage damage in chondral (C) and osteochondral (OC) lesions of the patella. NC – Not categorised as O or OC.

Table 12: Detailed information on the patella defects reported in the Registry.

Variable	Subtype	Chondral Lesion		Osteochondral Lesion	
		N	%	N	%
Containment	Contained	44	88.0	43	82.7
	Not Contained	6	12.0	9	17.3
Shouldered	Shouldered	46	92.0	45	86.5
	Unshouldered	4	8.0	7	13.5
Osteophytes	No Osteophytes	20	74.1	12	24.0
	Early Osteophytes	6	22.2	35	70.0
	Well Established Osteophytes	1	3.7	3	6.0

4.3 Trochlear Defects

A trochlear defect was reported in 176 patients in the Registry. Additional information was available for 161 (91.5%) of these patients. Thirty-seven of these patients had a chondral defect, while 20 had an osteochondral defect.

Chondral lesions were less likely to be contained and shouldered than osteochondral lesions of the trochlea, but most people in both groups had contained and shouldered lesions (Table 13). 70-80% of patients with trochlear lesions had no osteophytes. Well-established osteophytes were similarly common in both groups.

On average, chondral lesions of the trochlea were 16.6±6.4mm wide (range: 2-30mm), 15.1±6.8mm long (range: 3-36mm) and 2.7±1.5mm deep (range: 1-6mm). These dimensions were similar to the osteochondral lesions, which were 15.3±6.4mm wide (range: 4-25mm), 18.2±6.3mm long (range 6-30mm), and 2.8±1.6mm deep (range: 0.6-6.2mm).

These values are smaller than the average total size reported in Figure 21, because they are calculated from only 32.4% of all reported trochlear lesions. They are also based on data from all patients with a trochlear lesion and not only those whose cartilage damage is restricted to their trochlea.

As expected, the ICRS grade of cartilage damage was worse for the osteochondral lesions (Figure 25).

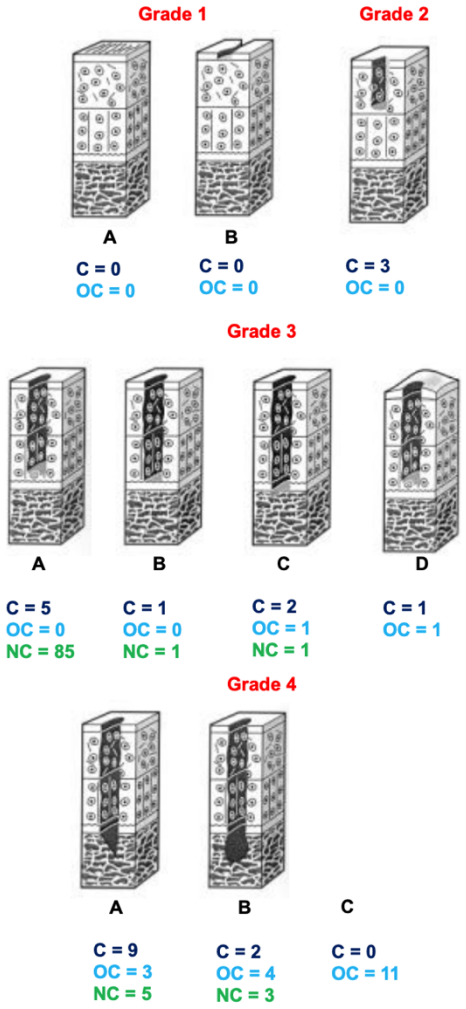

Figure 25: ICRS Grade of cartilage damage in chondral (C) and osteochondral (OC) lesions of the trochlea. NC – Not categorised as O or OC.

Table 13: Detailed information on the trochlear defects reported in the Registry.

Variable	Subtype	Chondral Lesion		Osteochondral Lesion	
		N	%	N	%
Containment	Contained	31	83.8	20	100.0
	Not Contained	6	16.2	0	0.0
Shouldered	Shouldered	34	91.9	19	95.0
	Unshouldered	3	8.1	1	5.0
Osteophytes	No Osteophytes	29	80.5	14	70.0
	Early Osteophytes	2	5.5	3	15.0
	Well Established Osteophytes	5	13.9	3	15.0

4.4 Medial Femoral Condyle Defects

A defect of the medial femoral condyle was reported in 214 patients within the Registry. Additional information was available for 154 (72.0%) of these patients. Sixty-nine were reported to have a chondral defect, whereas the 25 had an osteochondral defect. The remaining defects were uncategorised.

Unlike other areas of cartilage defect, chondral lesions were equally as likely to be contained than osteochondral lesions (Table 14). However, the frequency of shouldered defects was greater in the osteochondral group, with at least 4/5th of patients presenting with shouldered lesions. Osteophytes were also more prevalent in patients with osteochondral lesions than chondral lesions (Table 14).

Chondral lesions on the medial femoral condyle were 17.8±8.0mm wide (range: 6->40mm), 3.3±2.4mm long (range: 0.2-15mm), and 2.5±0.7mm deep (range: 2-4mm). Osteochondral lesions were 17.8±5.3mm wide (range: 8-30mm), 19.8±8.6mm long (range 8-40mm), and 4.4±3.5mm deep (range: 2-12mm).

Like other regions of cartilage damage within the knee, the ICRS grade of cartilage damage was more severe in patients with osteochondral defects to the medial femoral condyle (Figure 26).

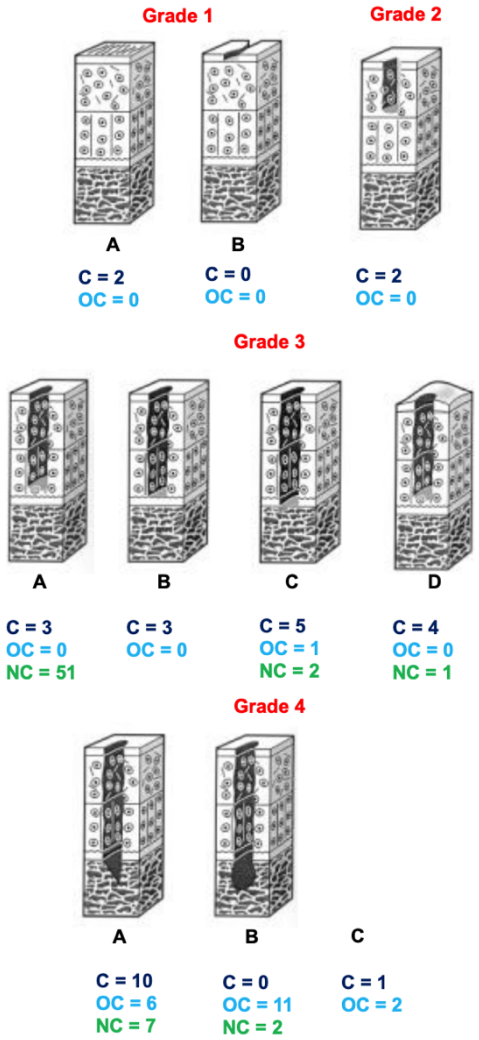

Figure 26: ICRS Grade of cartilage damage in chondral and osteochondral lesions of the medial femoral condyle.

Table 14: Detailed information on the medial femoral condyle defects reported in the Registry.

Variable	Subtype	Chondral Lesion		Osteochondral Lesion	
		N	%	N	%
Containment	Contained	48	69.6	16	69.6
	Not Contained	21	30.4	7	30.4
Shouldered	Shouldered	45	65.2	18	78.3
	Unshouldered	24	34.8	5	21.7
Osteophytes	No Osteophytes	63	91.3	18	78.2
	Early Osteophytes	5	7.2	4	8.7
	Well Established Osteophytes	1	1.4	1	4.3

4.5 Lateral Femoral Condyle Defects

There were 119 reports of a cartilage lesion in the lateral femoral condyle. Further information was available on 101 (84.9%) of these. Forty-one were listed as chondral lesions, while 18 were listed as osteochondral. The remaining defects were uncategorised.

Most (92.7%) of the chondral lesions were contained, while all osteochondral lesions were contained. Lesions were more likely to be shouldered than unshouldered in both chondral and osteochondral lesions (Table 15). Generally, patients with lesions of the lateral femoral condyle presented with no osteophytes (Table 15).

On average, the chondral lesions were 15.1±4.9mm wide (range: 8-25mm), 16.5±6.0mm long (range: 8->40mm), and 2.6±0.9mm deep (range: 2-4mm). Osteochondral lesions were similarly sized at 16.8±7.4mm wide (range: 10-40mm), 14.7±7.6mm long (range 5-40mm), and 3.8±2.0mm deep (range: 2-9mm).

As expected, the ICRS grade of cartilage damage was more severe in the osteochondral defects (Figure 27).

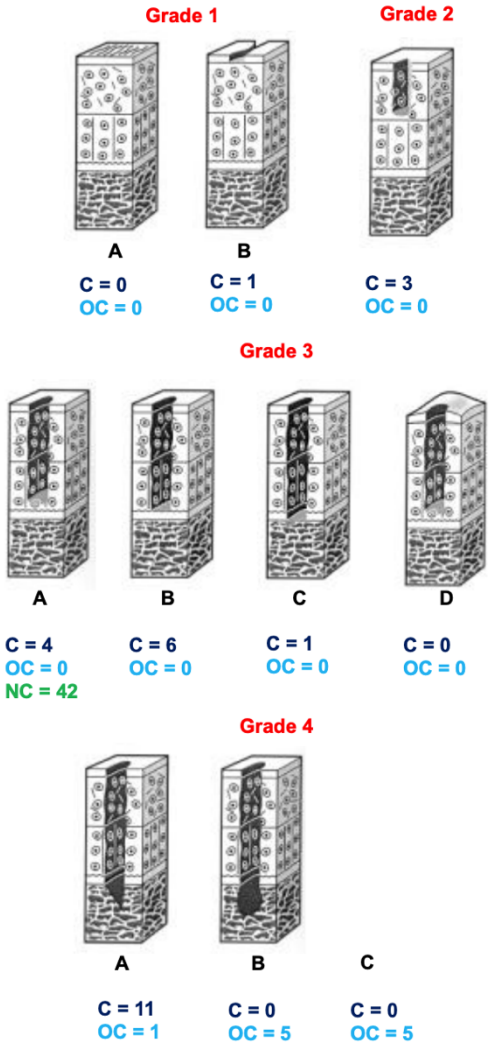

Figure 27: ICRS Grade of cartilage damage in chondral and osteochondral lesions of the medial femoral condyle.

Table 15: Detailed information on the lateral femoral condyle defects reported in the Registry.

Variable	Subtype	Chondral Lesion		Osteochondral Lesion	
		N	%	N	%
Containment	Contained	38	92.7	18	100.0
	Not Contained	3	7.3	0	0.0
Shouldered	Shouldered	36	87.8	17	94.5
	Unshouldered	5	12.2	1	5.5
Osteophytes	No Osteophytes	39	95.1	16	88.9
	Early Osteophytes	2	4.9	2	11.1
	Well Established Osteophytes	0	0.0	0	0.0

4.6 Medial Tibial Plateau Defects

A defect of the medial tibial plateau was reported in 102 patients within the Registry. Additional information on the ICRS grading was available for 94 (92.1%) of these patients. There was little additional information due to the new inclusion of this section in the Registry. Of the data available, three reported a chondral defect, and two reported an osteochondral defect (Table 16). The remaining defects were uncategorised.

Of the limited available data, chondral lesions on the medial plateau were 16.0±12.2mm wide (range: 8-30mm), 19.7±18.4mm long (range: 4-40mm), and 6.7±7.4mm deep (range: 1.5-12mm). One Osteochondral lesion was reported to be 30mm wide and 15mm long.

