

# A comparison of preoperative scores prior to anterior cruciate ligament reconstruction with optimal preinjury scores and final scores at two-year follow up



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## Aims

The aim of this study was to compare the preinjury functional scores with the postinjury preoperative score and postoperative outcome scores following anterior cruciate ligament (ACL) reconstruction surgery (ACLR).

## Methods

We performed a prospective study on patients who underwent primary ACLR by a single surgeon at a single centre between October 2010 and January 2018. Preoperative preinjury scores were collected at time of first assessment after the index injury. Preoperative (pre- and post-injury), one-year, and two-year postoperative functional outcomes were assessed by using the Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm Knee Score, and Tegner Activity Scale.

## Results

We enrolled 308 males and 263 females of mean age 27 years (19 to 46). The mean preinjury and preoperative post-injury Lysholm Knee Scores were 94 (73 to 100) and 63 (25 to 85), respectively, while the respective mean scores at one and two years postoperatively were 84 (71 to 100) and 89 (71 to 100;  $p < 0.001$ ). The mean Tegner preinjury and preoperative post-injury scores were 7 (3 to 9) and 3 (0 to 6), respectively, while the respective mean scores at one and two years postoperatively were 6 (1 to 8) and 6 (1 to 9) ( $p < 0.001$ ). The mean KOOS scores at preinjury versus two years postoperatively were: symptoms (96 vs 84); pain (94 vs 87); activities of daily living (97 vs 91), sports and recreation function (84 vs 71), and quality of life (82 vs 69), respectively ( $p < 0.001$ ).

## Conclusion

Functional scores improved following ACLR surgery at two years in comparison to preoperative post-injury scores. However, at two-year follow-up, the majority of patients failed to achieve their preinjury scores. The evaluation of ACLR outcomes needs to consider the preinjury scores rather than the immediate preoperative score that is usually collected.

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## Introduction

Injuries of the anterior cruciate ligament (ACL) are commonly associated with sports participation, particularly in sports involving cutting, jumping, and pivoting. Surgical treatment, in the form of ACL reconstruction (ACLR), is the preferred treatment

choice for athletes, young active patients with high physical demands, patients with multiple knee ligament injuries, and those who remain symptomatic following a trial of nonoperative management.<sup>1</sup>

There is a plethora of published studies in the literature reporting improvement in the

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functional outcome scores following ACL reconstruction (ACLR) surgery. Outcome studies enable clinicians to better understand the prognosis and the likely outcome of their treatment choice. Moreover, it enables surgeons to counsel patients undergoing ACLR surgery about expected outcomes of the surgery and set realistic treatment goals.

However, most of the clinical studies reporting on ACLR outcomes rely on the preoperative postinjury functional outcome score as a baseline measurement of knee function. Understandably, the post-injury preoperative scores are often poor when compared to the postoperative scores. Therefore, most ACLR outcome studies have shown significant improvements following surgery when compared to the preoperative post-injury scores. However, this overlooks the patients' preinjury functional status when evaluating the outcome of the surgical intervention. Patients often expect to return to their preinjury functional status when they consent for ACLR surgery. The aim of this study was to compare the preinjury functional scores for patients undergoing ACLR procedures with the post-injury preoperative score and postoperative outcome scores. Our hypothesis was that patients do not usually return to their preinjury functional level at two years following ACLR surgery.

## Methods

We performed a prospective study on patients who underwent primary ACLR surgery at our NHS institution between October 2010 and January 2018. Inclusion criteria from this cohort were adult patients aged between 18 and 45 years, ACL tears confirmed clinically and radiologically with an MRI scan, and diagnosis was made within three months of the knee injury. Exclusion criteria were associated other knee ligamentous injuries (e.g. posterior cruciate ligament) which would require surgical reconstruction at the same time of ACLR surgery, revision ACLR surgery, lateral extra-articular tenodesis, concomitant acute knee injury on the contralateral side, and patients presenting more than three months from the index injury.

Patients were assessed in our outpatient clinic for their knee injury. Patients with ACL tears that fulfilled the above inclusion and exclusion criteria were invited to participate in this study at the end of their first clinic appointment after the index injury.

