

Post-ACL Reconstruction Rate of Return to Sport at 2-Year Follow-Up

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Abstract

Introduction: Anterior cruciate ligament (ACL) ruptures are a common sports injury. However, research into the prognosis of local patients returning to amateur sport has been limited. This paper aims to determine factors which may significantly influence rate of return to sports after ACL reconstruction surgery in our local patients. Orthopedic surgeons will be better equipped with this data to counsel patients on their prognosis for return to sport.

Hypothesis: Based on previous studies done on post-ACL reconstruction outcomes, we postulate that young age, male gender and high pre-operative knee function scores would all have a positive effect on the patient's likelihood of returning to sport. For the purpose of this paper, return to sport constitutes a return to a patient's pre-injury Tegner score.

Methods: We retrospectively analyzed a prospectively-collected database of 165 patients who had undergone ACL reconstruction surgery under 3 consultant orthopedic surgeons at Singapore General Hospital (SGH) in 2015, and compared their age, sex, body mass index (BMI), pre-operative Lysholm knee and Tegner activity scores with minimum 2-year follow-up. International Knee Documenting Committee (IKDC) scores for knee function were also measured pre-operatively and at every follow-up up to 2 years. Patients were also interviewed regarding post-surgical self-reported outcomes, in particular participation in sport. We excluded patients with a pre-injury Tegner score below 4. In total, the data of 83 patients was collected and analyzed.

Results: Data analysis was performed using R (Version 3.22) [R core Team, 2015]. Binomial logistic regression was used to analyze factors that may influence the patient's return to sports. All comparisons were two-tailed and a P-value <0.05 was considered statistically significant. Utilizing a p-value of 0.05, none of the abovementioned postulated factors were found to have statistically significant impact on the rate of return to sport.

Limitations & Conclusions: The sample size of 83 patients is relatively small and could benefit from having a larger pool of patients. Also, a minimally mandated 2-year follow-up period meant that many patients were likely to be uncontactable or lost to follow up, given the large proportion of foreign expatriates within the patient pool.

This study has found that age, gender, BMI, pre-operative knee scores are not significant factors affecting rate of return to sport. However, this opens up possibilities for future studies to target other factors including psychological factors, adherence to physiotherapy, surgical technique and choice of graft.

Keywords: Anterior Cruciate Ligament Reconstruction; Return to sport; Anterior Cruciate Ligament; IKDC score; Orthopedic Surgery; Knee Surgery.

Abbreviations: ACL – Anterior cruciate ligament; SGH – Singapore General Hospital; IKDC – International Knee Documenting Committee; BMI – Body mass index; ACL-RSI – Anterior cruciate ligament return to sport after injury; IRB – Institutional Review Board

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Introduction

ACL tear is well-established as one of the most common knee injury caused by sports (Aydemir, 2018), and they are increasingly common among younger patients in Singapore. It has been found that roughly 82.4% of ACL injuries can be attributed to sport. As the government continues to encourage healthier lifestyles and incentivizing participation in sport, doctors and surgeons face an increasing number of patients with ACL injuries. Kim, *et al.* predicted a rise in ACL reconstructions by 77% from 1996 to 2006 in the United States, attributed to the population exercising more often.

A good indicator of success of surgery has been widely considered to be the ability to return to baseline function, or to previous levels of athletic activity (Kvist, 2004). As these patients tend to be younger athletes with greater functional needs and requirements (Prentice, 2018), the importance of post-surgical return to function cannot be overstated.

However, despite its importance, minimal research has been undertaken recently in the local context. Post-surgical outcomes of ACL tears and reasons for ACL surgery failure have not been well-documented, as studies tend to analyze 5- to 10-year follow-up periods rather than more immediate post-surgical outcomes. Research on the Western patient populations, however, may not be fully applicable to local patients due to differing epidemiology, beliefs and practices. This gap in knowledge can affect the patient's ability to make a decision regarding conservative versus surgical therapy.

Psychological readiness has been thoroughly studied as a positive predictive indicator of post-surgical knee function. In fact, scores like the ACL-Return to Sport after Injury (ACL-RSI) scale have been developed to measure an athlete's level of kinesophobia or willingness to comply with rehabilitation (Bonasia, 2018). These factors have a heavy bearing on patient-reported outcomes, which should be regarded as a cornerstone in medical research since it is a measure of the patient's perception of his treatment.