The chondral lesions had ICRS gradings on 3B (n=1), 3C (n=1) and 4A (n=1). One osteochondral lesion had a grading of 4B. Eighty-nine uncategorised lesions were graded 3A.

4.7 Lateral Tibial Plateau Defects

Lateral tibial plateau defects were reported in 75 patients. Additional information on the ICRS grading was available for 74 (98.7%) of these patients. Similar to the medial tibial plateau, there was little additional information due to the new inclusion of this section in the Registry. Of the data available, three were reported to have a chondral defect, and one reported to have an osteochondral defect (Table 16). The remaining defects were uncategorised.

One chondral lesion was reported to be 15mm wide and long. Another was reported to have a depth of 2mm, while the third had a width of 20mm and a length of 4mm. The osteochondral lesion was reported to be 15mm wide and 5mm deep.

The chondral lesions had ICRS gradings of 2 (n=2) and 4A (n=1). The osteochondral lesion had a grading of 4A. Seventy uncategorised lesions were graded 3A.

Table 16: Detailed information on the medial (top) and lateral (bottom) plateau defects reported in the Registry.

Variable	Subtype - Medial	Chondral Lesion		Osteochondral Lesion	
		N	%	N	%
Containment	Contained	2	69.6	2	100.0
	Not Contained	1	30.4	0	0.0
Shouldered	Shouldered	2	65.2	1	50.0
	Unshouldered	1	34.8	1	50.0
Osteophytes	No Osteophytes	1	91.3	1	50.0
	Early Osteophytes	1	7.2	0	0.0
	Well Established Osteophytes	1	1.4	0	0.0

Variable	Subtype - Lateral	Chondral Lesion		Osteochondral Lesion	
		N	%	N	%
Containment	Contained	2	69.6	1	100.0
	Not Contained	1	30.4	0	0.0
Shouldered	Shouldered	3	100.0	0	0.0
	Unshouldered	0	0.0	1	100.0
Osteophytes	No Osteophytes	3	100.0	0	0.0
	Early Osteophytes	0	0.0	1	100.0
	Well Established Osteophytes	0	0.0	0	0.0

5. Surgical Treatment

5.1 Primary Treatments for Defects

1,758 (80.2% of all patients) patients in the Registry underwent a surgical procedure. Demographic data on the patients who underwent surgery is given in Table 17. On average, patients who underwent surgery were younger than the general population of the Registry by 5 years. Height, weight and BMI were consistent with the general population. The data also showed that more males than females underwent surgery on the knee (57.8% vs 42.2%). This trend is also seen in the general population of Registry patients.

Table 17: Demographics of patients who underwent a surgical procedure.

	Average	SD	Data Available (n)	Data Available (%)
Age (years)	36.4	14.0	1754	99.8
Height (m)	175.2	12.0	1022	58.1
Weight (kg)	80.1	17.8	1014	57.7
BMI (kg/m^2)	26.1	5.2	1002	57.0
Side (L/R)	339L 257R	-	696	39.6
Sex (M/F)	742F 1015M	-	1757	99.9

The data also showed that females and males undergoing surgery were of similar age and that males were generally taller and heavier (Table 18).

Table 19: Comparison of male and female demographics for patients who underwent a surgical procedure.

	Average		SD	
	Males	Females	Males	Females
Age (years)	35.4	37.7	13.3	14.8
Height (m)	180.8	166.9	10.3	9.0
Weight (kg)	87.0	70.1	16.3	15.1
BMI (kg/m^2)	26.7	25.1	4.7	5.8

Detailed information on which areas of the knee were primarily treated by surgical intervention was available for 1,051 (56.9% of all surgical pathways) patients. The most common sites to be treated were the medial condyle (43.5%) and the lateral condyle (24.3%), even though isolated lesions were equally as likely to be reported in the patella (Figure 21). The medial plateau was the site least likely to be treated (1.7%). Generally, one area was treated per site, but multiple defects were treated per site in some patients (Table 19).

Table 18: Number of areas treated by anatomical site as a primary treatment.

	Lateral Condyle		Lateral Plateau		Medial Condyle		Medial Plateau		Patella		Trochlea	
	N	%	N	%	N	%	N	%	N	%	N	%
Number of Patients	256	100.0	42	100.0	457	100.0	18	100.0	162	100.0	116	100.0
1 area treated	194	75.8	36	85.7	278	60.8	9	50.0	117	72.2	54	46.6
2 areas treated	52	20.3	6	14.3	139	30.4	6	33.3	37	22.8	44	37.9
3 areas treated	10	3.9	0	0.0	27	5.9	3	16.7	6	3.7	13	11.2
4 areas treated	2	0.8	0	0.0	11	2.4	0	0.0	2	1.2	4	3.4
5 areas treated	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0
6 areas treated	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	1	0.9

The type of surgical procedure used to treat the areas was explicitly stated for 248 of the 1,051 (24.4%) patients. Almost half of these patients underwent a cell therapy cartilage reconstruction (Table 20). The second most common procedure was osteochondral repair (23.1%).

Table 20: Type of intervention carried out on a subset of patients in the Registry.

Type of Intervention	N	%
Cell Therapy Cartilage Reconstruction	120	48.4
Osteochondral Repair	86	34.7
Debridement or Chondroplasty Only	11	4.4
Microfracture	9	3.6
Conservative Treatment of Cartilage Defect	6	2.4
Microfracture + Scaffold Cartilage Reconstruction	5	2.0
Scaffold/Carrier Cartilage Reconstruction	5	2.0
Debridement or Chondroplasty Only & Microfracture	3	1.2
Cell Therapy/Scaffold on Top of Bone Graft Cartilage Reconstruction	1	0.4
Osteochondral Repair Refixation	1	0.4
Filling of Defect with Graft Bone	1	0.4

Seven different cell therapy products were listed in the Registry, and three different scaffold carriers were mentioned, suggesting that multiple variables need to be considered when interpreting the outcomes of these procedures. The type of fixation was reported in 122 of cases that underwent cell therapy cartilage reconstruction as a primary procedure. While 15 (12.3%) were fixed with fibrin glue, 11 (9.0%) were fixed with both fibrin glue and suture, 2 (1.6%) had no fixation, and the remaining 94 (77.0%) were listed as 'Other - Unknown'.

Please may we remind clinical users to use the text boxes provided within the Registry to clarify which methods of fixation was used if it is not listed in the Registry already.

Although only 87 cases were originally reported as an osteochondral repair or refixation as a primary treatment (Table 20), 117 cases were later described as fitting this category. 36 (30.8%) were allograft, 77 (65.8%) were autograft, one (0.8%) was Episealer, one (0.8%) was MaioRegen and the remaining 2 (1.7%) were defined refixations. The number of plugs used for the osteochondral autograft procedures is given in Table 21.

Table 21: Number of plugs used for osteochondral autograft procedures.

Number of Plugs	Number of Patients	% Patients
1	7	6.0
2	5	4.3
3	13	11.1
4	7	6.0
5	14	12.0
6	19	16.2
7	5	4.3
8	3	6.8
Unknown	44	37.6

The use of five or six plugs was most commonly reported. The diameter of the plugs ranged from 4.5-19mm. 6mm diameter plugs were the most common (Figure 28).

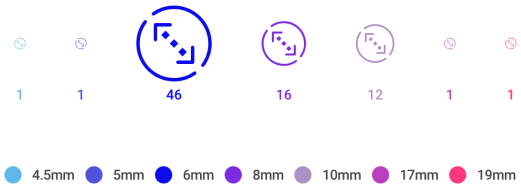

Figure 28: Varying diameters of osteochondral autograft plugs reported in the Registry.

While osteochondral allograft repair was only assigned to 36 patient pathways in the Registry as a primary treatment, 507 pathways were later revealed to have had a plug implanted during an allograft procedure, and an additional 278 patients were implanted with a shell graft. One pathway was reported to have both. This data suggests that many more patients enrolled in the Registry underwent osteochondral allograft repair than the

initial data suggests. This may be because the users had not identified the treatment type appropriately for all patients. It also reflects that many of our retrospective data imports were kindly donated by users of osteochondral allografts, and until we reach a steady state of prospective data input, this data should be viewed cautiously. We will then be able to comment further on the prevalence of various treatments.

Data on the diameter of allograft plugs were available for 503 (99.0%) patients implanted with an allograft plug. The most common diameter plug was 20mm, and 6mm was the most common reported depth. However, the average dimensions across all entries were 22.3±4.1mm in diameter and 6.3±2.2mm deep (Table 22). The average total area covered was 5.1±1.8cm^2.

Table 22: The dimensions of the osteochondral allograft plugs reported in the Registry.

Diameter		Depth		Total Area	
mm	N	mm	N	mm	N
0.0-5.9	2	0.0-5.9	93	0.0-5.9	327
6.0-10.9	0	6.0-10.9	375	6.0-10.9	171
11.0-15.9	26	11.0-15.9	20	11.0-15.9	2
16.0-20.9	193	16.0-20.9	1	16.0-20.9	0
21.0-25.9	215	21.0-25.9	0	21.0-25.9	0
26.0-30.9	64	26.0-30.9	0	26.0-30.9	0
31.0-35.9	1	31.0-35.9	0	31.0-35.9	0
36.0-40.9	2	36.0-40.9	0	36.0-40.9	0
Unknown	0	Unknown	19	Unknown	8

There was no data available for the diameter of the shells. However, the average depth was 9.1±10.4mm, and the average area was 8.9±5.8cm^2. As expected, the shells tended to be larger than the plugs (Table 23; Figure 29).

Table 23: The dimensions of the osteochondral allograft shells reported in the Registry.

Depth		Total Area	
mm	N	mm	N
0.0-5.9	83	0.0-5.9	65
6.0-10.9	61	6.0-10.9	104
11.0-15.9	94	11.0-15.9	65
16.0-20.9	7	16.0-20.9	22
21.0-25.9	1	21.0-25.9	6
26.0-30.9	0	26.0-30.9	2
31.0-35.9	0	31.0-35.9	0
36.0-40.9	0	36.0-40.9	0
41.0>	1	41.0>	1
Unknown	32	Unknown	14

The allograft fixation used varied, but pins were generally more common for both plugs and shells (Figure 29).

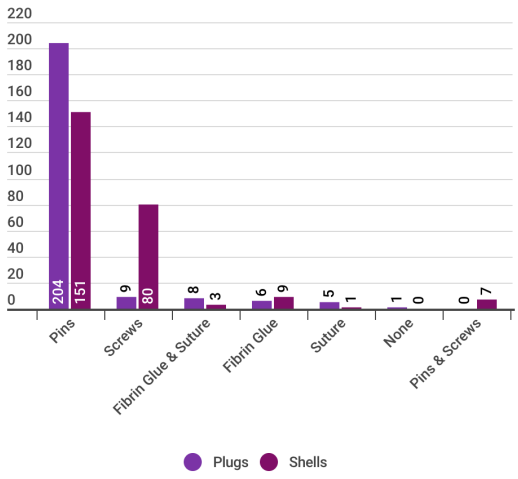

Figure 29: Allograft fixation used with the plugs and shells for the primary treatment.

Where additional bone grafts were necessary, autografts appeared to be more common than allografts for the patients who had undergone both plug and shell allografts (Figure 30).