A total of 626 patients (338 males and 288 females) were eligible for this study according to our inclusion and exclusion criteria. Among these patients, 571 patients (91%) agreed to participate in this study. There were 308 males (54%) and 263 females (46%). The mean age was 27 years (19 to 46). A total of 98 patients (17%) sustained their ACL injury during non-sports activities while 473 patients (83%) had their ACL injury during recreational and amateur sports activities. Overall,

493 patients (86%) completed the questionnaires at one year following the index procedure. At two-year postoperative follow-up, 434 patients (76%) were available to complete the final questionnaires.

**Surgical technique.** All patients underwent arthroscopic single bundle ACLR. The senior author (FSH) performed all the procedures, either as a first surgeon or supervising a senior clinical fellow surgeon. All patients received a quadrupled hamstring tendon autograft. Femoral tunnel drilling was through an anteromedial portal technique. All tendon grafts were fixed with Endobutton (Smith & Nephew Endoscopy, USA) suspensory mechanism on the femoral side and interference screws on the tibial side. All patients had the same rehabilitation protocol. Patients were allowed to start weightbearing with crutches from day one postoperatively. No splints or braces were used. Patients were discharged on the day of surgery or the following day. Closed kinetic chain quadriceps strengthening exercises were allowed for the first three postoperative months. Isometric and open chain proprioceptive exercises were performed. Emphasis was placed on the restoration of full knee range of motion, especially knee extension.

**Outcome measures.** Functional outcomes were assessed using patient-reported outcome measures (PROMs). These were Knee injury and Osteoarthritis Outcome score (KOOS),<sup>2</sup> Lysholm Knee score, and Tegner Activity scale.<sup>3</sup> Patients who agreed to participate in the study were given two copies of these questionnaires during their first clinic appointment. Both of these copies reflect their preoperative functional status. On the first copy, we asked patients to fill in the questionnaires recording their preinjury functional status. On the second copy, we asked patients to record their post-injury functional level. Patients were then given another copy of the questionnaires to complete at one year and two years following their ACLR procedure.

**Statistical analysis.** The data obtained from recording the outcome measures are ordinal data, so non-parametric statistics were used. Friedman's test (one-way repeated measures analysis of variance for non-parametric data) was performed with the independent variable being the time of assessment (preinjury, post-injury preoperative, one year, and two years following ACLR), to identify a significant improvement in each of the PROMs. A p-value < 0.05 was considered statistically significant. Statistical analysis was performed using IBM SPSS statistics v. 26.0 (IBM, USA)

## Results

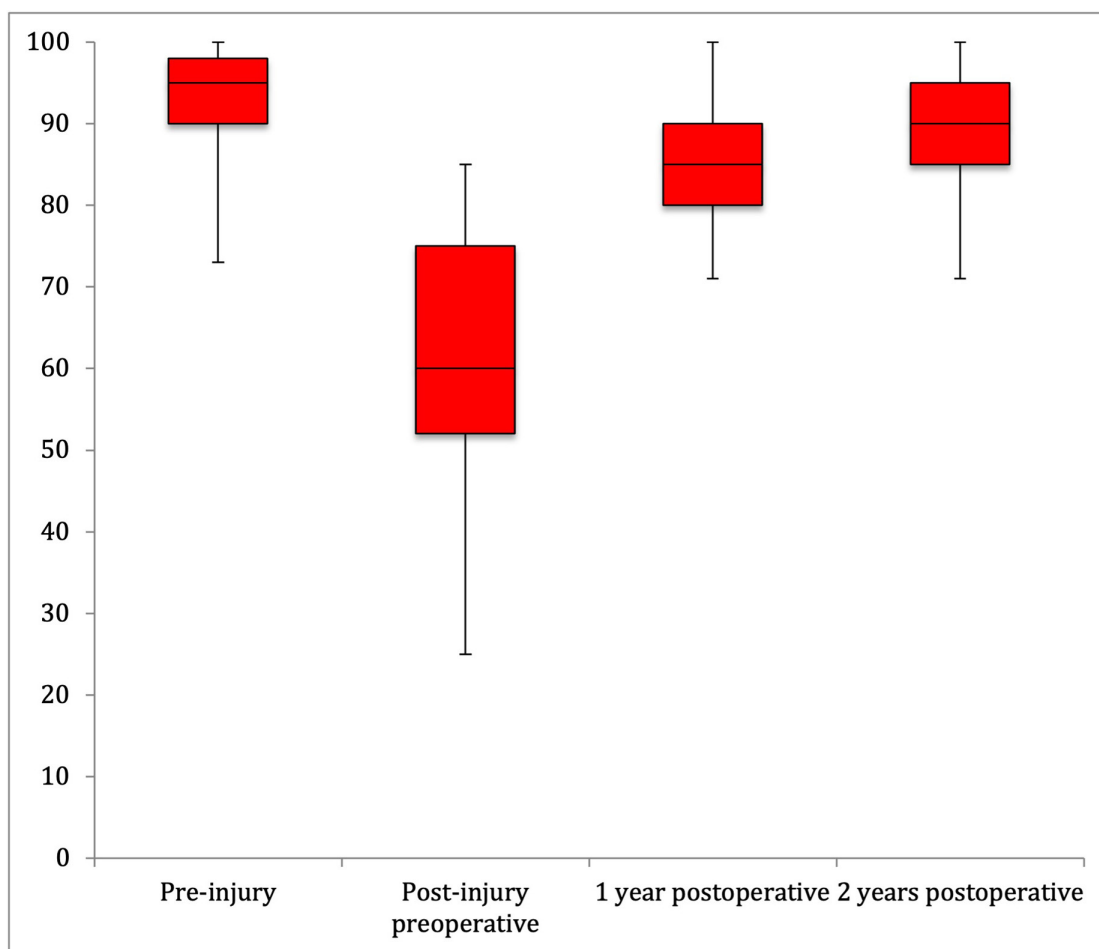
Outcome measures are reported in Table I and Figures 1 to 3.