Return to sport is generally accepted as an important outcome measure of surgery. Hence, this research paper aims to improve local knowledge regarding the prognosis of patients undergoing ACL surgery, as well as target certain variables identified as crucial to the rehabilitation process and return to sport. It will help to guide post-surgical management and provide a better idea of patients' prognosis.

The primary hypotheses of this study are that age, BMI, psychological factors and pre-operative knee scores are important predictive indicators of post-surgical knee function and ability to return to sport. This study would serve to identify which of such disputed factors are indeed influential in post-surgical outcome.

Literature Review

This study aims to identify the most pertinent factors determining post-ACL reconstruction outcomes. From a basic literature review, it was revealed that studies on post-ACL reconstruction outcomes in a local context have been quite limited. One study which is more pertinent to the research question was Lee in 2008 who undertook a study based on patients with minimum 5-years follow-up. He reported a rate of return to sport of 62%. Yet, he claimed that different follow-up periods would alter the rate of return to sport. This paper thus has a role in improving knowledge of post-ACL reconstruction outcomes over a more immediate follow-up period of 2 years. Thus, there is value in conducting this study as most athletes would be eager to return to sport and would like to know more immediate outcomes.

Citation: Dominic Lim, *et al.* "Post-ACL Reconstruction Rate of Return to Sport at 2-Year Follow-Up". *Orthopaedic Surgery and Traumatology* 2.5 (2018): 387-396.

More recent studies place the rate of return to sport around this range of 50-70%. (Rosso, 2018-57.6%, Hamrin Senorski, 2016-54%, Ardern, 2010-67%, Gobbi, 2006-65%) These studies were done based on different cultural and ethnic contexts, which could contribute to the observed disparity. Further, it is noted that earlier studies report higher levels of return to sport than more recent studies. This could perhaps be further explored.

Many studies corroborate on factors affecting post-surgical outcomes of ACL reconstruction. Age has been found to significantly affect post-surgical outcomes. One study reported that children enjoyed the highest rate of return to sport, 78.6% (Kay, 2018). Another substantiates this with 85% return to sport for children (Placella, 2016). Patients in the young adult age range have poorer prognosis, with poorer compliance to physiotherapy cited as a possible reason (Miller, 2017). Other studies have also postulated that age was not a significant factor in determining a patient's likelihood of returning to sport (Iorio, 2018 & Tay, 2018).

Some papers report a positive relationship between male gender and return to sport. In a recent study done in 2018, 39 out of 92 males who underwent ACL reconstruction returned to sport, compared to 1 out of 18 females (Cheecharern, 2018). Ardern in 2010 also found that men were 1.5 times more likely to return to sport than women. Such findings are corroborated by multiple studies suggesting a similar trend (Hamrin Senorski, 2018), (Lin, 2018). Some studies further suggest that men fare better in objective knee function scores than women (Webster, 2017).

A high BMI has also been linked to poor surgical outcomes in terms of poorer knee function and activity (Senorski, 2018). There has been evidence to suggest that patient-reported outcomes in obese patients are similar to those who are of acceptable weight, but they fare worse in objective scores (DiSilvestro, 2017). However, research in this area is still lacking.

Post-injury pre-operative knee function scores have been shown to demonstrate a positive relationship with a patient's likelihood of return to sport. (Hamrin Senorski, 2016 & Thomeé, 2008) This has been linked with psychological factors which are taken into consideration in the ACL-RSI score (Webster, 2018). Some psychological factors like fear of re-injury, mood and emotions have been quoted as having significant impact (Ardern, 2013), but this has been shown to be debatable in its efficacy of affecting patient's return to sport (Coronado, 2018).

As previously mentioned, adherence to physiotherapy post-surgery was cited as a possible reason for better post-surgical outcomes. However, studies with in-depth analysis on comparing rate of return to sport with adherence to physiotherapy have been limited and difficult to conduct. Future studies may look towards a possibility of analyzing adherence to physiotherapy as a possible factor.

Some have also postulated a difference in outcomes between techniques or grafts used in ACL reconstruction. A postulated "over-the-top" combined intra- and extra-articular technique was shown to have improved outcomes (Rosso, 2017). However, some studies found no superior technique in ACL reconstruction in the comparison between a single bundle and double-bundle ACL reconstruction technique (Liu, 2016). This suggests the possibility of differing outcomes using different surgical techniques.