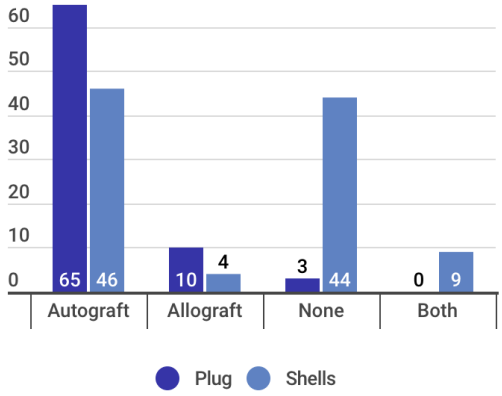

Figure 30: Number of patients reported to require additional bone grafts at the time of primary treatment.

5.2 Secondary Treatment Site for Defects

As has previously been established, some patients had numerous defects in different areas of their knee that required treatment. A secondary treatment site was reported for 347 patients in the Registry. As with the primary treatment location, the most common secondary location for treatment was the medial condyle (Table 24).

Most patients underwent osteochondral allograft repair (308, 88.9%). 214 (61.7%) patients were implanted with a plug graft, while the remaining 94 (27.9%) had a shell graft.

The plugs had a mean diameter of 15.5±4.2mm and a depth of 6.3±2.1mm. The average area was 3.7±1.6cm^2. Therefore, the secondary treatment site was generally smaller in size than the primary site.

Table 24: Number of locations treated by anatomical site as a secondary treatment.

	Lateral Condyle		Lateral Plateau		Medial Condyle		Medial Plateau		Patella		Trochlea	
	N	%	N	%	N	%	N	%	N	%	N	%
Number of Patients	44	12.7	23	6.6	139	40.1	15	4.3	58	16.7	67	19.3

The shells had a mean depth of 7.9±4.8mm and an average area of 9.2±5.7cm^2; similar to the primary treatment site.

Pins were most used to fix both plugs and shells (Figure 31). Few additional bone grafts were reported for the secondary site. However, autografts appeared to be more common when used (Figure 32).

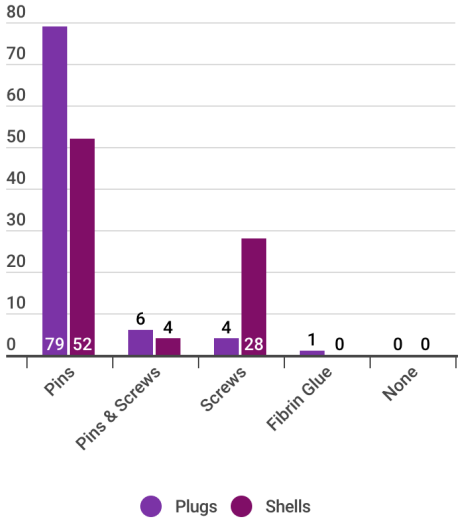

Figure 31: Allograft fixation used with the plugs and shells for the secondary treatment.

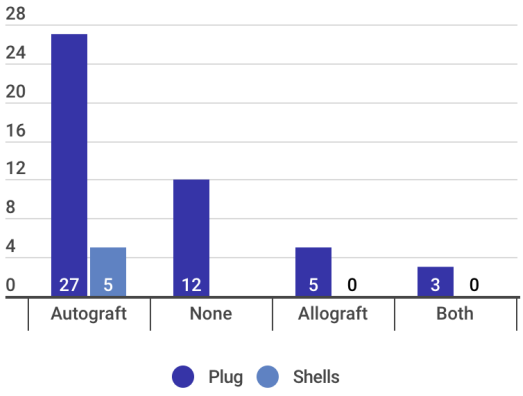

Figure 32: Number of patients reported to require additional bone grafts at time of secondary treatment.

5.3 Total Area of Graft

The combined total area grafted across all treated locations was reported for 839 (47.7% of all patients who underwent a surgical procedure) patients. On average, the graft area was 8.9±7.0cm^2.

5.4 Other Procedures

Procedures that were not related to the cartilage were reported for 397 (16.5% of all pathways) pathways. Unfortunately, little information was available for most pathways as one third were labelled as 'Other' in the Registry (Figure 33). This is presumably because the procedure was not listed as an option in the database, and the users did not use the text box to elaborate further. Of the available answers, osteotomies were the most common additional procedure (Figure 33). Additional procedures that were performed in combination with other procedures were less common. This is probably observed due to the personalised nature of complex procedures.

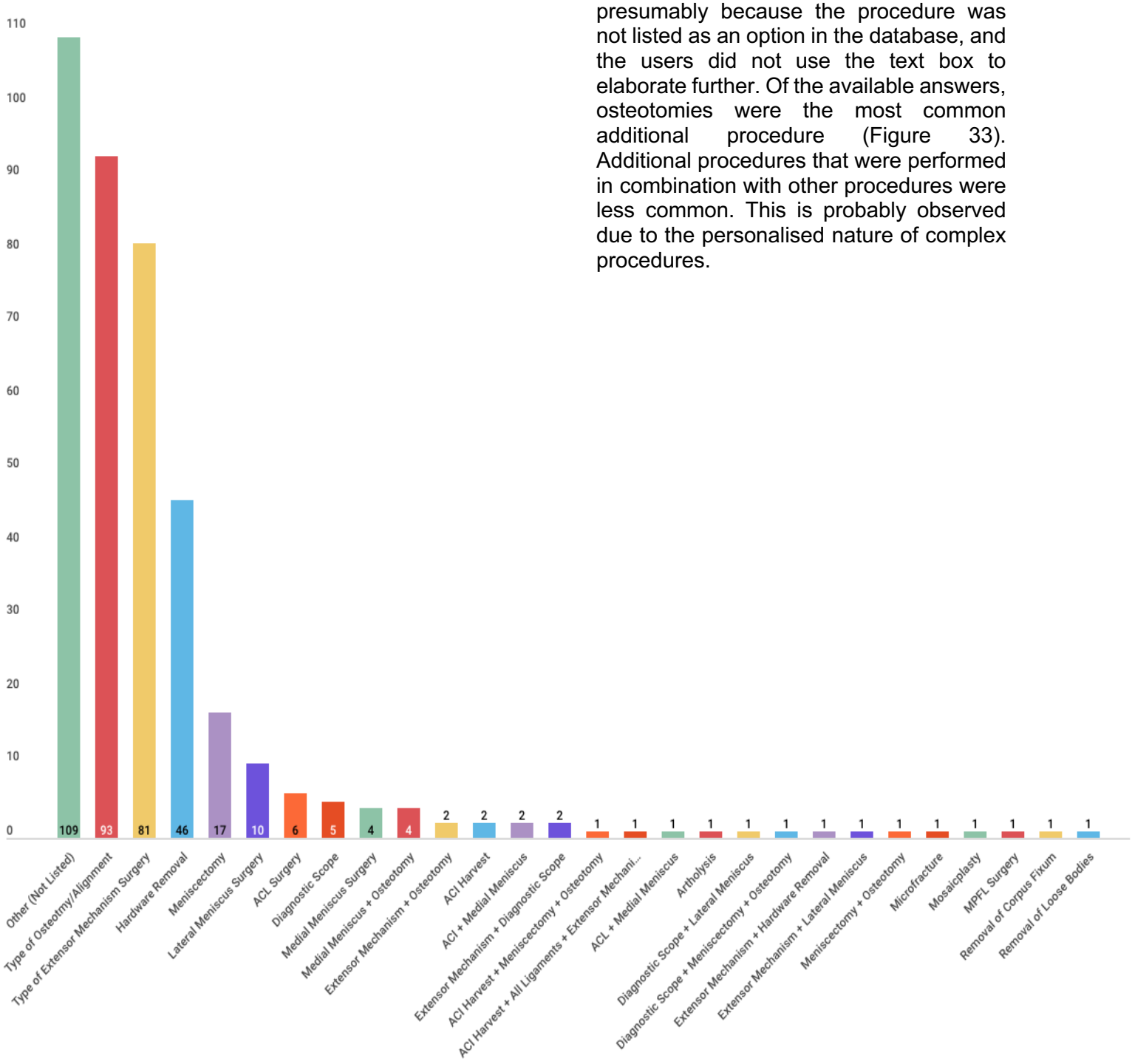

Figure 33: Additional procedures carried out on Registry patients.

Further information was available for 15 (54.8%) of the osteotomies – 6 were distal femoral osteotomies, 8 were high tibial osteotomies and one was a tibial tubercle osteotomy.

Eighty-one patients were found to have undergone an additional extensor mechanism surgery (Figure 33). More detail was available for 51 (63.0%) (Table 25).

Table 25: Extensor Mechanism Treatments

Type of Extensor Mechanism	N
Tibial Tubercle Transfer	37
Tibial Tubercle Transfer & Lateral Retinaculum Lengthening	4
Lateral Release	2
MPFL Reconstruction & Tibial Tubercle Transfer	2
Tibial Tubercle Distalisation	2
Lateral Release & Tibial Tubercle Anteriorisation	1
MPFL Reconstruction, Lateral Release & Tibial Tubercle Transfer	1
Patella Facetectomy	1
Tibial Tubercle Anteriorisation	1

Additional information regarding medial meniscal surgery was available for 69 patients. This exceeded the number of pathways assigned to medial meniscal surgery in Figure 33, suggesting that some users preferred to add this information in the question that specifically asks about the medial meniscus. Four (5.8%) cases were reported to be meniscal repairs, two (2.9%) were meniscectomies, and the remaining cases were allograft transplants (91.3%).

Further data on lateral meniscal surgeries performed were available for 12 pathways. Two (16.7%) were repairs, two (16.7%) were partial meniscectomies, one (8.3%) was a root repair and the remaining 7 (58.3%) were allograft transplants.

There was little further information on the other additional procedures.

5.5 Intra-Operative Complications

Data on intra-operative complications were reported for 358 (19.4% of all surgical procedures) procedures. Only one (0.3%) complication was reported, but further details about the complication were not available. This is a common feature of registry data.

6. Knee Injections

Knee injections were commonly reported in the Registry. 635 (26.5% of all pathways) patients underwent an injection of some kind. When combined with the surgical data, it can be seen that 2,481 treatments are reported; 83 more than the official number of pathways. This suggests that some patients have both an injection and surgery registered under one pathway.

When the surgical patient cohort and injection cohort were compared, it was clear that the patients who had an injection were older. While weight, height and BMI also appeared to be comparable, very little data was available for patients who had received an injection (Table 26). This may be because these data are less routinely collected before an injection. Thus, clinicians using the Registry should encourage their patients to enrol themselves (rather than being enrolled by the clinician) so that this information can be captured more frequently.

Table 26: Demographics of patients who underwent an injection.

	Average	SD	Data Available (n)	Data Available (%)
Age (years)	64.9	14.1	629	99.5
Height (m)	1.77	1.41	11	1.7
Weight (kg)	80.3	16.4	11	1.7
BMI (kg/m^2)	23.9	4.8	4	0.6
Side (L/R)	260L 297R	-	557	88.1
Sex (M/F)	223M 405R	-	628	99.4

When the demographics of males and females were separated, it was found that females were generally ten years older than males at the time of injection. Females were also shorter and weighed less (Table 27).

Table 27: Comparison of male and female demographics for patients who had an injection.

	Average		SD	
	Males	Females	Males	Females
Age (years)	58.7	68.2	15.6	12.0
Height (m)	1.83	1.61	11.2	1.47
Weight (kg)	86.3	70.0	11.6	1.5
BMI (kg/m^2)	23.9	26.4	4.8	-

Compared to the kinds of injections patients in the Registry had previously received prior to their enrolment, the Registry data shows how trends have changed. Where hyaluronic acid was previously the most common injection (Figure 8), most patients now underwent a stem cell injection when enrolled in the Registry (Figure 34). All stem cell injections were reported to be adipose-derived. **Please note that the terminology for stem cell injections has now changed, but the terms used in the Registry are yet to be updated to reflect this.** The second most common injection was PRP. This was also the second-most common injection patients had received prior to their enrolment in the Registry (Figure 8; Figure 33). This is likely to be a reporting bias rather than a reflection of the general population treatment distribution.