**Table I.** Mean outcome scores.

PROM	Preinjury (range)	Preoperative post-injury (range)	One year (range)	Two years (range)	p-value*
Lysholm Knee Score	94 (73 to 100)	63 (25 to 85)	84 (71 to 100)	89 (71 to 100)	< 0.001
Tenger Activity Scale	7 (3 to 9)	3 (0 to 6)	6 (1 to 8)	6 (1 to 9)	< 0.001
<b>KOOS</b>					
Symptoms	96 (91 to 100)	71 (42 to 80)	81 (62 to 91)	84 (65 to 95)	0.02
Pain	94 (88 to 100)	72 (38 to 84)	84 (71 to 93)	87 (69 to 100)	0.04
ADL	97 (93 to 100)	80 (62 to 90)	87 (73 to 96)	91 (74 to 100)	0.1
Sports and recreation	84 (70 to 98)	39 (10 to 56)	66 (34 to 86)	71 (58 to 96)	0.03
QoL	82 (74 to 95)	37 (21 to 48)	64 (28 to 83)	69 (42 to 94)	< 0.001

\*Friedman's test.

ADL, activities of daily living; KOOS, Knee injury and Osteoarthritis Outcome Score; PROM, patient-reported outcome measure; QoL, quality of life.

**Fig. 1**

Box and whisker plot representing the Lysholm scores (mean and absolute range) at pre-injury, post-injury preoperatively, one year postoperatively, and two years postoperatively.

## Discussion

Clinical studies have often reported improvement in patients' functional outcome following ACLR.<sup>4-7</sup> This view is also supported by recent reports from the Swedish, Danish, and UK national ligament registries.<sup>8-10</sup> However, this conclusion is based on comparing the preoperative post-injury PROMs to the postoperative outcome

scores. Although this comparison proves the success of the surgical intervention in improving patients' symptoms, it completely overlooks their functional status prior to the ACL injury. Patients usually expect to eventually return to their preinjury functional level following ACLR procedure.<sup>11</sup> Therefore, comparing the preinjury functional level to the postoperative functional status would

