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Derivation and validation of a risk calculator for the prediction of incidence of complications following repair of Achilles Tendon Rupture

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Abstract

Background The Achilles tendon is the body's strongest and largest tendon. It is commonly injured, particularly among athletes, accounting for a significant portion of serious tendon injuries. Several factors play a precipitating role in increasing the risk of these injuries.

Objective Our objective is to derive and validate a risk calculator for the prediction of incidence of any complication following Achilles tendon repair.

Methods We used de-identified data from the American College of Surgeons' National Surgical Quality Improvement Project (NSQIP) database from 2005 to 2021. It comprises 7010 individuals who had undergone Achilles tendon rupture repair. Demographic and risk factors information was collected. To develop the calculator, the sample was divided into a derivation cohort (40%) and a validation cohort (60%). Multivariate logistic regression was used for statistical analysis, and a risk calculator for incidence of any complication was derived from the derivation cohort and validated on the remaining 60% of the sample. Patients with missing data were excluded, and the significance level was set at $p < 0.05$.

Results We analyzed the derivation cohort of 2245 individuals who underwent Achilles tendon repair surgery between 2005 and 2021, with a 5.5% overall complication. Multivariate logistic regression identified anesthesia type, ASA classification, certain co-morbidities (pre-operative dialysis and medication-requiring hypertension), and wound classification as significant predictors of complications. The developed risk calculator model had an area under the curve (AUC) of 0.685 in the derivation cohort and 0.655 in the validation cohort, surpassing the widely used and validated modified frailty index. A cut-off score threshold of 0.06 was established using Youden's index to dichotomize individuals into low and high risk for developing any postoperative complications.

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Conclusion Our risk calculator includes factors that most significantly affect the incidence of any complication following Achilles tendon repair.

Keywords Achilles repair, Achilles rupture, Risk calculator, Complications, Orthopedic surgery

Background

The Achilles tendon, the body's strongest and largest tendon, bears the greatest body stresses and encounters increased physical requirements during a wide range of sports and physical activities [1]. It is frequently ruptured, especially among athletes, and constitutes approximately 20% of all large tendon ruptures, making it one of the most prevalent musculoskeletal injuries [2, 3]. The frequency of Achilles tendon rupture (ATR) within the general population is approximately 5 to 10 cases per 100,000 individuals, although it may be greater in specific geographic areas and demographic groups, and there is a growing trend in overall incidence [4–6]. Over the past decade, this increase has been largely attributed to growing engagement in different sports activities [7, 8]. Recurrence or re-injury following damage to the Achilles tendon was more common after inadequate rest and recovery, as shown by Gajhede-Knudsen et al. [3]. In addition to sports, there are other risk factors that contribute to ATRs. Achilles tendon ruptures may be linked to a range of both internal and external risk factors. The precise reason for Achilles tendon ruptures remains unclear. However, this condition has been associated with various factors, including inflammatory issues, autoimmune disorders, collagen irregularities, infections, exposure to fluoroquinolone antibiotics, the use of systemic or injectable steroids, repetitive microtrauma, tendon variations, reduced blood circulation, and abnormal mechanical factors [9–11]. Microtraumatic injuries normally result in minor injuries through which collagen fibers can remodel and repair; however, significant repetitive trauma or severe injury may result in damage or rupture that would require surgical management [11]. Some studies also suggest an association between Achilles tendon rupture and sciatica, possibly due to impaired sensory signalling from the site of injury in the lower leg or due to similar vascular and collagen compromise existing between the back and the lower leg [12]. Previous studies have examined risk factors as potential predictors for Achilles tendon ruptures. Several systematic reviews have been conducted to investigate the factors associated with Achilles tendon ruptures. The most recent systematic review showed that ATR is in fact a multifactorial injury [13]. Xergia et al. further recommended future studies to identify the factors contributing to Achilles tendon ruptures and assess their significance [13].

Therefore, the objective of our study was to derive and validate a risk calculator to estimate the risk of incidence of any complication following repair of the Achilles tendon rupture.