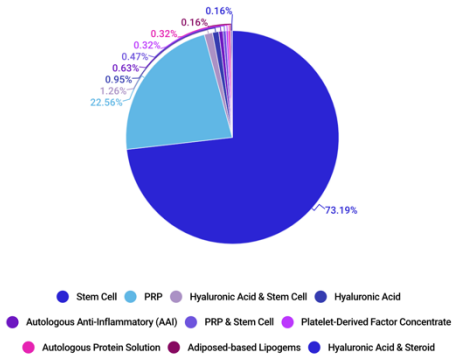

Figure 34: The types of knee injections received by Registry patients for their cartilage injuries.

7. Post-Treatment Recommendations

7.1. Treatments Following Surgery

Additional information for the post-operative treatment prescribed by clinicians was available for 257 (13.9% of all surgical pathways) patients.

7.1.1 Bracing

Three quarters of patients were not prescribed a brace post-operatively (Figure 35). The remaining patients were prescribed a kind of brace after their operation. The double-upright double-hinge was most common.

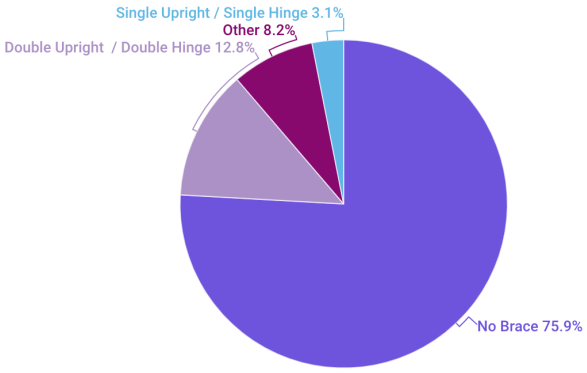

Figure 35: post-operative brace usage.

7.1.2 Weightbearing

Weightbearing data was available for 171 patients. Some patients were allowed to fully weight-bear after their operation (n=26; 15.2%). However, most were advised to partially weight-bear (n=118, 69.0%). Of those partially weightbearing, most were advised to do so as tolerated (Table 28). On average, patients were asked to partially weight-bear for 6.3±3.2 weeks. The duration of weightbearing depended on the prescribed type of weightbearing (Table 28).

Twenty-seven (15.8%) patients were not allowed to weight-bear. The average duration of non-weight-bearing was 7.0±3.2 weeks, with a minimum duration of 2 weeks and a maximum duration of 12 weeks.

Weightbearing instructions will vary depending on the treated area and the technique employed, so it is not surprising to see the wide variations in reported protocols.

Table 28: Type of partial weight-bearing recommended following surgery.

Type	Number of Patients	Percentage of Patients (%)	Average Duration (weeks)
25%	2	1.7	2.0±0.0
50%	3	2.5	2.0±0.0
75%	1	0.8	2.0
As Tolerated	79	66.9	6.7±3.0
Toe Touch	32	27.1	9.0±0.0

7.1.3 Physiotherapy

Most patients underwent physiotherapy with immediate effect (Table 29). Physiotherapy was delayed for 40% of patients at an average 2.5±1.6 weeks. The minimum reported delay was 2 weeks, while the maximum reported delay was 12 weeks.

Table 29: Type of physiotherapy recommended following surgery.

Physiotherapy	Number	Percentage (%)
Delayed	100	41.1
Immediate	138	56.8
None	5	2.1

137 (56.4%) patients underwent closed-chain physiotherapy at an average duration of 8.3±8.2 weeks. There is a large standard deviation here, as the range was 2 weeks to 12 months. Open-chain physiotherapy was prescribed for 32 (13.2%) patients at an average duration of 10.0±3.1 weeks.

7.2. Treatments Following Injections

Further data for 192 (30.2% of all patients who had an injection) patients who underwent an injection to the knee was available in the Registry.

7.2.1 Bracing

Two (1.0%) patients required a brace following their injection; one double-upright/double hinge and one single upright/single hinge. The majority (n = 190, 99.0%) required no brace, however.

7.2.2 Weightbearing

Most (96.9%) patients were allowed to weight-bear after their injection. One patient was advised to non-weight-bear for 4 weeks, another patient was advised to partial weight-bear (75% of body weight) for 6 weeks. No further information was provided for the remaining 5 patients.

7.2.3 Physiotherapy

The majority of patients were not prescribed physiotherapy after their injection (Table 30). Those who required physiotherapy after a delay were recommended to wait an average 1.7±1.2 weeks after their injection (minimum delay of 1 week and a maximum delay of 4 weeks).

Eleven (64.7%) patients underwent closed-chain physiotherapy at an average duration of 3.6±3.5 weeks. Open-chain physiotherapy was prescribed for 5 (29.4%) patients at an average duration of 3.8±2.6 weeks. Six (37.5%) patients underwent a combination of closed-chain and open-chain physiotherapy for 3.9±3.6 weeks.

As the timing and type of physiotherapy prescribed is dependent on the type of treatment received, it should be noted that the data presented here may not be generalisable to all patients.

Table 30: Type of physiotherapy recommended following a knee injection.

Physiotherapy	Number	Percentage (%)
Delayed	6	3.1
Immediate	11	5.7
None	170	88.5

8. Patient-Reported Outcomes

Patients complete a series of patient-reported outcome measures for the Registry. The routine questionnaires include the Knee Osteoarthritis Outcome Score (KOOS), Euroqol 5-Dimensional score (E5-5D), and a record of complications. The Kujala Anterior Knee Pain Score is also included for patients with patellar pain. Outcome measures are administered at baseline, 6-weeks, and 6-months post-intervention, then annually thereafter for up to 10 years depending on the intervention.

Clinicians may also request their patient to complete additional questionnaires, including the International Knee Documentation Committee Subjective Knee Form (IKDC), the Lysholm Knee Scoring Scale, the Tegner Activity Scale, or the Visual Analogue Score (VAS) for pain.

8.1 Knee Osteoarthritis Outcome Score

The KOOS is patient-reported outcome measure evaluating the patients' perception of their knee function. It is scored out of 100 and comprises of 5 sub-scales: Pain, Symptoms, Activities of Daily Living, Sports and Recreation, and Quality of Life. A higher score denotes a better outcome.

The KOOS Pain data currently available in the Registry is shown in Figure 36. Pain scores generally improve following the intervention during the first 6 years.

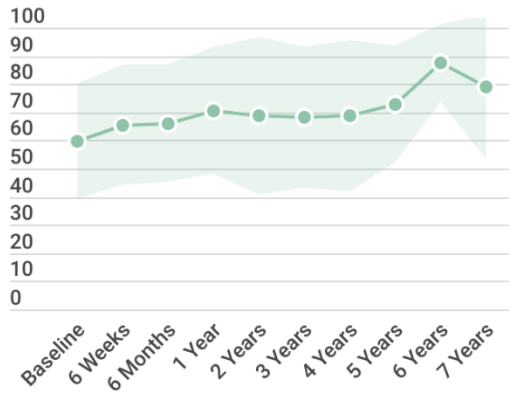

Figure 36: KOOS Pain scores for patients enrolled in the Registry

KOOS Symptom scores were also shown to have the same trends post-treatment (Figure 37).

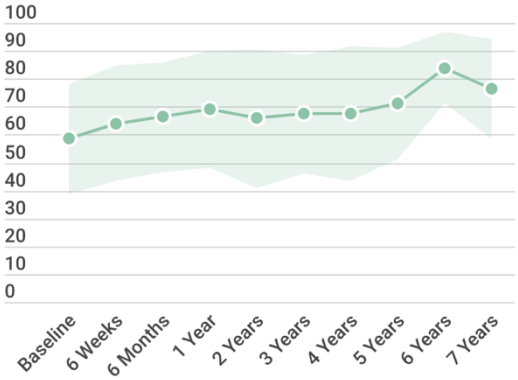

Figure 37: KOOS Symptom scores for patients enrolled in the Registry.

KOOS Activity of Daily living scores remained largely constant across the first 5 post-operative years (Figure 38).

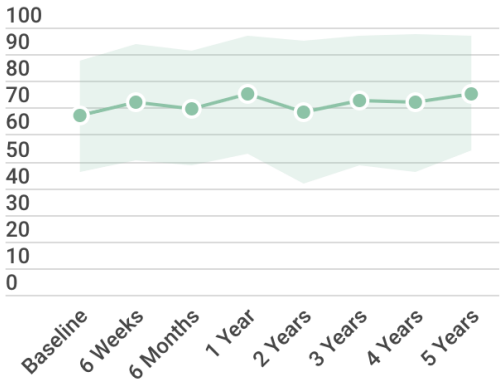

Figure 38: KOOS Activities of Daily Living scores for patients enrolled in the Registry.

KOOS Sport and Quality of Life scores significantly improved following intervention, particularly over the first 5 years (Figure 39 & Figure 40).

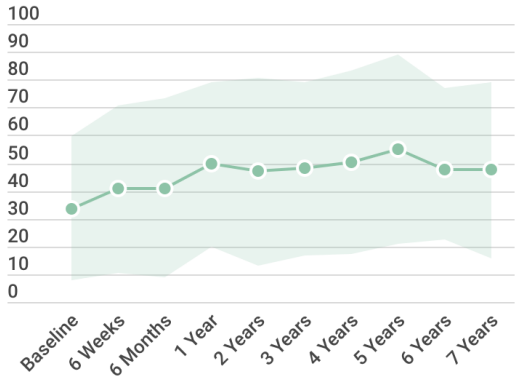

Figure 39: KOOS Sport scores for patients enrolled in the Registry.

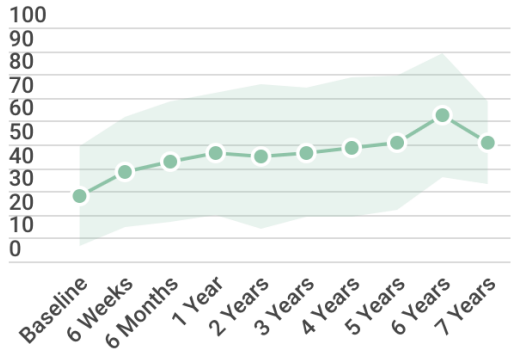

Figure 40: KOOS Quality of Life scores for patients enrolled in the Registry.

The change in total KOOS score over time is shown in Figure 41.

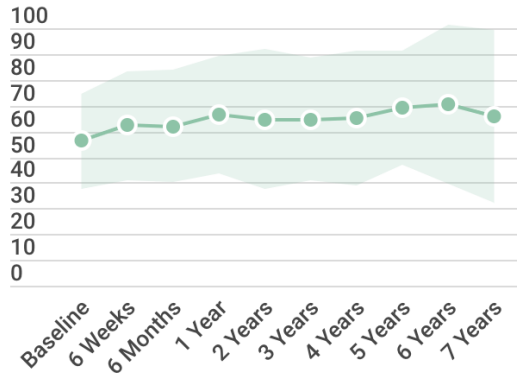

Figure 41: KOOS Total scores for patients enrolled in the Registry.

Generally, participants appeared to score worst at baseline in the KOOS Sport and Quality of Life. This suggested that patients undergoing treatment for a cartilage injury were relatively satisfied with their ability to undertake activities of daily living before their treatment, but that more demanding activities were impacting their quality of life. Of all KOOS scores, both the Sport and Quality of Life scores improved the most after the intervention.