In terms of usage of grafts, hamstring grafts are postulated to yield better outcomes in terms of knee function and symptoms as compared to the use of bone-patellar tendon-bone grafts (Zaffagnini, 2006). However, this is complicated by a possible higher failure rate of hamstring grafts (Laboute, 2018). Hence, there is further potential for exploration into surgical techniques and graft choices affecting surgical outcomes.

Materials and Methods

The Institutional Review Board (IRB) at the author's institution defined this study as exempt from IRB approval on the grounds that it is an observational analytic study with a retrospective study design on a well-established surgical procedure without a control group. Data on variables deemed as likely to influence the level of return to sport, specifically those of age, gender, BMI, pre-operative knee function scores were identified and studied. Of those who did not return to sport or returned to a lower level of sport, their reasons were explored.

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One hundred and sixty-five patients who were diagnosed with ACL tear and underwent ACL surgery at Singapore General Hospital in 2015 were included in this study. Patients included sustained an ACL injury and underwent surgical reconstruction with a minimum 2-year follow-up. Fourteen patients who had a pre-injury Tegner score of less than 4 were excluded as they were deemed to not play sports regularly. Sixty patients were uncontactable and 8 patients were unwilling to participate in the study, leaving a remainder of 83 patients participating in this study.

All patients identified underwent either left or right knee arthroscopic anterior cruciate ligament reconstruction, performed by 1 of 3 experienced orthopedic surgeons at SGH. Some patients who suffered concomitant meniscal tear also underwent meniscectomy at the same surgery. All patients underwent standard post-reconstruction physiotherapy and rehabilitation and were regularly followed up.

All patients completed the IKDC subjective and objective scores, Lysholm Knee and Tegner activity questionnaires pre-operatively. Patients were interviewed via telephone at minimum 2-year follow-up to determine the level of return to sport and current knee function. All patients also underwent KT-1000 arthrometer physical examination stability testing, all of the above assessed by qualified physiotherapists. The Tegner score was used to define return to sport, which was deemed as a pre-operative Tegner of more than 3, i.e. playing sports regularly. The IKDC and Lysholm scores were used for objective and subjective evaluation of knee function respectively.

Results and Discussion

In total, 151 patients were included in the study, with those having a Tegner score of less than 4 prior to injury already being excluded. Of the 151 patients, 8 were unwilling to participate in the study and 60 were uncontactable, leaving a sample population of 83.

Figures on patient demographics, pre-operative subjective knee function scores and objective knee function scores are reported below. For categorical variables, a percentage is used to present the data. For continuous variables, the means and standard deviations are calculated and compared to the sample size.

Data analysis was performed using R (Version 3.22) [R core Team, 2015]. Binomial logistic regression was used to analyze factors that may influence the patient’s return to sports. All comparisons were two-tailed and a P-value <0.05 was considered statistically significant.

Sample population analysis

Out of the 83 who were interviewed, 61 were males (73.5%) and 22 were females (26.5%). In terms of race, 51 were Chinese (61.4%), 20 were Indian (24.1%), 8 were Malay (9.6%) and 4 were of other races (4.8%). Figure 1 demonstrates the epidemiology clearly.