Materials and methods

Data source and collection

A retrospective cohort study was performed using the database of the American College of Surgeons, which is the National Surgical Quality Improvement Project (NSQIP). The study involved de-identified data prospectively collected over a 30-day period post-operation, encompassing more than 150 preoperative, operative, and postoperative variables per patient. Patients who were lost to follow-up before the 30-day mark were not included in the dataset. Data spanning from 2005 to 2021 were extracted for subsequent analysis. The NSQIP annually updates a user guide that outlines the process of preventing bias during data collection and provides a comprehensive description of each variable within the database [14]. Previous publications on the NSQIP Database were referenced for relevant variables and general methodology [15–17]. We used STROBE as the assessment tool [18].

Patient selection and characteristics

Patients were identified through the use of Current Procedural Terminology (CPT) codes 27,650 and 27,652 denoting the primary repair of Achilles tendon rupture without graft and with graft, respectively. A total of 7010 patients were obtained. There were no specific exclusions. This study did not require the approval of the institutional review board of our institution, the American University of Beirut, since the data were deidentified. Data on relevant demographic characteristics and important risk factors were extracted and are shown in Table 1.

Outcome measures

The primary outcome was the incidence of any complications, further subdivided into systemic complications and local complications. Local complications were defined as involving only the surgical site and returning to the operating room, while systemic complications involved unfavourable events and medical complications other than local complications. Systemic complications were further subdivided into major and minor complications.

Statistical analysis

The complete sample was randomly divided into two distinct cohorts: a derivation cohort comprising 40% ($n=2677$) of the total sample and a validation cohort including the remaining 60% ($n=4333$). The derivation cohort served as the foundation for conducting statistical analyses to formulate the risk calculator model, while the validation cohort was utilized for the subsequent assessment and validation of the developed risk calculator. Statistical analysis was carried out using SPSS version 29. Patients with missing data were removed from the analysis and the significance for all analyses was set to a p-value less than 0.05.

Derivation cohort

2245 patients were included in the analysis. Summary statistics, including the mean, standard deviation and percent, were used to describe the demographic characteristics. Regarding continuous measures, the independent t-test was used to assess mean differences between the 2 groups (any complications vs. not); and for categorical measures, the Chi-squared test was used to assess the association between the 2 groups. Variables with minimal counts (<80% of total derivation cohort) were excluded from the model testing.

First, a backward stepwise logistic regression was done to assess the demographics with all variables with a p-value less or equal to 0.2 based on the Chi-square test between the variable of interest and the incidence of any complications. Afterwards, additional variables included in the model were clinically relevant based on thorough literature review. The final model included the following risk factors: dialysis status, anesthesia type, ASA classification, wound classification, hypertension and chronic steroid use.

Area under the receiver-operating characteristics (ROC) curve was calculated to assess the performance of the model in predicting the incidence of any complications. Youden's index was computed using the derivation cohort to identify an optimal cut-off value for the risk calculator model. This threshold was subsequently applied to the validation cohort for robust evaluation and validation of the risk calculator's performance.

Validation cohort

3568 patients were included in the analysis. The validation of the risk calculator involved applying the model formula to the validation cohort and computed Youden's Index from the derivation cohort was used to assess whether higher scores correlated with a greater incidence of complications. In addition, an area under the ROC curve was computed to assess the performance of this risk calculator model.

ROC analysis was conducted to compare the performance of the risk calculator model with the 5-item modified frailty index-5 (mFI-5), a well-established predictor of complications following lower extremity orthopedics surgeries [19]. This analysis aimed to assess and compare the discriminatory ability of both models, providing insights into their predictive power for post-surgical complications following Achilles tendon rupture repair with/without graft.

Based on the adjusted model a risk calculator on the incidence of any complications was computed on Microsoft Excel found in the supplementary material (S-I).

