Decreased Performance and Return to Play Following Anterior Cruciate Ligament Reconstruction in National Football League Wide Receivers

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Purpose: To identify the time to return to play (RTP) and evaluate the performance level in wide receivers in the National Football League following anterior cruciate ligament (ACL) reconstruction. Methods: A total of 29 wide receivers in the National Football League who underwent ACL reconstruction between 2013 and 2017 who met inclusion criteria were retrospectively identified and reviewed. For each player, a matched control with similar demographics was identified to compare various in-game performance measurements and seasons played. Results: Of the wide receivers that met the inclusion criteria, 9 of 29 (31%) did not RTP in a regular season game following ACL reconstruction. For players who did RTP, 20 of 29 (69%), the average time was 10.9 months (331.4 ± 41.6 days). When we compared the tear group with the matched control cohort, players with ACL tears ended their careers on an average of 1.9 seasons earlier (2.2 vs 4.1 seasons, \( P < .001 \)) and also played less than half the number of games (25.5 vs 56.6 games, \( P = .001 \)), respectively. Those that RTP also saw decreased performance statistics in targets (353.6 vs 125.2 \( P < .001 \)), receptions (208.0 vs 74.4, \( P = .001 \)), receiving yards (2691.0 vs 987.9, \( P = .001 \)), and touchdowns (17.4 vs 6.2, \( P = .002 \)). Conclusions: Sixty-nine percent of wide receivers who underwent ACL reconstruction were able to RTP at an average of 10.9 months, or 331.4 days. Despite the majority of players being able to RTP, there was a significant decrease in both statistical performance and career duration. Level of Evidence: Level III, case-control study.

It is estimated that there are more than 200,000 anterior cruciate ligament (ACL) injuries in the United States per year. Clinical outcome following ACL reconstruction is most significant in professional athletes, where performance can dictate financial compensation and career longevity.

ACL tears account for 2% of all injuries in the National Football League (NFL). In NFL players who sustain an ACL tear, it has been shown that between 8% to 37% do not return to play (RTP) in a regular season game. These RTP rates are partially dependent on position played, with skill position players having a greater RTP than unskilled players. Dodson et al. demonstrated that receivers and backs (halfbacks, fullbacks, and linebackers) were at a significantly greater injury risk than other position players.

When compared with other procedures, ACL reconstruction, along with patellar and Achilles tendon repairs, have the greatest effects on an NFL athlete’s career. These athletes had statistically significant decreases in games played one year after their surgery. In addition, a similar study looking at outcomes following ACL reconstruction in the four major sports (football, baseball, hockey, and basketball) found that NFL players had the shortest postinjury careers and greatest decrease in performance.

The purpose of this study was to identify the time to RTP and evaluate the performance level in NFL wide receivers following ACL reconstruction. We
hypothesized that because of the specific positional athletic demands, wide receivers who undergo ACL reconstruction would show a significant decrease in statistical performance and career length.

**Methods**

NFL wide receivers were identified using public injury data, from team releases, NFL injury reports, press releases, and other internet resources, as demonstrated by previous studies. The term “ACL injury” was used as a basis for our search. This data is publicly available; therefore, no formal institutional review board approval was required. Wide receivers who sustained an isolated, unilateral ACL injury between the 2013 and 2017 NFL seasons were evaluated. Many public injury reports specified if the ACL injury was isolated versus if additional injuries were sustained; however, it cannot be stated with complete certainty that all ACL injuries were truly isolated. Players must have participated in at least one regular season NFL game before injury to be included. Wide receivers were excluded if they had a previous ACL reconstruction, reported concomitant ligamentous/meniscal injuries in the ipsilateral knee, or other reported simultaneous injuries. The subset of players who were able to RTP were further analyzed to identify statistical performance following RTP. RTP was defined as participation in one NFL regular season game following ACL reconstruction. A player did not RTP if they only played in a preseason game, played in another football league outside of the NFL, or did not play in any NFL games following reconstruction.

Demographic data obtained for the identified players included age, body mass index (BMI), date of injury, and date of RTP. Performance statistics collected were seasons played, games played, games per season, targets, targets per season, yards per target, receptions, receptions per game, yards per reception, catch percentage, receiving yards, receiving yards per game, receiving yards per season, and touchdowns. Preseason statistics were excluded. In addition, variables such as injury laterality, player draft position, and season injured were evaluated. These variables were recorded both preinjury and postinjury for each receiver. In-game performance statistics were analyzed as an average over the years preinjury and postinjury.