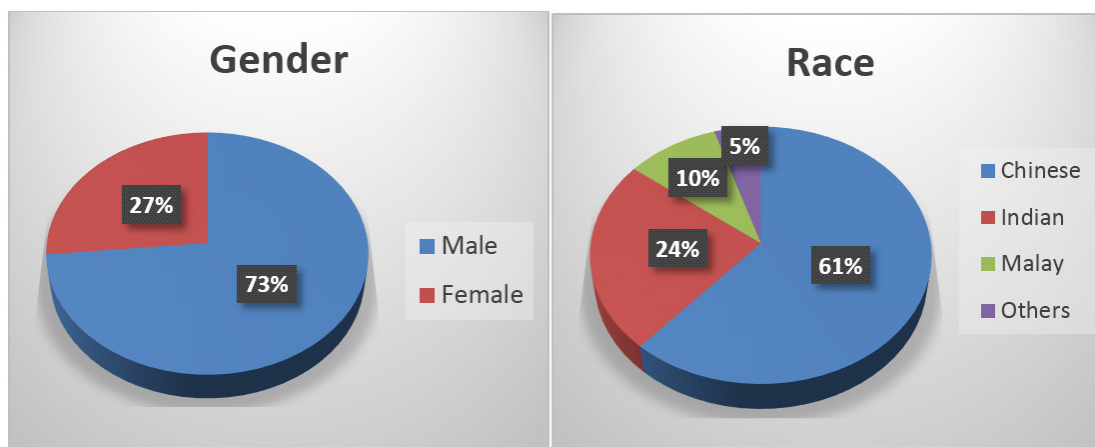


Figure 1: Gender and race profiles of the sample population.

The BMI ranges were calculated according to Asian standards for the Indians, Chinese and Malays, where underweight is classified as $<18.5 \text{ kg/m}^2$, acceptable is $18.5\text{-}23 \text{ kg/m}^2$, overweight is $23\text{-}27.5 \text{ kg/m}^2$ and obese is $>27.5 \text{ kg/m}^2$. The normal international BMI cutoffs were used instead for those of other races as the patients were all of Caucasian descent.

According to these cutoffs, 2 participants are classified as underweight (2.5%), 31 are classified acceptable (38.3%), 27 are overweight (33.3%) and 21 classified as obese (25.9%), with 2 participants having missing measurements. This stratification into weight groups facilitates a categorical analysis for BMI which is essential as standards for BMI differ for the patients of Caucasian descent. This is shown in Figure 2.

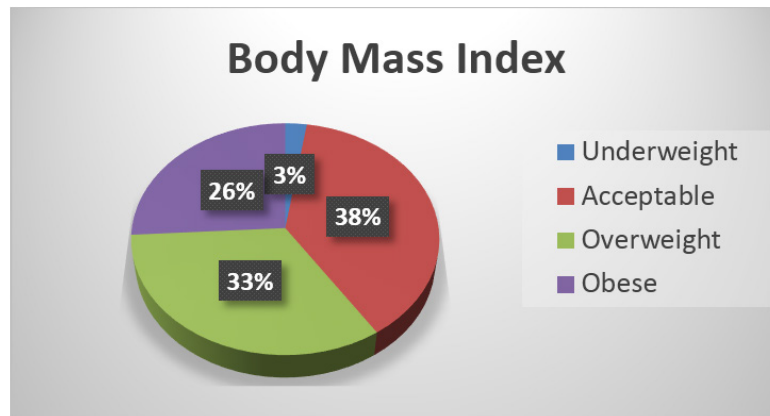


Figure 2: BMI profile of sample population.

As for the continuous variables, the means and estimates of standard deviation for each factor was taken into account.

- In terms of age at the time of injury, the mean age was 28 years old with an estimated standard deviation of 9.14.
- The average BMI among the patient pool was 24.8 with an estimated standard deviation of 27.3.
- Statistical analysis of patients' pre-operative Lysholm score and pre-injury Tegner score was carried out.
- The mean Lysholm score was 64.8 with an estimated standard deviation of 84.9.
- The mean pre-injury Tegner score was 7.13 with an estimated standard deviation of 8.20.

The commonest main sport played was soccer, with 32 out of 83 patients playing. This was followed by basketball/netball with 18 out of 83 patients playing and rugby/touch rugby with 6 out of 83 patients playing, as shown in Figure 3.

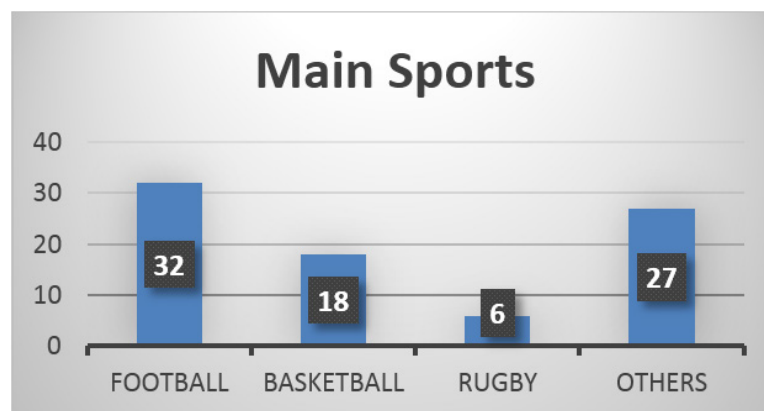


Figure 3: Main sports.