Overall, patients appear to achieve a clinically important improvement in KOOS by 1 year post-intervention. According to KOOS, the minimum clinically important change is 8-10 points.

8.2 EQ-5D

The EQ-5D is an overall health quality of life scale. The scale was developed by the EuroQol Group and has 5 sub-scales as well as an overall index. The five subscales are mobility, self- care, usual activities, pain/discomfort, and anxiety/depression. The instrument has a license fee. However, users of the ICRS patient registry can collect the EQ-5D at no cost; we are most grateful to the EuroQol Group for allowing us to do so.

The visual analogue scale component of the EQ-5D asks patients to score their overall health on the day they answer the questionnaire, with 0 being equivalent to the worst health they can imagine and 100 being equivalent to the best health they can imagine. Patients in the Registry improved their scores over time following their intervention (Figure 42).

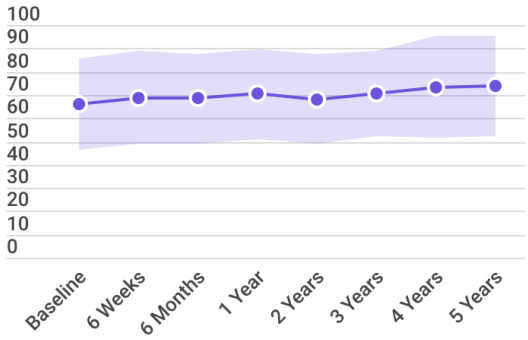

Figure 42: EQ-5D VAS scores for patients enrolled in the Registry.

The other component of the EQ-5D score is the 5L component, which includes the five subscales described previously. A score of 1.0 denotes better health. Figure 43 shows how this score improved post-operatively for the initial 2 years before declining slightly thereafter.

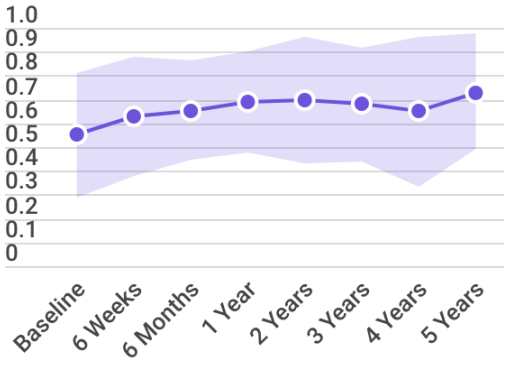

Figure 43: EQ-5D 5L scores for patients enrolled in the Registry.

Generally, the data from the EQ-5D questions suggest that patients' perceptions of their general health improved following treatment.

8.3 Kujala Anterior Knee Pain Scale

The Kujala Anterior Knee Pain Scale is a patient-reported outcome instrument to measure function and symptoms in patients with patellofemoral disorders. The outcome is out of 100 and has 13 questions. Higher scores are indicative of better outcomes. The questions assess the patients' overall pain and swelling as well as the patient's ability to walk, run, climb stairs, and squat.

Figure 44 shows an increase in the Kujala score over time, suggesting that anterior knee pain improved following treatment.

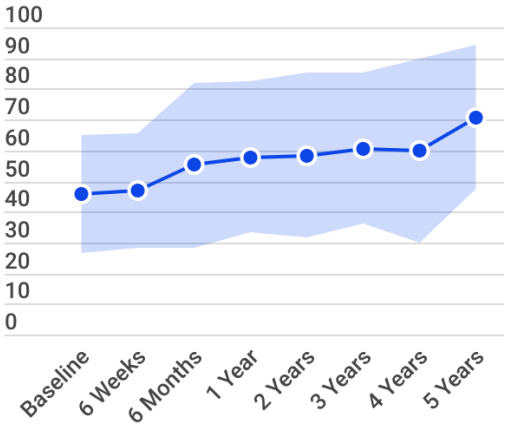

Figure 44: Kujala scores for patients enrolled in the Registry.

8.4 Visual Analogue Score - Pain

The VAS Pain score is a Likert scale that spans between 0 (No pain) and 100 (worst pain imaginable).

Pain scores worsened in the first 6 weeks then improved beyond pre-treatment levels by 5 years post-intervention (Figure 45). This was consistent with the trend observed in the KOOS Pain scores.

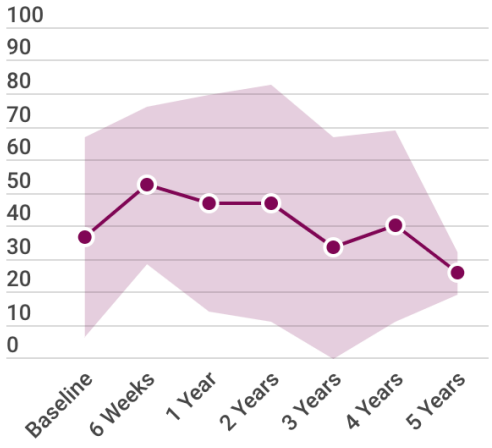

Figure 45: VAS Pain scores for patients enrolled in the Registry.

The data across all patient-reported outcome measures suggest that patients perceived their symptoms and general health to improve for the first 5 years following surgery. However, the number of patients with long-term data is still low. Thus, trends in patient-reported outcomes could change over the coming years with increased usage of the Registry.

9. Post-Treatment Complications

9.1 Patient-Reported Complications

Patients reporting the absence of complications to registries are commonly seen as reliable, but it can be difficult for patients to attribute complications they perceive after treatment correctly. Despite there being 2,398 patient pathways in the Registry, only 104 (4.3% of all pathways) patients returned data on their complication status following treatment. Most of these patients had no complications to report (Figure 46). However, two-fifths of patients reported some complications. Problems that began within 6 weeks of the treatment and continued beyond 6 weeks were most common.

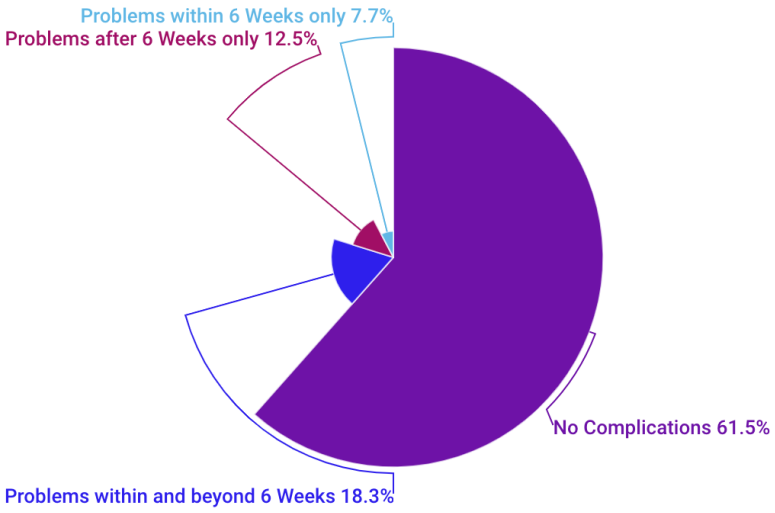

Figure 46: Percentage of patients reporting complications following treatment.

Ongoing pain was the most common complication reported by patients (31.9%, Figure 47). Although, pain at 6 weeks is not necessarily indicative of a medical complication.

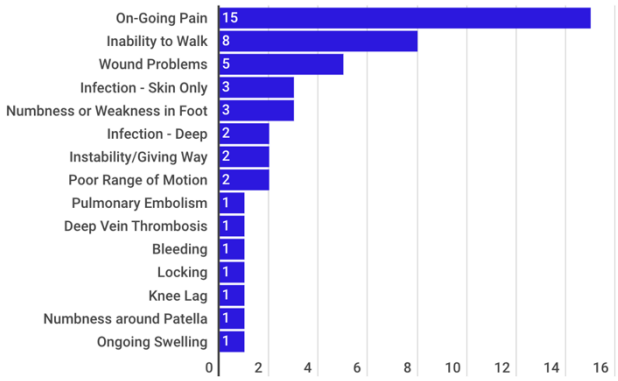

Figure 47: Post-treatment complications as reported by patients. Note that some patients reported more than one complication.

Twenty-three patients confirmed whether treatment was required for their complications. Eight (34.8%) stated no further treatment was required, whereas 15 (65.2%) disclosed that additional treatment was necessary. The prescription of additional painkillers (21.2%) and extended physiotherapy (18.2%) were the most common treatments (Figure 48).

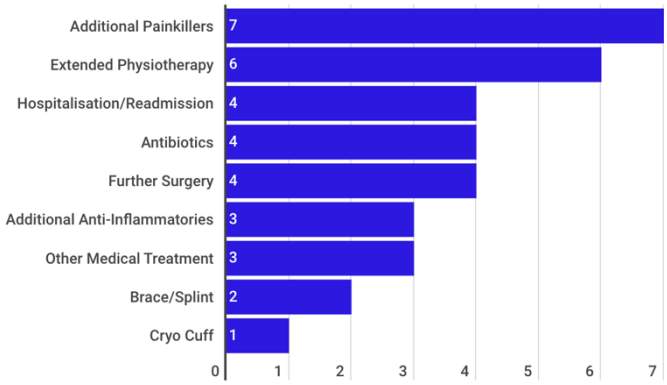

Figure 48: Additional treatment(s) required by patients with complications. Note that some patients reported more than one treatment.

Little was known about why patients were readmitted or hospitalised post-operatively, although one patient reported needing to return to the hospital to have their wound redressed. Only four patients reported requiring further surgery (Figure 48). One patient had metalwork removed, another underwent a revision of the original procedure, a third had an abscess drained and irrigated, and the final patient required surgery to remove scar tissue.

9.2 Clinician-Reported Complications

Fewer clinicians had reported complications for patients; 47 (1.9% of all pathways) were reported in the Registry. Half were reported to have no complications (Figure 49). Of those who had complications, problems that began after 6 weeks of the treatment were most common. This disagreed with the data provided by patient.

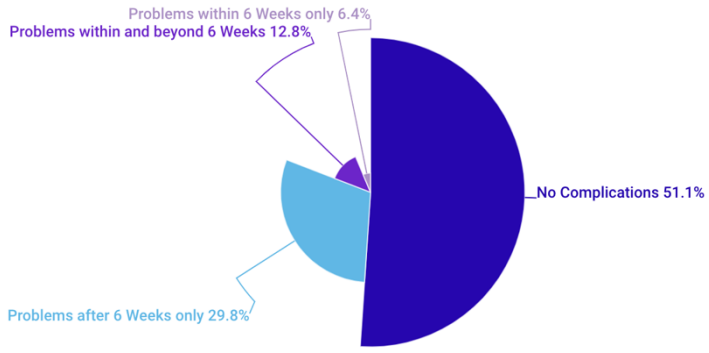

Figure 49: Percentage of clinicians reporting complications following treatment.

Ongoing pain was the most common problem (39.1%, Figure 50).

Patients reported pain as a complication up to 6 weeks following treatment, yet surgeons reported it as a complication after 6 weeks. This highlights the potential opportunity for improving patient comprehension during shared clinical decision-making to improve patient understanding of typical pain duration after surgery.