Each wide receiver in the ACL tear group was matched to a player without a documented history of ACL injury based on experience level, in-game performance, and demographics as described by previous studies. In decreasing order of importance for matching: previous NFL seasons, individual (non-average) performance statistics, and BMI. Exclusion criteria for the matched control group included players with a history of ACL injury. The control players had statistically similar performance averages preinjury and preindex year as well as similar demographics. Other injuries before the ACL injury in the matched control group were not identified. The time from the start of a player’s career to the time they tore their ACL was identified in the tear group. A matched index year was applied to the control group that directly correlated to the year of injury in the tear group for each player. As an example, if a receiver tore his ACL after 5 years in the NFL, the appropriately matched control player was assigned an index year of 5. This example control would have preindex year statistics based on years 1 through 5, and all subsequent seasons would be used for postindex year statistics.

The preinjury performance variables of players in the ACL tear group who were able to RTP were compared with the preinjury statistics of players who did not return. Then, further regression analysis was done to determine player risk factors for no RTP after ACL reconstruction. In addition, of the players who were able to RTP, preinjury performance was compared with postinjury performance measures. Lastly, the postinjury performances in the tear group were compared with the postindex variables in the matched control group. A power analysis was performed for sample size estimation based on Wise and Gallo comparing performance statistics for wide receivers and tight ends for postinjury to postindex controls in the National Collegiate Athletic Association Football Bowl Subdivision. With an alpha of 0.05 and power of 0.80, the projected sample size needed for a between group comparison would be n = 12 (6 per group) based on difference in receptions per game and n = 16 (8 per group) based on difference in receiving yards per game. Our sample size for performance comparison between groups of n = 40 (20 per group) would be adequate for the primary aim of our study and should allow for appropriate comparison of additional performance statistics.

All statistical analyses were performed with SPSS, version 26 (IBM Corp., Armonk, NY). Patient demographics and in-game statistics of ACL tear players, who were and were not able to RTP, were compared using independent samples $t$ tests for continuous variables, and the Pearson $\chi^2$ analyses or Fisher exact test for categorical variables. Further logistic regression was performed to determine independent risk factors of no RTP. Then, demographics and in-game statistics for players who returned to play after ACL reconstruction were compared with controls using paired samples $t$ test. Tests were deemed significant with a $P$ value less than .05. Holm–Bonferroni correction determined an adjusted significant $P$ value for regression analysis.

**Results**

We identified a total of 43 wide receivers who suffered a torn ACL between the 2013 and 2017 seasons. Six players had not played a regular season NFL game.
before their injury. Three players had previously torn the same or contralateral ACL in their NFL career. An additional 5 players were excluded due to concomitant injuries suffered at the time of ACL tear (i.e., ACL/posterior cruciate ligament with or without MCL/lateral collateral ligament injury as well). After we excluded these 14 players, the remaining 29 were included in this study. Of the included 29 players, 20 (69.0%) were able to RTP in an NFL game after their injury. Nine (31%) did not RTP following their ACL reconstruction. The receivers who were able to return did so at a mean of 10.9 months (331.4/C641.6 days) following their injury. Eleven of the 29 (37.9%) tore their ACL in the pre-season. The ACL group that returned to play had similar ages (26.0 vs 25.8 years), BMI (26.5 vs 27.2), and previous seasons of experience (3.3 vs 3.9) (Table 1). Both groups also had similar injury and draft data, with 75% of the wide receivers who RTP were drafted compared with 77.8% of those unable to RTP. There were no significant differences in any demographic, injury, or preinjury performance statistics between the ACL tear group that were able to RTP compared with the ACL tear group who did not return (Table 2). A multivariate logistic regression was performed to identify independent risk factors for no RTP. Age (odds ratio 0.11; 95% confidence interval 0.02-0.72; $P = .022$) and previous NFL seasons (odds ratio 10.51; 95% confidence interval 1.43-77.04, $P = .021$) approached but did not reach statistical significance as risk factors for no RTP (Table 3).