Calculating the overall return to sport rate, 57 out of 83 patients returned to some level of sport (68.7%). Of the 57, 40 returned to the same levels as before (48.2%). 26 did not return to their previous sports (31.3%). Overall satisfaction rate was 45.8%, with 38 out of 83 patients reporting that their knee is similar or better than before injury. The percentage mean of patient-reported function of the knee at 2 years post-operation was 81.4%.

For the 43 patients who failed to return to their previous levels of sport, their reasons were analyzed: 20 cited a phobia of re-injury as part of their reason for not being able to return to sport. 14 cited an inferior knee function barring them from rejoining their sports at the same level, while 7 cited confirmed re-injuries to either knee that stopped them from rejoining their sports. 14 cited non-injury and non-surgery related reasons like being busy at work or school, or losing interest in the sport. Patients were allowed to cite multiple reasons. Figure 4 illustrates the proportion of patients returning to sport and the commonest reasons for not doing so.

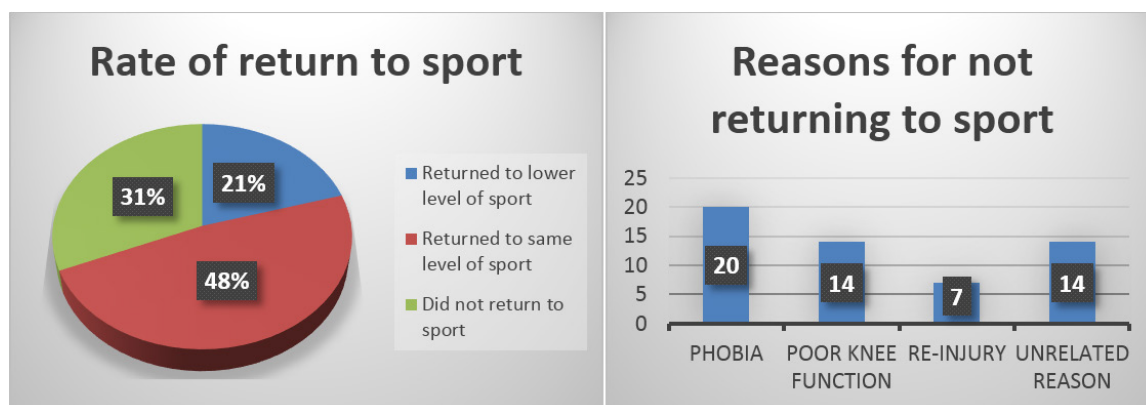


Figure 4: Rate of return to sport and reasons for not doing so.

Categorical and continuous analyses

The continuous analysis and attainment of p-values for each factor was achieved by input of data into R software and carrying out logistical regression analysis. For analysis of age with return to sport, a p-value of 0.087 was reported, which is higher than the level of statistical significance of 0.05. This means that there is some correlation between age and return to sport but this cannot be proven to be statistically significant.

For the analysis of gender, a categorical analysis yields that males may have a higher rate of return to sport than females, illustrated in Figure 5:

- Males had a higher return to sport rate than average. 43 males returned to sport (70.5%) out of 61, 30 of whom returned to the same level (49.2%).
- Females had a return to sport rate of 63.6%, with 14 out of 22 returning to sport, and 10 of whom returned to the same level (45.5%).

However, a continuous variable analysis yields a p-value of 0.313, above the level of statistical significance. Analysis of BMI as a continuous variable yielded a p-value of 0.980. This is hence statistically insignificant. However, to corroborate findings, the analysis for BMI was supplemented with a categorical analysis to decrease confounding by differing standards across ethnicities. The results, excluding the subjects with missing data, are shown in Figure 6:

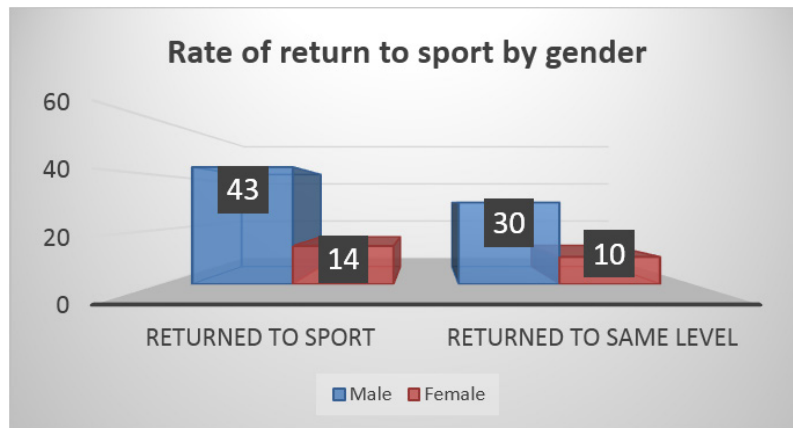


Figure 5: Rate of return to sport by gender.

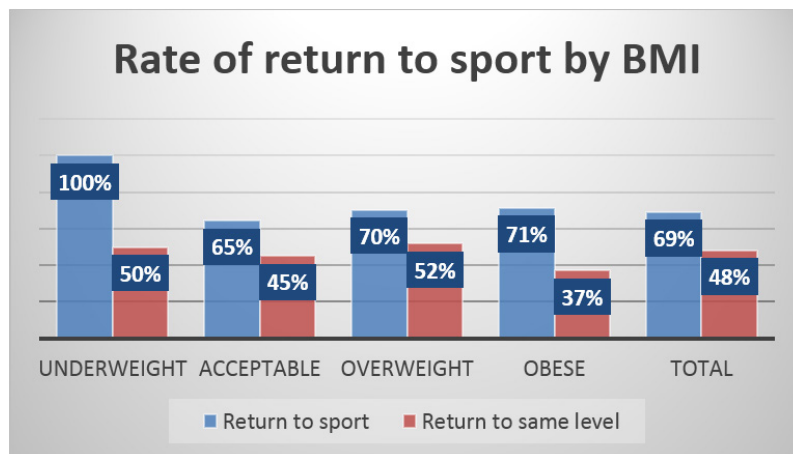


Figure 6: Rate of return to sport by BMI.

This set of results does not demonstrate any significant relationship between BMI and return to sport and corroborates the results found via continuous analysis.

Analysis of pre-operative Lysholm scores yielded a p-value of 0.266, above the level of statistical significance. Pre-operative Lysholm scores were hence deemed to be insignificant in predicting a patient’s likelihood of returning to sport. Pre-injury Tegner scores were also found to be statistically insignificant, with a p-value of 0.792.

All IKDC scoring systems also did not yield significant p-values. These were ranging from 0.41 to 0.99. KT arthrometer measurement of side-to-side distance also yielded a p-value of 0.791, above the level of significance. All pre-operative knee evaluation scores thus had low predictive value in the patients’ eventual rate of return to sport.

Surgeon-specific analysis

Surgeon B had both the highest rate of return to sport, at 71.7%, as well as the highest rate of return to sport at the same level at 50%. Surgeon B also operated on the most patients, 46. As all surgeons have preferred surgical techniques and methods, this shows a possible advantage in outcomes of a certain technique over others, specifically, the method used by surgeon B. The numbers are shown in Figure 7 below. Further studies into advantages of certain techniques over others are hence warranted.