Results

In the derivation cohort, a total of 2245 patients from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) dataset who had undergone Achilles tendon repair surgery between 2005 and 2021 were assessed. More than half of the population were men among repair groups (75.4% with no complications and 62.9% with any complication). The cohort exhibited notable diversity in terms of age, race, gender, and body mass index (BMI). Notably, the most common type of anesthesia used was general anesthesia, administered in 75.6% of the cases who developed complications after repair. Among both groups majority of the individuals did not have a history of diabetes, and 99.2% exhibited functional independence. Moreover, the great majority of surgical wounds were classified as clean, with an incidence of 98% among patients without complications and 94.4% among patients with complications. A detailed overview is thoroughly described in Table 1.

With regards to the post-operative complications in individuals who had undergone a surgical repair of their Achilles tendon, our analysis reported a total complication rate of 5.5%. Systemic complications were observed in 4.0% of patients, whereas localized ones were seen in 1.3% of cases. A detailed report of the different subtypes of observed complications is included in the supplementary material (S-II) for further review. Complications were divided in a manner consistent with that of the published literature, according to involvement of the surgical site and impact on patient recovery [16].

In developing our model, we conducted a multivariate logistic regression analysis on the incidence of any complications, taking into consideration (1) the patient demographics and (2) risk factors of statistical or clinical significance. Overall, the anesthesia type was a statistically significant parameter. When comparing patients who had undergone general anesthesia to those who had spinal anesthesia, statistically significant differences ($p<0.001$) were found. Furthermore, the ASA classification and the wound classification were also deemed statistically significant parameters ($p<0.01$ and $p<0.05$, respectively). Moreover, other variables that were included in the model that were clinically significant, although not statistically significant, were pre-operative dialysis status, chronic steroid use, and hypertension requiring medications. A detailed overview

Table 1 Demographic characteristics and risk factors of the patients based on complications

Characteristics	No complications (*n* = 2121)	Any complications (*n* = 124)	*P*-value
Age, years, mean ± SD	43.06 ± 13.76	47.95 ± 17.57	**0.003**
Age group, years, *n*(%)			0.11
< 45	1222 (57.6%)	62 (50%)	
>=45	899 (42.4%)	62 (50%)	
Male	1599 (75.4%)	78 (62.9%)	**0.002**
BMI, mean ± SD	30.54 ± 6.58	32.49 ± 7.75	**0.008**
BMI, category, *n*(%)			**< 0.001**
< 25 (Normal weight)	411 (19.4%)	26 (21.1%)	
>=25 - <30 (Overweight)	826 (38.9%)	28 (22.8%)	
>=30 - <40 (Obese)	715 (33.7%)	47 (38.2%)	
>=40 (Morbidly Obese)	169 (8.0%)	22 (17.9%)	
Morbidly obese vs. Others	169 (8.0%)	22 (17.9%)	**0.001**
Race			0.33
White	1163 (54.8%)	69 (55.6%)	
Black	423 (19.9%)	18 (14.5%)	
Others	13 (0.6%)	1 (0.8%)	
Unknown	522 (24.6%)	36 (29.0%)	
Risk factors			
ASA classification, *n*(%)			**< 0.001**
1	822 (38.8%)	34 (27.4%)	
2	992 (46.8%)	48 (38.7%)	
3	296 (14.0%)	39 (31.5%)	
4	10 (0.5%)	3 (2.4%)	
Anesthesia type, *n*(%)	2114	123	**0.007**
General	1780 (84.2%)	93 (75.6%)	
Spinal	173 (8.2%)	22 (17.9%)	
Regional	48 (2.3%)	3 (2.4%)	
MAC	113 (5.3%)	5 (4.1%)	
Spinal vs. Others	173 (8.2%)	22 (17.7%)	**0.001**
Diabetes, *n*(%)			0.11
No DM	1990 (93.8%)	111 (89.5%)	
Non insulin dependent DM	93 (4.3%)	9 (7.3%)	
Insulin dependent DM	38 (1.8%)	4 (3.2%)	
Smoking, *n*(%)	282 (13.4%)	16 (12.9%)	1
Functional status, *n*(%)	2098	121	0.09
Independent	2092 (99.2%)	120 (99.2%)	
Partially dependent	6 (0.3%)	0 (0.0%)	
Totally dependent	0 (0.0%)	1 (0.8%)	
COPD, *n*(%)	16 (0.8%)	3 (2.4%)	0.08
CHF, *n*(%)	2 (0.1%)	0 (0.0%)	1
HTN, *n*(%)	433 (20.4%)	38 (30.6%)	**0.009**
Chronic Steroid use, *n*(%)	34 (1.6%)	4 (3.2%)	0.16
Dialysis, *n*(%)	2 (0.1%)	1 (0.8%)	0.16
Bleeding disorders, *n*(%)	19 (0.9%)	4 (3.2%)	**0.04**
Transfusion > 4 units PRBCs in 72 h before surgery, *n*(%)	0 (0.0%)	0 (0.0%)	
Operative time (mins), mean ± SD	58.35 ± 27.03	70.43 ± 31.11	**< 0.001**
Wound classification, *n*(%)	2121	108	**0.03**
clean	2079 (98.0%)	102 (94.4%)	
others	42 (2.0%)	6 (5.6%)	
Serum albumin g/dl, mean ± SD (*n*)	4.25 ± 0.45 (316)	3.92 ± 0.58 (19)	**0.003**
White blood count 10^3, mean ± SD (*n*)	7.25 ± 2.22 (741)	8.14 ± 2.82 (60)	**0.004**
Hematocrit, mean ± SD (*n*)	42.78 ± 4.05 (786)	41.37 ± 4.70 (76)	**0.01**