When compared with the preindex year control cohort before ACL reconstruction, wide receivers demonstrated no significant differences among parameters matched for experience, individual in-game performance, and BMI; however, there were differences in age and receiving yards per season between the 2 groups (Table 4). The preindex and postindex in-game statistics were compared for the control players, which demonstrated variable differences in almost all individual and average in-game performances, but these did not reach statistical significance (Table 5). There were pervasive decreases in the in-game performance statistics of the ACL reconstruction cohort following RTP, with a considerable drop in receiving yards (2117.5 vs 987.9 yards, $P = .121$). Nevertheless, no significant differences were present between pre-injury and postinjury in-game in all in-game statistics for the wide receiver who underwent ACL reconstruction (Table 6).

### Table 1. Demographic and Preinjury Performance Data for Wide Receivers Who Returned to Play Compared With Those With No Return to Play

| Parameters          | RTP          | No RTP       | $P$ Value |
|---------------------|--------------|--------------|-----------|
| Age, y              | 26.0 ± 3.2   | 25.8 ± 3.1   | .892      |
| BMI                 | 26.5 ± 1.5   | 27.2 ± 1.7   | .291      |
| Previous NFL seasons| 3.3 ± 3.1    | 3.9 ± 3.5    | .636      |
| Games played        | 44.4 ± 47.3  | 48.4 ± 47.8  | .833      |
| Games played per season| 11.6 ± 4.9 | 11.6 ± 1.3   | .962      |
| Starts              | 28.1 ± 41.4  | 29.7 ± 41.0  | .926      |
| Targets             | 259.2 ± 370.9| 241.4 ± 337.7| .900      |
| Targets per game    | 4.4 ± 2.8    | 3.6 ± 2.0    | .470      |
| Receptions          | 159.2 ± 235.8| 130.0 ± 179.6| .746      |
| Receptions per game | 2.6 ± 1.8    | 1.9 ± 1.1    | .283      |
| Catch percentage    | 52.5 ± 20.4  | 52.0 ± 9.2   | .944      |
| Receiving yards     | 2117.5 ± 3159.7| 1918.9 ± 2966.8| .872      |
| Receiving yards per target| 7.4 ± 3.6  | 7.1 ± 2.0    | .798      |
| Receiving yards per reception| 12.9 ± 7.3 | 13.6 ± 3.4   | .795      |
| Receiving yards per game | 35.2 ± 22.6 | 25.7 ± 18.0  | .279      |
| Receiving yards per season| 476.1 ± 342.5| 311.9 ± 245.6| .208      |
| Touchdowns          | 13.4 ± 19.9  | 12.6 ± 19.2  | .916      |

NOTE. Values are mean ± standard deviation.
BMI, body mass index; NFL, National Football League. RTP, return to play.

### Table 2. Injury and Draft Data for Wide Receivers Who Returned to Play Compared With Those With No Return to Play

| Parameters          | RTP          | No RTP       | $P$ Value |
|---------------------|--------------|--------------|-----------|
| Right laterality    | 9 (45.0)     | 3 (33.3)     | .694      |
| Drafted             | 15 (75.0)    | 7 (77.8)     | 1.000     |
| Draft round         |              |              | .643      |
| 1st                 | 3 (15.0)     | 0 (0.0)      |           |
| 2nd                 | 5 (25.0)     | 3 (33.3)     |           |
| 3rd and above       | 7 (35.0)     | 4 (44.4)     |           |
| Undrafted           | 5 (25.0)     | 2 (22.2)     |           |
| Season injured      |              |              | .683      |
| 2013                | 7 (35.0)     | 5 (55.6)     |           |
| 2014                | 3 (15.0)     | 0 (0.0)      |           |
| 2015                | 4 (20.0)     | 2 (22.2)     |           |
| 2016                | 2 (10.0)     | 1 (11.1)     |           |
| 2017                | 4 (20.0)     | 1 (11.1)     |           |

NOTE. Values are n (%).
RTP, return to play.
and games played, as well as receiving yards and touchdowns. Interestingly, while player’s performance averages dropped post-ACLR reconstruction, these decreases were not statistically significant when comparing pre- and post-ACLR reconstruction in players who RTP. This can possibly be explained by the partial bias of patients selected for analysis. It has been shown that players with 4 years or more of experience have greater RTP percentage after ACL reconstruction. In our cohort of players who RTP, there were 30% that had 4 years or more experience. However, there was no statistically significant difference in games and seasons played between the RTP and non-RTP groups. Results after ACL reconstruction can be variable, with poor results having the most detrimental effect on professional athletes mentally, physically, and financially. Despite the constant advancement in reconstruction techniques, based on this study, 31% of NFL wide receivers are unable to RTP in an NFL game after surgery.