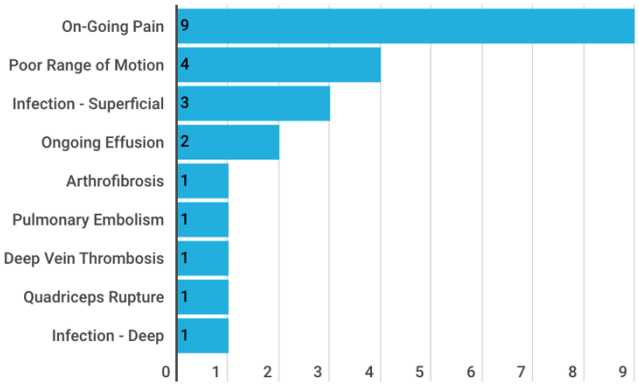

Figure 50: Post-treatment complications as reported by clinicians. Note that some clinicians reported more than one complication.

Additional treatment was reported for 17 (73.9% of patients with complications) patients. Further surgery was commonly reported, with antibiotics to treat an infection being the second most common treatment (Figure 51).

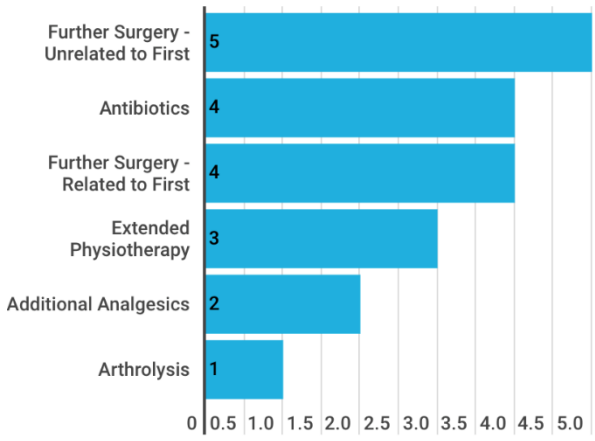

Figure 51: Additional treatment(s) required by patients with complications. Note that some patients reported more than one treatment.

Of the surgical treatments required, arthroscopic debridement was recommended in one patient, removal of metalwork in two, and scar tissue excision in two.

No patient within the Registry has yet been reported to have subsequently undergone an arthroplasty or other end point surgery.

While the information provided is valuable, it is impossible to determine how common complications follow cartilage repair or joint preservation treatments, due to the size of the dataset. Therefore, we would kindly ask that Registry users keep their patients' records up-to-date to enable further analyses of the data in the future. This includes reporting when no complications have occurred.

10. Collaborative Projects with Registry Data

We would like to remind ICRS Registry users and ICRS Members that Patient Registry Steering Committee accept applications for access to anonymous ICRS Registry data for the purposes of research.

The ICRS Patient Registry Steering Committee will assess the merits of all applications as per the FINER criteria (Feasibility, Interest, Novelty, Ethics, and Relevance).

Please note that IRB approval will be required prior to project start. It is expected that successful applicants will publish their findings in a peer-reviewed journal.

For your reference, the data currently captured by the Registry include the following:

Data captured by patients when they enrol:

- Demographics (age, sex, height, weight, smoking status)
- Information about knee in question
    - Side of injury

- Mechanism of injury/condition
- Previous history of treatments on the knee
- Duration of symptoms
- Condition of other knee/other joints

- PROMs
  - KOOS
  - EQ-5D
  - Kujala (if patella is involved)
  - Pre-injury and pre-treatment activity scores

Data captured by patients following treatment (6-weeks/3-months/6-months/annually for up to 10 years):

- PROMs
  - KOOS
  - EQ-5D
  - Kujala (if patella is involved)
  - Pre-injury and pre-treatment activity scores
- Complications

Data captured by clinicians pre-treatment:

- Demographics (if not provided by patients)
- Information about knee in question
  - Side of injury
  - Mechanism of injury/condition
  - Previous history of treatments on the knee
  - Duration of symptoms
  - Onset of symptoms
  - Any concomitant injuries
  - Condition of other knee and other joints

Data captured by clinicians post-treatment (ideally on treatment date):

- Side of treatment
- Condition of opposite knee
- Clinical findings
  - Knee laxity assessment results
  - If surgical
    - type of anaesthetic/ torniquet use/ primary or revision/ approach/ antibiotic use/ incisions/ portals/ instruments used
    - State and volume of synovial fluid
    - State of synovium
  - If cartilage or subchondral defect
    - Location(s) of any abnormal tissue
    - Total area of tissue defect(s)
    - Depth, length and width of each individual defect
    - ICRS/AMADEUS Grading of each defect
    - Description of defect
    - State of menisci
    - State of ligaments
- Procedure performed (conservative/injections/surgery)
  - Location(s) of repair
    - Type(s) of repair per location
  - Other procedures carried out at the same time e.g. meniscal/ligamentous etc.
  - Adverse events/complications at time of treatment
  - Duration of treatment
- Post-treatment bracing protocol/ weight-bearing protocol/ physio protocol

Data captured by clinicians at follow-up:

- Complications
- Additional treatments performed since initial treatment in Registry

11. Patient and Public Involvement

Over the last 12 months, we have been working to improve our engagement with our patients and members of the public. As the Registry develops, we must ensure its evolution is co-developed with patient users. Involving patients in the Registry's development enables us to learn from and improve patient engagement and experience for better goal alignment regarding expectations and improving outcomes.

11.1 Focus Groups

In March 2023, clinical users of the Registry were informed of our intention to invite patients enrolled in the Registry to take part in a focus group on their perceptions and opinions of using the Registry.

An advertisement for the focus group was then designed with input from an independent patient-public involvement group (Figure 52).

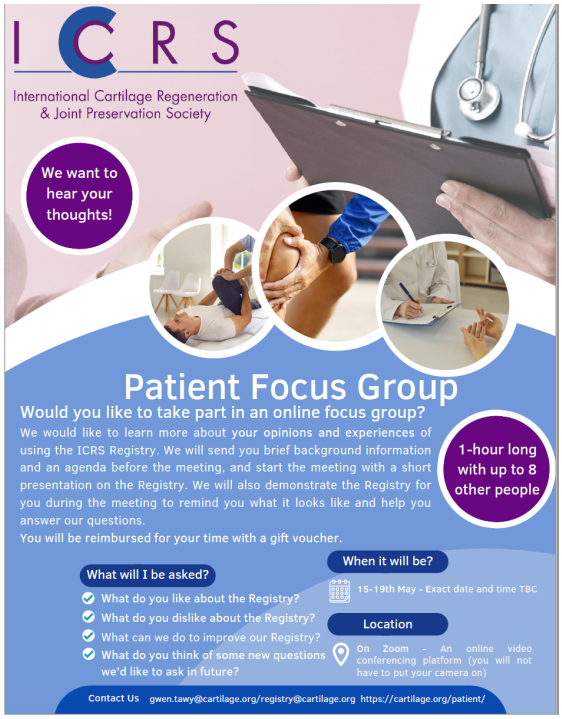

Figure 52: Advert for patient focus group.

Two semi-structured focus groups and one interview were arranged in May 2023. Five males and 4 females took part. At the beginning of the workshop, Dr Tawy provided participants with some information on the ICRS and the Registry. Participants were then given a demonstration of the patient portal to assist them with answering the questions. Participants were asked the following questions:

- What do you think about how the portal looks?
- What do you think about how long it takes to answer the questions?
- Are there any important questions missing?
- Is there anything else you would like to see in the portal?
- Is there anything we can improve?
- What makes you answer the questionnaires when prompted?

In general, participants were very happy with the Patient Portal. Some feedback from participants is provided below:

- Participants agreed the Registry questions are easy and straightforward.
- Participants agreed the questions do not take too long to complete.
- Participants thought some questions were difficult to answer because of injuries on the contralateral knee or other joints i.e. the knee enrolled in the Registry is not the cause of the problem.
- Participants thought some questions were difficult to answer because some activities mentioned (e.g. jumping) are physically impossible for the patient.
- Participants thought some questions were difficult to answer because they have been advised not to perform certain activities that are mentioned (e.g. kneeling).
- Participants thought patients would benefit from a community of patients whom they can discuss their experiences with.
- Participants thought some of the questions were repetitive.
- Participants thought the term 'usual activities' in some questions is unclear, as it is difficult to know whether the question refers to activities the patient could do before their injury or after the injury.
- Participants thought that patients would benefit from learning the results of the questionnaires to track their progress.
- Participants thought that patients would benefit from a method of providing the Registry with an update between routine requests to complete the questionnaires.
- Participants thought that patients would benefit from some information on the risks, and success rates for cartilage injury and joint preservation treatments.

Participants were then provided with information on new questions we would like to incorporate into the Registry. These questions are hoped to address patient preferences with regards to their treatment options and outcomes. Examples of the questions we may include are as follow:

1. What matters most to you from your treatment? (Pain relief/Improved function etc.)
2. What is your personal preference with regards to your treatment? (Surgery/Non-surgical treatment/Not sure)
3. How confident are you that the decision you took with regards to your treatment was the right one?

Once presented with the example questions, participants were asked the following questions:

- Would you be happy to answer these questions?
- Is anything missing?
- How may we modify the questions to better fit your treatment priorities?
- What are your top 3 priorities?

Participants provided the following feedback:

- Participants thought the addition of Patient Preference questions would add value to the Registry.
- Participants would be happy to answer additional questions on Patient Preference.
- Participants thought that patients would benefit from a decision-aid tool to help them plan their treatment with their healthcare professional.
- Participants thought that patients would benefit from access to national guidelines on the available treatments for cartilage repair and joint preservation to help them make decisions on their treatment plan.

11.2 Actions Taken

Considering the comments made by participants in the focus group, the following amendments have now been implemented within the Patient Portal and on the ICRS website:

1. A statement has been added to the start of the questionnaires to highlight that some questions may be repetitive because of the use of multiple validated patient-reported outcome measures.
2. The term 'usual activities' has been clarified at the start of the questionnaire, so that patients can better answer the questions.
3. A new question has been added to clarify whether the problems encountered by patients are because of the knee in question or because of the opposite knee, or both.
4. A new question has been added to clarify whether some of the restrictions experienced by patients are because they have been advised against doing said activity e.g., running/squatting/kneeling, or if they are restricted because they are physically unable to do the activities listed.
5. A new text box has been added at the end of the questionnaire for patients to enter further information.
6. A statement has been added to the end of the questionnaire to instruct patients to contact their clinician should they wish to learn more about their results.
7. A statement has been added to the end of the questionnaire to direct patients to the ICRS Patient Registry Manager should they wish to provide an update to the Registry between one questionnaire and another.
8. A paragraph on the benefits, risks, and success rates for cartilage injury and joint preservation treatments has been added to the patient-facing website.

11.3 Future Actions

Our Registry is continually growing and evolving. Our ongoing work includes the following:

1. We are in the process of developing a patient advisory board for the ICRS Registry.

2. We are arranging online annual public engagement events to share Registry updates with patients and members of the public.

3. We are working on producing a set of questions to address patient preference with regards to their treatment options. Once co-created, the patient preference questions (to aid in shared decision-making) will be piloted with patients for validity. The ICRS Patient Registry Steering Committee, including patient partners, will provide final approval for implementation.

4. A list of online resources for patients requiring more information on their condition and treatment is being collated for the ICRS website. If you know of any valuable resources for patients, particularly for non-English speaking countries, please do not hesitate to get in touch with the Registry Manager.

12. Summary

The ICRS Patient Registry is continuing to grow with valuable information that is helping us better understand the success and failures of new and current cartilage repair and joint preservation treatments.

The data presented in this annual review suggests that males generally undergo intervention for cartilage regeneration or joint preservation between early adulthood and middle-age, whereas females tend to start and end treatments later in life. The reason for this remains unknown. The most common reasons for requiring treatment are the treatment of lesions caused by osteochondritis dissecans or chondral damage. As reported in the previous annual report, pre-treatment assessments on patients continue to show that these diagnoses significantly impact quality of life, so treating the defects effectively is paramount.