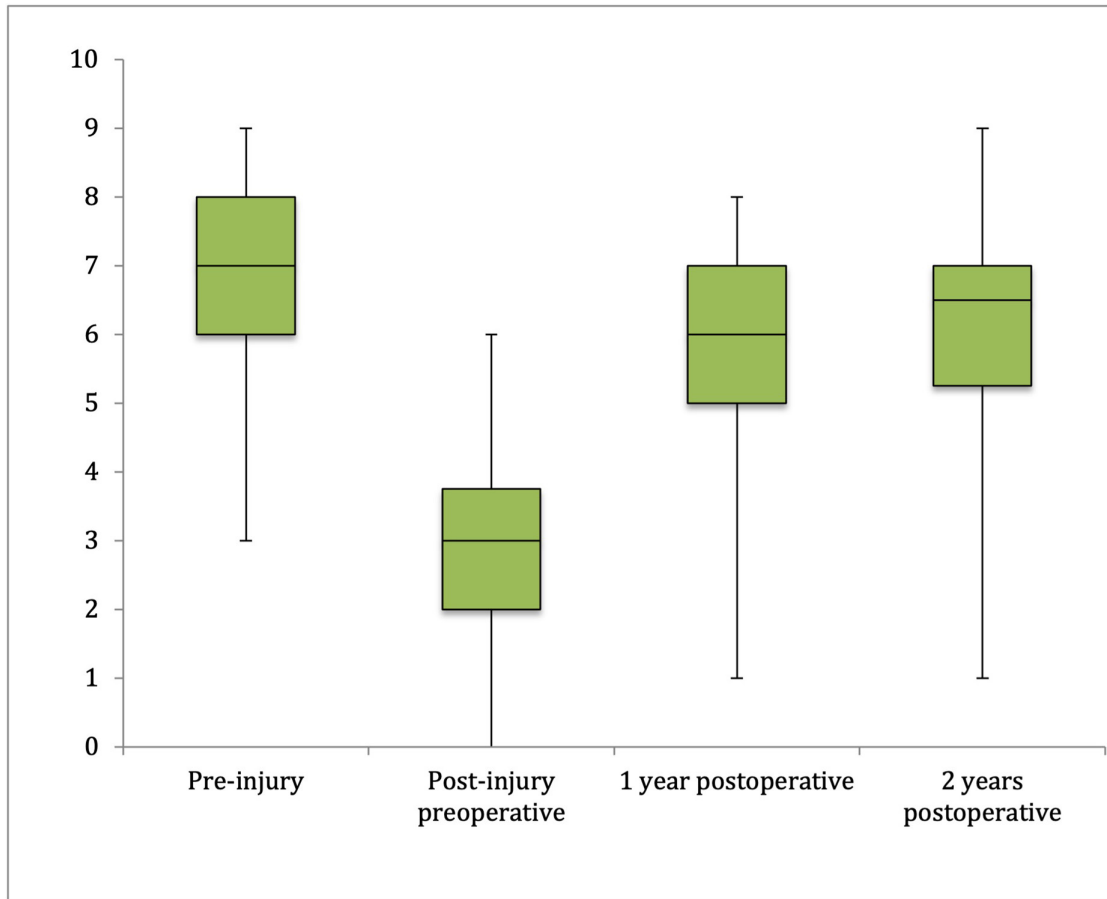


Fig. 2

Box and whisker plot representing the Tegner scores (mean and absolute range) at pre-injury, post-injury preoperatively, one year postoperatively, and two years postoperatively.

represent a true reflection on the efficiency of the surgical intervention.

Our study has shown improvement in the mean postoperative Tegner, Lysholm, and KOOS compared to the preoperative post-injury scores. There was a significant improvement at one year postoperatively and this continued to progress slightly at two-year follow-up. However, most of the patients have not managed to return back to their preinjury functional level. The mean postoperative outcome scores at two years were lower than the mean preinjury scores across the three PROMs in our study. The results from this study supports our hypothesis that majority of patients do not return to preinjury level after two years postoperatively.

In our cohort, all the five subscales of the KOOS have shown clinically significant improvement by at least ten points at two years postoperatively compared to the postinjury preoperative scores in our cohort. The sport and quality of life (QoL) subscales were the most sensitive subscales preoperatively, and most sensitive to change postoperatively. There was also a clinically significant difference between the preinjury and two-year

postoperative scores in three subscales of the KOOS (symptoms, sport, and QoL).