Our findings indicate that when compared with matched controls, wide receivers who undergo ACL reconstruction have a significant decrease in certain performance measures and career duration. Wide receivers post-ACLR reconstruction played fewer games, games per season, and total seasons compared with matched controls. This data appears plausible, as wide receivers frequently perform explosive pivoting maneuvers in their route running, and this increased repetitive stress on the knee could predispose them to more risk for ACL injury. This data coincides with previous studies on athletes in the NFL as well as other professional sports. One study demonstrated that up to 40% of NFL players were no longer on an active team roster after just 3 seasons post-ACLR reconstruction. This same study compared professional athletes in the NFL, National Basketball Association, National Hockey

**Discussion**

From our results, of the NFL wide receivers who underwent ACL reconstruction and were able to RTP, they had evidence for a significant reduction in performance and career length as compared with matched controls. These results were most notable in seasons and games played, as well as receiving yards and touchdowns. Interestingly, while player’s performance averages dropped post-ACLR reconstruction, these decreases were not statistically significant when comparing pre- and post-ACLR reconstruction in players who RTP. This can possibly be explained by the partial bias of patients selected for analysis. It has been shown that players with 4 years or more of experience have greater RTP percentage after ACL reconstruction. In our cohort of players who RTP, there were 30% that had 4 years or more experience. However, there was no statistically significant difference in games and seasons played between the RTP and non-RTP groups. Results after ACL reconstruction can be variable, with poor results having the most detrimental effect on professional athletes mentally, physically, and financially. Despite the constant advancement in reconstruction techniques, based on this study, 31% of NFL wide receivers are unable to RTP in an NFL game after surgery.

Our findings indicate that when compared with matched controls, wide receivers who undergo ACL reconstruction do have a significant decrease in certain performance measures and career duration. Wide receivers post-ACLR reconstruction played fewer games, games per season, and total seasons compared with matched controls. This data appears plausible, as wide receivers frequently perform explosive pivoting maneuvers in their route running, and this increased repetitive stress on the knee could predispose them to more risk for ACL injury. This data coincides with previous studies on athletes in the NFL as well as other professional sports. One study demonstrated that up to 40% of NFL players were no longer on an active team roster after just 3 seasons post-ACLR reconstruction. This same study compared professional athletes in the NFL, National Basketball Association, National Hockey

**Table 3. Multivariate Logistic Regression Evaluating Demographic and Injury Parameters as Risk Factors for No Return to Play**

| Parameters | Independent Risk of No Return to Play |
|------------|---------------------------------------|
|            | [(Odds Ratio: 95% CI) P Value]         |
| Age, y‡    | 0.11 [0.02-0.72] 0.022                |
| BMI§       | 2.32 [0.98-5.51] 0.055                |
| Right laterality | 3.25 [0.32-33.00] .319  |
| Draft round* | 2.44 [1.06-5.62] .037              |
| Previous NFL seasons* | 10.51 [1.43-77.04] .021 |

BMI, body mass index; CI, confidence interval; NFL, National Football League.

*Treated as continuous variable in regression. Holm–Bonferroni correction determines new significant P < .01. Regression model demonstrated significance with a χ² of 12.12 (P = .026), explaining 50.0% of the variance and correctly classifying 86.2% of cases.

When comparing the post-ACLR group with matched post-index year controls, athletes showed significant decreases in subsequent participation and in-game effectiveness. Following ACL reconstruction, wide receivers played 1.9 seasons less (2.2 vs 4.1 seasons, P < .001) and less than half the number of games (25.5 vs 56.6 games, P < .001) when compared with their postindex year matched controls. In addition, there were significant decreases in targets, receptions, receiving yards, and touchdowns after undergoing ACL reconstruction (Table 7).