The patella and medial femoral condyle were the most common locations for cartilage damage, with cell therapy cartilage reconstruction and osteochondral repair being the most common surgical approaches for treatment. Stem cells and platelet-rich plasma (PRP) were the most administered injections. In general, the population of patients undergoing injections were older than those undergoing surgery by approximately thirty years. These trends are consistent with those identified in the last annual report.

The patient-reported outcome data suggest that patients perceive their health and symptoms to improve during the first 5 post-operative years. However, given the fact that the ICRS Registry was only launched in 2016, the long-term data remains lacking. Encouragingly, the current compliance rate for questionnaire completion fluctuates between 65-75%. While the Registry automatically sends up to 3 email reminders to patients to complete their questionnaires, it should be noted that clinicians can prompt additional automated email reminders for patients whose questionnaires remain overdue.

Patients whose questionnaires are overdue are flagged for clinicians when they log in to their portal, and an email icon next to the flagged patient can be clicked to activate an additional reminder.

As described in our last annual report, patients reporting the absence of complications to registries are commonly seen as reliable, but it can be difficult for patients to attribute complications they perceive after treatment correctly. Complications after cartilage restoration procedures are thankfully uncommon. One of the strengths of "Big Data" sets that registries can deliver is that they allow us to capture uncommon events. Given how important it is to allow us to correctly counsel our patients pre-operatively on the risks that our patients may face by undergoing our interventions, further data on post-operative complications would be extremely useful, and we encourage our users to please complete the no complication/complication data set in the future.

Overall, ICRS Registry data suggests that joint preservation continues to rely on a personalised treatment plans which not only combines surgical approaches, but later during the patient journey, also involves other non-surgical treatments such as injections. As our patients are followed-up longer-term, it will become increasingly interesting to observe how their treatment pathways develop. The data this Registry will produce in coming years will therefore serve as an important adjunct to the long-term randomised controlled clinical trials in joint preservation that are currently underway.

There remain many unanswered questions in the field of joint preservation. Therefore, the ICRS community must continue contributing to our Patient Registry. We recommend that clinicians and delegate users of the Registry encourage their patients to enrol. This will improve the amount of data we can capture in the Registry, and provide better opportunities for patient follow-up, without burdening the clinicians.

We are grateful to the ICRS Executive leadership for their ongoing support and encouragement, and are indebted to those members of the ICRS and other users who have so generously entered their patient data to enable us to produce this report. We look forward to the dataset growing and the increasingly granular conclusions that we can draw from our combined efforts. None of this would be possible without the generous financial support of our sponsors and the ICRS. Thank you to you all for your ongoing contribution to the Registry fulfilling its mission statement's aims and objectives.

Appendix A – Prior Treatments

Table A: Type of surgical procedures undergone by patients prior to enrolment in ICRS Patient Registry.

Procedure	Number of Patients	Percentage of Patients (%)
Debridement of Cartilage Defect	288	36.3
Subchondral Marrow Stimulation & Debridement of Cartilage Defect	117	14.8
No Cartilage Procedures	98	12.4
Debridement of Cartilage Defect & Subchondral Marrow Stimulation	54	6.8
Subchondral Marrow Stimulation	41	5.2
Debridement of Cartilage Defect & Mosaicplasty/OATS	30	3.8
Microfracture Alone	30	3.8
Mosaicplasty/OATS	14	1.8
Bone Graft & Debridement of Cartilage Defect	13	1.6
Subchondral Marrow Stimulation & Cap/Implant & Debridement of Cartilage Defect & ACI	13	1.6
Subchondral Marrow Stimulation & Debridement of Cartilage Defect & Mosaicplasty/OATS	12	1.5
Other	11	1.4
Cap/Implant & Debridement of Cartilage Defect & ACI	10	1.3
Debridement of Cartilage Defect & Microfracture Alone	10	1.3
Debridement of Cartilage Defect & Mosaicplasty/OATS & Subchondral Marrow Stimulation	7	0.9
Subchondral Marrow Stimulation & Bone Graft & Debridement of Cartilage Defect	5	0.6
Bone Graft	4	0.5
Bone Graft & Debridement of Cartilage Defect & Subchondral Marrow Stimulation	4	0.5
ACI	3	0.4
Cap/Implant & Debridement of Cartilage Defect & ACI & Subchondral Marrow Stimulation	3	0.4
Microfracture Alone & Other	3	0.4
Cap/Implant & Cap/Implant & Debridement of Cartilage Defect & ACI & Subchondral Marrow Stimulation	2	0.3
Debridement of Cartilage Defect & Other	2	0.3
Scaffold Alone	2	0.3
Subchondral Marrow Stimulation & Bone Graft & Debridement of Cartilage Defect & Mosaicplasty/OATS	2	0.3
Subchondral Marrow Stimulation & Cap/Implant & Cap/Implant & Debridement of Cartilage Defect	2	0.3
Augmented Microfracture & Other	1	0.1
Bone Graft & Debridement of Cartilage Defect & Mosaicplasty/OATS	1	0.1
Bone Graft & Debridement of Cartilage Defect & Mosaicplasty/OATS & Subchondral Marrow Stimulation	1	0.1
Cap/Implant & Cap/Implant & Debridement of Cartilage Defect	1	0.1
Cap/Implant & Cap/Implant & Debridement of Cartilage Defect & Mosaicplasty/OATS & Subchondral Marrow Stimulation	1	0.1
Cap/Implant & Debridement of Cartilage Defect & Microfracture Alone & Other	1	0.1
Cap/Implant & Mosaicplasty/OATS	1	0.1
Cap/Implant & Other	1	0.1
Microfracture Alone & Mosaicplasty/OATS	1	0.1
Subchondral Marrow Stimulation & Bone Graft	1	0.1
Subchondral Marrow Stimulation & Bone Graft & Mosaicplasty/OATS	1	0.1
Subchondral Marrow Stimulation & Cap/Implant & Debridement of Cartilage Defect & Mosaicplasty/OATS & ACI	1	0.1
Subchondral Marrow Stimulation & Mosaicplasty/OATS	1	0.1

Table B: Details of non-cartilage procedures carried out on patients prior to their enrolment in the ICRS Patient Registry.

Procedure	Number of Patients	Percentage of Patients (%)
Meniscal Surgery	141	24.2
Loose Body Removal	111	19.1
Meniscal Surgery & Ligament Surgery	33	5.7
ORIF	33	5.7
Extensor Mechanism Surgery	27	4.6
Loose Body Removal & Meniscal Surgery	22	3.8
Ligament Surgery	17	2.9
Osteotomy	12	2.1
Osteotomy & Meniscal Surgery	11	1.9
ORIF & Hardware Removal	9	1.5
Loose Body Removal & ORIF	8	1.4
Drilling and Pinning	7	1.2
Extensor Mechanism Surgery & Meniscal Surgery	7	1.2
I&D washout for infection & Meniscal Surgery	6	1.0
Loose Body Removal & ORIF & Hardware Removal	5	0.9
Osteotomy & Extensor Mechanism Surgery	5	0.9
Osteotomy & Extensor Mechanism Surgery & Hardware Removal	5	0.9
Extensor Mechanism Surgery & Loose Body Removal	4	0.7
Meniscal Surgery & Other	4	0.7
ORIF & Hardware Removal & Meniscal Surgery	4	0.7
ORIF & Meniscal Surgery	4	0.7
Hardware Removal	3	0.5
Manipulation	3	0.5
Osteotomy & Extensor Mechanism Surgery & Meniscal Surgery	3	0.5
Osteotomy & Hardware Removal & Meniscal Surgery	3	0.5
Osteotomy & Loose Body Removal & Meniscal Surgery	3	0.5
Refixation	3	0.5
Bone Graft & Meniscal Surgery	2	0.3
Extensor Mechanism Surgery & Ligament Surgery	2	0.3
Extensor Mechanism Surgery & Ligament Surgery & Meniscal Surgery	2	0.3
Extensor Mechanism Surgery & Loose Body Removal & Meniscal Surgery	2	0.3
Hardware Removal & Meniscal Surgery	2	0.3
I&D Washout for Infection	2	0.3
Ligament Surgery & Other	2	0.3
Loose Body Removal & ORIF & Meniscal Surgery	2	0.3
ORIF & Hardware Removal & Ligament Surgery	2	0.3
Osteotomy & Lateral Release & Hardware Removal & Meniscal Surgery	2	0.3
Osteotomy & ORIF	2	0.3
Patellectomy & Meniscal Surgery	2	0.3
Physeal Staples	2	0.3
Plica Excision	2	0.3
Removal of Corpus Liberum	2	0.3
Bioabsorbable Screw	1	0.2
Bone Cement Packing	1	0.2
Carbon Fibre Rods	1	0.2
Chondroplasty & Meniscal Surgery	1	0.2

Excision of Plica & Synovitis & Meniscal Surgery	1	0.2
Exploration of Peroneal Nerve	1	0.2
Extensor Mechanism Surgery & Hardware Removal	1	0.2
Extensor Mechanism Surgery & Loose Body Removal & ORIF	1	0.2
Extensor Mechanism Surgery & Loose Body Removal & ORIF & Hardware Removal	1	0.2
Extensor Mechanism Surgery & MPFL Reconstruction & Patella Microfracture	1	0.2
Extensor Mechanism Surgery & Patellofemoral Surgery	1	0.2
External Fixation	1	0.2
External fixation Fasciotomies	1	0.2
Fasciotomy	1	0.2
Fixation of OCD	1	0.2
Fracture Repair & Meniscal Surgery	1	0.2
Hardware Removal & Ligament Surgery	1	0.2
Hardware Removal & Meniscal Surgery & Ligament Surgery	1	0.2
I&D & Bone Plugs & Manipulation & Osteotomy & Hardware Removal & Meniscal Surgery	1	0.2
Irrigation & Lysis of Adhesions & Meniscal Surgery	1	0.2
Ligament Surgery & Lateral Tenodesis	1	0.2
Ligament Surgery & Patellofemoral Surgery	1	0.2
Loose body removal & Debridement	1	0.2
Loose Body Removal & Hardware Removal	1	0.2
Loose Body Removal & Ligament Surgery	1	0.2
Loose Body Removal & Meniscal Surgery & Ligament Surgery	1	0.2
Loose Body Removal & ORIF & Hardware Removal & Meniscal Surgery	1	0.2
Loose Body Removal & Osteochondritis Dissecans Fixation	1	0.2
Meniscal Surgery & Ligament Surgery & Osteotomy	1	0.2
Meniscal Surgery & Loose Body Removal	1	0.2
Microfracture	1	0.2
Microfracture & Meniscal Surgery	1	0.2
ORIF & Fasciotomy	1	0.2
ORIF & OCD Fixation	1	0.2
Osteochondritis Dissecans Fixation	1	0.2
Osteotomy & Extensor Mechanism Surgery & Hardware Removal & Meniscal Surgery	1	0.2
Osteotomy & Extensor Mechanism Surgery & Ligament Surgery & Meniscal Surgery	1	0.2
Osteotomy & Extensor Mechanism Surgery & Loose Body Removal & Meniscal Surgery	1	0.2
Osteotomy & Extensor Mechanism Surgery & ORIF	1	0.2
Osteotomy & Extensor Mechanism Surgery & ORIF & Hardware Removal & Meniscal Surgery	1	0.2
Osteotomy & Hardware Removal & Meniscal Surgery & Ligament Surgery	1	0.2
Osteotomy & Ligament Surgery	1	0.2
Osteotomy & ORIF & Meniscal Surgery	1	0.2
Osteotomy & Other	1	0.2
Osteotomy & Other & Extensor Mechanism Surgery	1	0.2
Osteotomy & Other & Extensor Mechanism Surgery & Loose Body Removal & Hardware Removal	1	0.2
Patellar Surgery & Meniscal Surgery	1	0.2
Patellar Tendon Reconstruction	1	0.2
Patellectomy	1	0.2
PCC & Meniscal Surgery	1	0.2
Periosteum Implant	1	0.2
Periosteum Implant & Meniscal Surgery	1	0.2

Pin fixation	1	0.2
Removal Screws & Debridement	1	0.2
Slurry Graft	1	0.2
Synovectomy	1	0.2
Synovectomy & Meniscal Surgery	1	0.2
Tendon Surgery	1	0.2
Tibia Plateau Reconstruction	1	0.2

Table C: Breakdown of the meniscal procedures prior to Registry enrolment.