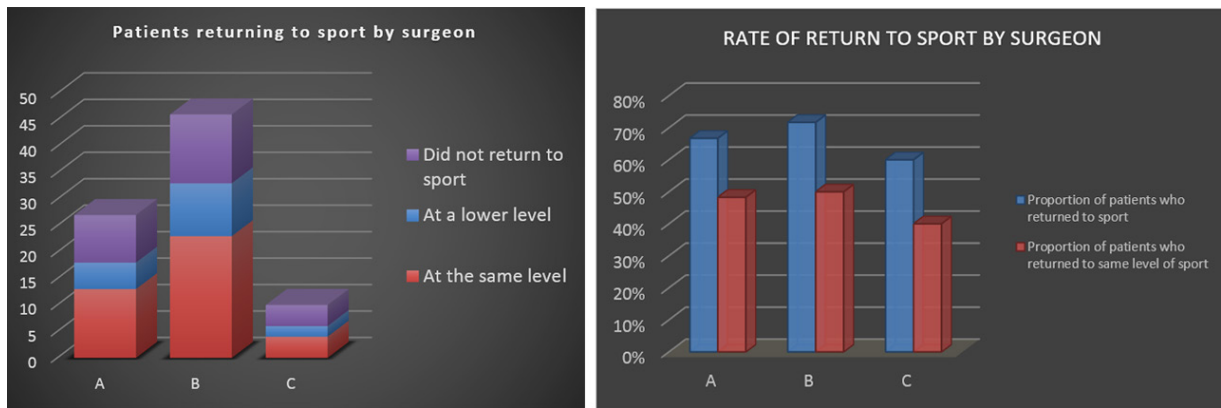


Figure 7: Number and rate of patients returning to sport by surgeon.

These results were analyzed with the help of Dr Andy Yew from the department of research in orthopedic surgery in SGH.

Discussion

The rate of return to sport in this study was found to be 68.7%: this is higher than most of the figures obtained by other studies (Lee, 2008–62%, Hamrin Senorski, 2016–54%, Bonasia, 2018–57.6%). The rate of return to the same level of athletic participation (measured by return to the same Tegner score) was 48.2%.

The primary hypothesis was that age, BMI, gender and pre-operative knee function scores would have a significant impact on the patient’s likelihood of returning to sport post-ACL reconstruction. After analysis, none of these factors were found to be statistically significant in affecting post-surgical outcomes.

This may have come about as a result of an insufficient sample size: with relatively low sample sizes, outliers can more significantly distort the general trends observed. The variable with the p-value closest to value of significance was age (0.087), which was correctly identified to be the likeliest factor to affect rate of return to sport as compared to the p-values for gender (0.313), BMI (0.98), pre-operative Lysholm (0.266) and Tegner (0.79) scores.

While no significant relationship was found between the factors identified and the rate of return to sport, it does not detract from its value to the orthopedics community. Surgeons can similarly advise their patients based on our findings, and even encourage those deemed to be from “more vulnerable” groups (female, older age etc) to go for surgery to optimize knee function.

Additionally, this study opens up further possibilities of research into psychological factors and adherence to physiotherapy, which have been backed strongly by evidence from other papers to significantly affect post-surgical outcomes. With the fast-paced advancement of medicine today, newer surgical techniques are being tried and tested and further studies can also help to prove or disprove the superiority of certain techniques over others. There is also a role in future studies to determine whether the abovementioned factors may affect the speed at which patients recover rather than the percentage of whom do recover fully.

Limitations & Conclusion

As this paper was done under time and resource constraint, there were several weaknesses identified which could set a foundation for improvement in future studies.

Firstly, it is a retrospective study prone to information and selection biases. Causal relationships also cannot be identified with certainty. There is thus a role for future researches to observe sportsmen over the entire course of their rehabilitation period to ensure that the relationship demonstrates causality.

This paper also does not adequately address psychological factors, which has been found to play an important role in post-surgical outcomes. This is a potential area for exploration into how personal and environmental influences affect outcomes.

Additionally, surgical techniques between different surgeons do differ, as some may prefer traditional method of transtibial drilling while others use the more modern double-bundle method. Alternatively, the type of graft used may differ: patellar tendon or hamstring grafts are the two common choices used. This variance in surgical techniques could account for some of the differences in the findings and hence affect our results significantly.

A poor response rate and small sample size may be significant factors in this study. These can cause some bias and inaccuracies in the analysis of data distribution. However, due to time and resource constraint, the response rate is difficult to improve.

Our rate of return to sport at minimum of 2-years follow-up was 68.7%. The rate of return to the same level of sport, defined in this paper as a return to the pre-injury Tegner score, was 48.2%. This percentage is higher than that quoted in other papers and may be due to advancement in surgical technique and rehabilitation regimens, or a variety of other factors.

However, we were not able to identify significant factors affecting an athlete's likelihood of returning to their sport. Despite this, the findings expounded on in this paper are valuable to the Orthopaedic community as more updated and informed advice can be provided to patients regarding surgery. This also paves the way for future studies on psychological factors and adherence to physiotherapy to be conducted to further analysis the reasons behind a better or faster recovery. Further analysis can also be done to compare the various efficacies of different surgical techniques and graft choices in returning patients back to pre-injury levels of participation in sport.

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