**Discussion**

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**Table 4. Wide Receiver Baseline Comparison: Pre-ACLR Cohort Versus Preindex Control**

| Parameters                  | Pre-ACLR       | Preindex       | P Value |
|-----------------------------|----------------|----------------|---------|
| Age, y                      | 26.0 ± 3.2     | 25.3 ± 3.2     | .023    |
| BMI                         | 26.5 ± 1.5     | 26.5 ± 1.3     | .918    |
| Previous NFL seasons        | 3.3 ± 3.1      | 3.3 ± 3.1      | 1.000   |
| Games played                | 44.4 ± 47.3    | 45.2 ± 42.6    | .741    |
| Games played per season     | 11.6 ± 4.9     | 12.0 ± 4.4     | .525    |
| Targets                     | 259.2 ± 370.9  | 304.6 ± 364.8  | .175    |
| Targets per game            | 4.4 ± 2.8      | 5.5 ± 2.9      | .056    |
| Receptions                  | 159.2 ± 235.8  | 182.4 ± 217.4  | .255    |
| Receptions per game         | 2.6 ± 1.8      | 3.2 ± 1.7      | .081    |
| Catch percentage            | 52.5 ± 20.4    | 52.2 ± 19.2    | .872    |
| Receiving yards             | 2117.5 ± 3159.7| 2490.8 ± 3124.5| .107   |
| Receiving yards per target  | 7.4 ± 3.6      | 6.9 ± 2.7      | .533    |
| Receiving yards per reception| 12.9 ± 7.3    | 12.1 ± 4.9     | .604    |
| Receiving yards per game    | 35.2 ± 22.6    | 43.6 ± 25.1    | .049    |
| Receiving yards per season  | 476.1 ± 342.5  | 610.1 ± 364.7  | .040    |
| Touchdowns                  | 13.4 ± 19.9    | 16.8 ± 21.1    | .049    |

NOTE. Values are mean ± standard deviation.

ACLR, anterior cruciate ligament reconstruction; BMI, body mass index; NFL, National Football League.
Potentially limited the generalizability throughout NFL wide receivers. Nevertheless, comparing unvalidated markers of performance instead of performance statistics may have introduced bias and their power rating comparison only reflects a difference in yards and touchdowns.

A multivariate analysis was performed on player demographics who were unable to RTP following ACL reconstruction. To account for cumulative type I error in our tests of multiple hypotheses, Holm–Bonferroni method was used to set new threshold $P$ value for statistical significance at .01. None of the variables tested were statistically significant; however, number of

### Table 5. Wide Receiver Index Comparison: Preindex Cohort Versus Postindex Cohort

| Parameters                        | Preindex   | Postindex   | $P$ Value |
|-----------------------------------|------------|-------------|-----------|
| NFL seasons                       | 3.3 ± 3.1  | 4.1 ± 2.3   | .420      |
| Games played                      | 45.2 ± 42.6| 56.6 ± 34.1 | .392      |
| Games played per season           | 12.0 ± 4.4 | 13.3 ± 2.4  | .295      |
| Targets                           | 304.6 ± 364.8| 353.6 ± 305.6| .611      |
| Targets per game                  | 5.5 ± 2.9  | 5.7 ± 2.3   | .709      |
| Receptions                        | 182.4 ± 217.4| 208.0 ± 184.8| .657      |
| Receptions per game               | 3.2 ± 1.7  | 3.4 ± 1.4   | .668      |
| Catch percentage                  | 52.2 ± 19.2| 59.5 ± 8.1  | .089      |
| Receiving yards                   | 2490.8 ± 3124.5| 2691.0 ± 2275.4| .803      |
| Receiving yards per target        | 6.9 ± 2.7  | 7.8 ± 0.9   | .153      |
| Receiving yards per reception     | 12.1 ± 4.9 | 13.3 ± 2.0  | .248      |
| Receiving yards per game          | 43.6 ± 25.1| 44.7 ± 19.3 | .819      |
| Receiving yards per season        | 610.1 ± 364.7| 598.2 ± 286.4| .870      |
| Touchdowns                        | 16.8 ± 21.1| 17.4 ± 15.5 | .923      |