Meniscus	Number of Patients (% across all meniscal surgery)	Type of Surgery	Number of Patients (% within meniscal type)
Medial Meniscus	257 (52.9)	Partial Meniscectomy	96 (37.3)
		Total Meniscectomy	8 (3.1)
		Meniscectomy (Unknown)	22 (8.6)
		Repair	2 (0.8)
		Transplant	1 (0.4)
		Unknown Surgery	128 (49.8)
Lateral Meniscus	154 (31.7)	Partial Meniscectomy	49 (31.8)
		Total Meniscectomy	24 (15.6)
		Meniscectomy (Unknown)	0 (0.0)
		Repair	1 (0.6)
		Transplant	0 (0.0)
		Unknown Surgery	80 (51.9)
Medial and Lateral Menisci	75 (15.4)	Partial Meniscectomy Medial/Partial Meniscectomy Lateral	21 (28.0)
		Partial Meniscectomy Medial/Total Meniscectomy Lateral	2 (2.7)
		Partial Meniscectomy Medial/Unknown Meniscectomy Lateral	2 (2.7)
		Unknown Meniscectomy Medial/Partial Lateral	6 (8.0)
		Unknown Meniscectomy Medial/Total Meniscectomy Lateral	1 (1.3)
		Total Meniscectomy Medial/Total Meniscectomy Lateral	3 (4.0)
		Total Meniscectomy Medial/Partial Meniscectomy Lateral	6 (8.0)
		Total Meniscectomy Medial/Unknown Meniscectomy Lateral	1 (1.3)
		Unknown Meniscectomy Medial/Unknown Meniscectomy Lateral	33 (44.0)

Appendix B – Underlying Causes of Injuries

Table D: Underlying causes of chondral injuries

Underlying Cause	Number	Percentage (%)
Osteochondritis Dissecans (OCD)	222	30.3
Damaged Chondral Lesion (DCL)	159	21.7
Osteoarthritis	87	11.9
Traumatic Cartilage Injury (TCI)	76	10.4
Osteonecrosis / AVN	58	7.9
Failed Osteochondral Allograft	27	3.7
Tibial Plateau Fracture	24	3.3
Other	9	1.2
Chondromalacia Patella	4	0.5
Chondral Injury	3	0.4
Patella Instability	3	0.4
Chondromalacia Patella & Chondromalacia Trochlea	3	0.4
DCL & Failed Osteochondral Allograft	2	0.3
OCD & DCL	2	0.3
Varus Malalignment	2	0.3
Valgus Malalignment	2	0.3
Chondromalacia Patella & Patella Maltracking	2	0.3
Patella Maltracking	2	0.3
Chondromalacia Trochlea	2	0.3
Postmeniscectomy Syndrome	1	0.1
Osteochondritis Dissecans & TCI	1	0.1
Osteochondritis Dissecans & Patella Instability	1	0.1
Osteochondritis Dissecans & Osteoarthritis	1	0.1
Osteochondritis Dissecans & Failed OATS	1	0.1
Osteochondral Fracture & Meniscal Tear/Deficiency	1	0.1
Meniscal Tear/ Deficiency	1	0.1
DCL & TCI	1	0.1
Malpositioned ACL Reconstruction	1	0.1
Osteochondral Fracture & Osteoarthritis	1	0.1
Chondral Injury & Patella Instability	1	0.1
Postmeniscectomy Syndrome & Varus Malalignment	1	0.1

Appendix C – Data on Patients with 3 or 4 Locations of Cartilage Damage

Table E: The average area of cartilage damage reported in patients with three or more involved areas.

Type	Number of Locations Involved	Number of Patients	Average Area (mm^2)	SD
Lateral Plateau Medial Femoral Condyle Lateral Femoral Condyle	3	1	6.00	N/A
Medial Plateau Lateral Plateau Lateral Femoral Condyle	3	1	5.00	N/A
Medial Plateau Lateral Plateau Patella	3	3	13.42	9.35
Medial Plateau Patella Lateral Femoral Condyle	3	1	17.60	N/A
Medial Plateau Patella Medial Femoral Condyle	3	4	7.76	3.78
Trochlea Lateral Plateau Lateral Femoral Condyle	3	1	6.25	N/A
Trochlea Lateral Plateau Patella	3	4	7.37	0.91
Trochlea Medial Femoral Condyle Lateral Femoral Condyle	3	5	11.57	5.03
Trochlea Medial Plateau Lateral Plateau	3	1	27.00	N/A
Trochlea Medial Plateau Medial Femoral Condyle	3	5	15.67	13.28
Trochlea Medial Plateau Patella	3	3	9.00	1.73
Trochlea Patella Lateral Femoral Condyle	3	6	12.58	9.02
Trochlea Patella Medial Femoral Condyle	3	10	19.16	7.64
Medial Plateau Lateral Plateau Patella Lateral Femoral Condyle	4	1	17.00	N/A
Trochlea Lateral Plateau Patella Lateral Femoral Condyle	4	2	8.87	8.30
Trochlea Medial Plateau Lateral Plateau Patella	4	2	14.75	6.01
Trochlea Medial Plateau Patella Lateral Femoral Condyle	4	1	10.80	N/A
Trochlea Medial Plateau Patella Medial Femoral Condyle	4	1	N/A	N/A
Trochlea Patella Medial Femoral Condyle Lateral Femoral Condyle	4	2	78.00	N/A
Trochlea Medial Plateau Lateral Plateau Patella Medial Femoral Condyle Lateral Femoral Condyle	6	2	11.06	2.91

An additional treatment was reported at a third location of the knee for 78 patients (Table F). As with the primary and secondary procedures, the medial condyle was treated the most (Table F).

Table F: Number of locations treated by anatomical site as a third treatment.

	Lateral Condyle		Lateral Plateau		Medial Condyle		Medial Plateau		Patella		Trochlea	
	N	%	N	%	N	%	N	%	N	%	N	%
Number of Patients	6	7.7	4	5.1	24	30.8	6	7.7	15	19.2	23	29.5

Seventy-six of these patients were known to have undergone an osteochondral allograft repair (97.4%). Three-quarters of patients had a plug graft (76.3%), and the remaining quarter had a shell graft (23.7%).

The plugs had a mean diameter of 18.0±5.5mm and a depth of 7.1±2.7mm. The average area was 3.9±2.2cm^2. The shells had a mean depth of 8.4±2.7mm and an average area of 8.7±7.3cm^2.

The third treatment site therefore appeared slightly larger than the second treatment site. One reason for this is that patients requiring the treatment of multiple areas during one procedure may have larger defects than patients requiring the treatment of one singular defect.

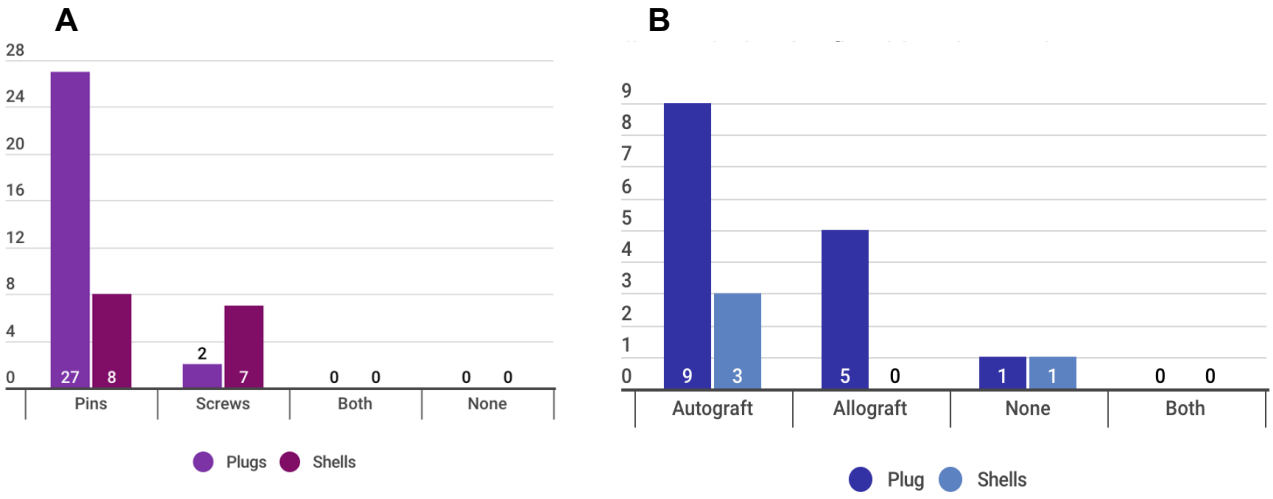

Figure A: Allograft fixation used with the plugs and shells for the third treatment; Figure B: Number of additional bone grafts performed.

Some patients underwent treatment at a fourth site during their surgical procedure. Detailed information was available for 22 patients, but the trochlea was the location most commonly reported (Table F)

Table F: Number of locations treated by anatomical site as a fourth treatment.

	Lateral Condyle		Lateral Plateau		Medial Condyle		Medial Plateau		Patella		Trochlea	
	N	%	N	%	N	%	N	%	N	%	N	%
Number of Patients	4	18.2	0	0.0	4	18.2	3	13.6	4	18.2	7	31.8

All patients underwent an osteochondral allograft repair. One-fifth had a shell graft (18.2%). The remaining patients had a plug graft (81.8%).

The plugs had a mean depth of 8.4±12.0mm and an average area of 2.9±1.2cm^2. Whereas the shells had a mean depth of 5.5±2.1mm and an average area of 4.7±4.2cm^2.

Data on fixation was available for 7 patients who underwent a plug graft (38.9%) and 3 of the shell graft patients (75.0%). All grafts reported were fixed by pins. One additional autograft was also reported.

User Assistance

If you would like to become a user of the Registry, please visit the ICRS website: https://cartilage.org/sign-up-icrs-registry/

SCAN ME

To learn how to use the Registry, visit our tutorials: https://cartilage.org/society/icrs-patient-registry/tutorials/

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You may also wish to view our ICRS Registry Workshop from February 2023: https://www.youtube.com/watch?v=j8bWg3CMx5E

Patients can enrol themselves in the Registry, if their clinician is already registered, by visiting the following site: https://secure.amplitude-registry.com/ICRS/patient-portal?pce=true

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If you require assistance or have any questions about using the Registry, please contact us on registry@cartilage.org.

Acknowledgements

We thank the ICRS members and sponsors for their continuing support of the Registry.

Your feedback is important to the ongoing development of the Registry and subsequent annual reports. Please address feedback to us by email on registry@cartilage.org.

This document is accessible at the ICRS website: https://cartilage.org/society/icrs-patient-registry/

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