To our knowledge, this is the first study to examine the PROMs for ACLR from preinjury stage to two years postoperative follow-up. PROMs have been used to represent patients' perspectives and eliminate clinicians' bias in reporting ACLR functional outcome.<sup>12</sup> The majority of patients undergoing ACLR procedures are young or middle-aged.<sup>13</sup> This group of patients usually has an active lifestyle and would expect a return to their preinjury functional level postoperatively.

Several studies have examined return to sports at a preinjury level in athletes who have had ACLR surgery. McCullough et al<sup>14</sup> studied 147 high school and collegiate football players who underwent ACLR in a multi-centre cohort study. The percentage of return to play was reported to be between 63% and 69% at two-year postoperative follow-up. However, only 45% of high school players and 38% of college school players were able to return to play at the same preinjury level. In a similar study, Arden et al<sup>15</sup> noted that only 140 out of 314 patients (45%) who had ACLR surgery had returned

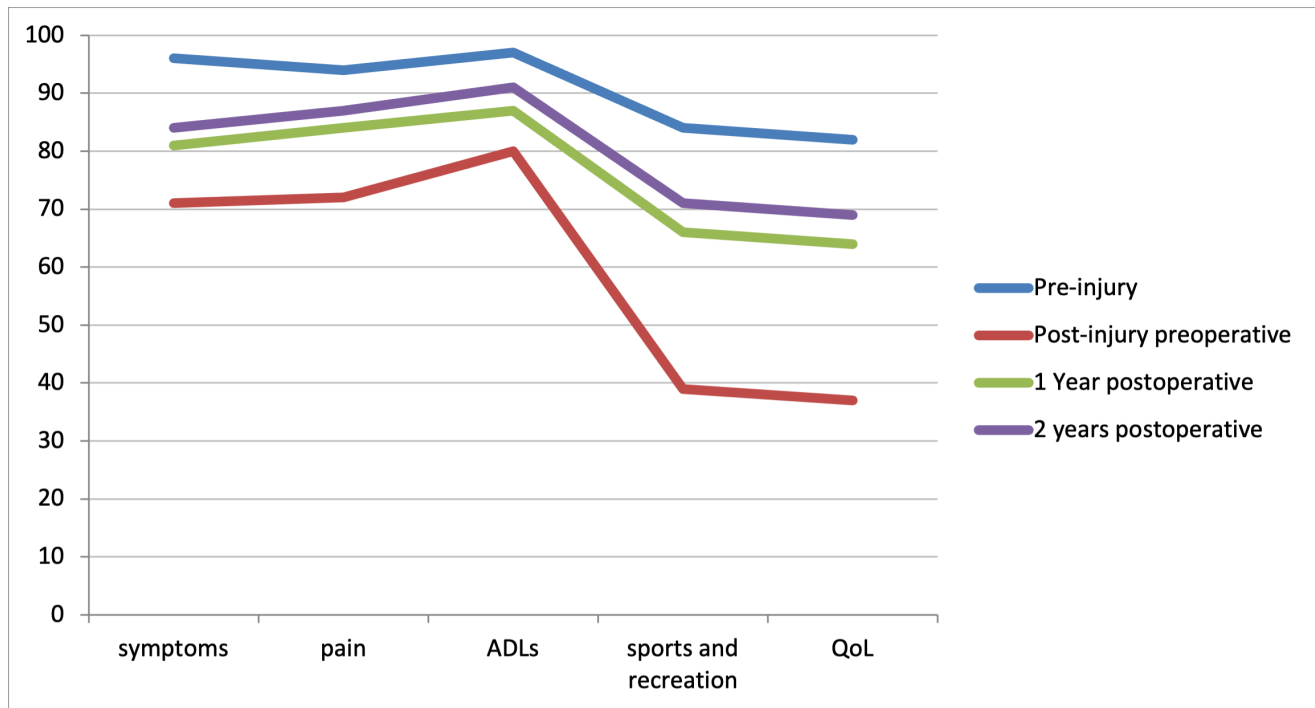


Fig. 3

Mean Knee injury and Osteoarthritis Outcome Scores at pre-injury, post-injury preoperatively, one year postoperatively, and two years postoperatively. ADLs, activities of daily living; QoL, quality of life.

to playing sport at their preinjury level or returned to participating in competitive sport when surveyed at two to seven years postoperatively. It is still unclear to why there is such a low rate of return to sports at a preinjury level after ACLR surgery. Ardern et al<sup>16</sup> noted in a systematic review that common reasons for failure to return to sports at preinjury level include fear of reinjury (19%), problems with the function of the reconstructed knee (13%), and reasons other than the reconstructed knee function (18%), such as lifestyle change and fear of job loss with reinjury (11%).