*NOTE. Values are mean ± standard deviation.*

### Table 6. Wide Receiver ACLR Comparison: Pre-ACLR Cohort Versus Post-ACLR Cohort

| Parameters                        | Pre-ACLR    | Post-ACLR   | $P$ Value |
|-----------------------------------|-------------|-------------|-----------|
| NFL seasons                       | 3.3 ± 3.1   | 2.2 ± 1.2   | .191      |
| Games played                      | 44.4 ± 47.3 | 25.5 ± 19.4 | .126      |
| Games played per season           | 11.6 ± 4.9  | 10.7 ± 4.5  | .495      |
| Targets                           | 259.2 ± 370.9| 125.2 ± 129.2| .118      |
| Targets per game                  | 4.4 ± 2.8   | 4.3 ± 2.8   | .893      |
| Receptions                        | 159.2 ± 235.8| 74.4 ± 79.1 | .114      |
| Receptions per game               | 2.6 ± 1.8   | 2.6 ± 1.9   | .903      |
| Catch percentage                  | 52.5 ± 20.4 | 58.1 ± 13.3 | .198      |
| Receiving yards                   | 2117.5 ± 3159.7| 987.9 ± 1051.9| .121      |
| Receiving yards per target        | 7.4 ± 3.6   | 7.8 ± 1.4   | .570      |
| Receiving yards per reception     | 12.9 ± 7.3  | 14.1 ± 3.7  | .415      |
| Receiving yards per game          | 35.2 ± 22.6 | 33.6 ± 22.6 | .660      |
| Receiving yards per season        | 476.1 ± 342.5| 417.5 ± 370.7| .308      |
| Touchdowns                        | 13.4 ± 19.9 | 6.2 ± 7.5   | .109      |

*NOTE. Values are mean ± standard deviation.*

ACLR, anterior cruciate ligament reconstruction; NFL, National Football League.
seasons played before injury approached statistical significance. For each year played before injury, players were at 10.51 times increased likelihood of not returning to play. This contradicts other studies demonstrating an increased percentage in RTP for players with 4 or more years of experience before injury. In future studies with an increased database of players, further data can be explored to determine whether this is truly a risk factor for decreased RTP.

Reduction in performance for NFL players after ACL reconstruction has been reported for defensive players, and this study found decreases in performance after surgery. A similar study by Erickson et al. looked at performance in NFL quarterbacks after ACL reconstruction did not find statistically significant differences in performance after surgery. A different study by Secrist et al. demonstrated a decrease in earnings following ACL reconstruction in NFL players during the 4 years after surgery. They also demonstrated that players earning more than $2 million per year before injury did not have negatively impacted careers versus those earning less than $2 million. The livelihoods of these players without larger contracts can be negatively affected by ACL injuries. This difference could partially be attributed to the higher-earning players having a more impactful role as opposed to the lower-earning players.

Future studies can further evaluate differences based on reconstruction technique as well as additional comparison across various positions. In addition, financial implications after injury can be further explored, which can help give teams a better understanding of player outcomes after surgical reconstruction. Developing a predictive model for performance after ACL reconstruction throughout NFL players would be beneficial for teams, personnel and players themselves.

**Limitations**

There are a few limitations noted by the authors. Due to the retrospective nature of the study, there are inherent flaws with data acquisition, although the authors used similar methodology described from previous studies. Second, while the injuries were made public, full disclosure of the exact severity and nature of the injuries as well as surgical technique is not known. NFL teams do not disclose details regarding player injuries to the public. In addition, the authors were not able to attain the operative notes or surgical methods used for each ACL reconstruction. Therefore, accounting for different surgical details (i.e., autograft vs allograft, graft choice, surgical techniques) was not able to be accomplished in this study. In addition, we also did not look at whether these injuries occurred during practice or games; however, it has been shown that the majority of injuries in the NFL occur during games and we recorded this as such.
performing our multivariate analysis to determine factors associated with decreased RTP, our study population consisted of only 9 players, limiting the power of our results. Nevertheless, our study was adequately powered to determine differences between post-ACL reconstruction and post-index groups performance based on previous literature demonstrating distinct receptions and yards per game among similar groups in National Collegiate Athletic Association receivers.12

**Conclusions**

Sixty-nine percent of wide receivers who underwent ACL reconstruction were able to RTP at an average of 10.9 months, or 331.4 days. Despite the majority of players being able to RTP, there was a significant decrease in both statistical performance and career duration.

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