Obtaining preinjury outcome scores after the injury is a big challenge for researchers and healthcare professionals. The preinjury functional status for patients presenting with ACL tears could be assessed through two methods.<sup>17</sup> The first option would be to collect PROMs retrospectively as we did in our study. The other option would be to use the normative data available for the PROMs that are used for patient assessment. Paradowski et al<sup>18</sup> reported the normative KOOS score in a random sample drawn from a population register in Sweden. They reported the normative KOOS score in adults between the age of 18 and 34 years to be: Pain, 90 to 95; Symptoms, 84 to 91; ADL, 92 to 98, Sports and recreation, 80 to 91; and QoL, 80 to 90. Cameron et al<sup>19</sup> reported on the normative KOOS scores for young physically active population with a mean age of 19 years. The normative KOOS subscales in their study were: Pain 100; Symptoms

96.4; ADL 100; Sports and recreation 100; and QoL 100. Nevertheless, the majority of ACLR studies have reported postoperative outcome scores at two to seven years' follow-up that are below the aforementioned normative KOOS scores.<sup>20</sup>

However, there are concerns with retrospective collection of PROMs. Patients' perception of their health might change following the acute injury. As patients might experience poor health function after ACL injury, they might tend to overestimate their preinjury health status. This theory is referred to as the 'response shift.'<sup>21</sup> Another important factor to consider when assessing retrospective PROMs is recall bias.<sup>22</sup> Reliability of retrospective PROMs depends on how patients have remembered their preinjury health status, which might be different to what they actually were. This would be influenced by patients' memory and the time lag between the injury and obtaining the retrospective PROMs. Further studies are needed to quantify the effect of response shift and recall bias when assessing retrospective PROMs in patients with knee injuries.

Future studies reporting on ACLR outcomes need to consider using preinjury PROMs when comparing the efficiency of the surgical procedure. Preinjury PROMs provide a more accurate assessment of patients' baseline functional status thus should be the benchmark to gauge against the success of ACLR surgery. The findings of our study are of paramount importance when

counselling patients for ACLR surgery. It provides patients and surgeon with a better understanding of patients' functional outcome following ACLR surgery. It is important to manage patients' expectations when obtaining consent for ACLR surgery, as this could help patients to decide whether to opt for conservative or surgical management for ACL tears.

This study has its own limitations. The patient cohort was a mixed group of recreational athletes and non-athletes. Furthermore, the results of this study might not be transferable to elite athletes or patients in the independent sector. Elite athletes usually have better access to physiotherapy, strict rehabilitation protocols, and higher motivation to return to sports at preinjury level.<sup>23</sup> These factors are likely to influence their abilities to return to their preinjury functional levels. Similarly, patients in the independent sector might have better rehabilitation facilities compared to our patient cohort from the NHS. Another limitation is that we collected PROMs retrospectively, which possesses the risks of recall bias and response shift as explained above. However, all patients included in this study have completed the preinjury PROMs scores within three months from the index injury to minimize the effect of recall bias. We also have not collected any objective outcome measures for the patients in this study, so it only relied on patients' subjective assessment.

Our study has shown that functional outcome scores have significantly improved at two years following ACLR surgery in comparison to preoperative post-injury scores. However, the majority of patients did not achieve their preinjury functional outcome scores at two-year post-operative follow-up. The evaluation of ACLR functional outcomes needs to consider the preinjury PROMs scores as the baseline assessment, rather than the immediate preoperative PROM scores that are usually collected.



### Take home message

- Patients undergoing anterior cruciate ligament (ACL) reconstruction showed improvement in their functional outcomes at one year and two years postoperatively compared to their preoperative scores.
- However, the majority of patients did not get back to their pre-injury functional levels.
- It is important to counsel patients appropriately regarding their expectations following ACL reconstruction surgery.

### Twitter

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- The study was approved by the North of Scotland Research Ethics Committee, reference number: 17/NS/0054

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