Table 1 (continued)

Characteristics	No complications (*n* = 2121)	Any complications (*n* = 124)	*P*-value
Hematocrit categories, *n* (%)	786	62	0.25
Normal (39–49)	639 (81.3%)	46 (74.2%)	
Low (< 39)	114 (14.5%)	14 (22.6%)	
High (> 49)	33 (4.2%)	2 (3.2%)	
Platelets 10 power 3, mean ± SD (*n*)	242.21 ± 62.30 (739)	241.80 ± 66.48 (61)	0.96
Platelets categories, *n* (%)	739		0.55
Normal (150–450)	704 (95.3%)	57 (93.4%)	
Low (< 150)	30 (4.1%)	4 (6.6%)	
High (> 450)	5 (0.7%)	0 (0.0%)	
creatinine g/dl, mean ± SD (*n*)	0.97 ± 0.39 (737)	0.94 ± 0.31 (57)	0.58
INR, mean ± SD (*n*)	1.04 ± 0.20 (244)	1.08 ± 0.12 (30)	0.227
PTT, mean ± SD (*n*)	29.23 ± 4.3 (185)	29.14 ± 8.5 (19)	0.96
> 10% loss body weight in last 6 months, *n*(%)	0 (0.0%)	0 (0.0%)	
Prior Operation within 30 days, *n*(%)	0 (0.0%)	0 (0.0%)	

*SD: Standard Deviation; *ASA: American Scientists of Anesthesiologists physical status; * MAC: Monitored Anesthesia Care; *DM: Diabetes Mellitus; COPD: Chronic Obstructive Pulmonary Disease; CHF: Congestive Heart Failure; *HTN: Hypertension; *Min: minutes; * INR: International Normalized Ratio; *PTT: Partial Thromboplastin Time

Table 2 Summary of statistical values pertinent to parameters included in the final risk calculator

Variables	References	OR Any complications	95% CI	*P*-value
Dialysis	Yes vs. No	3.449	0.277–42.937	0.336
HTN	Yes vs. No	1.137	0.689–1.878	0.615
Chronic Steroid use	Yes vs. No	1.148	0.369–3.572	0.812
Wound Classification	Others vs. Clean	2.994	1.172–7.398	**0.022**
ASA classification				**< 0.001**
	ASA 2 vs. ASA 1	1.243	0.752–2.055	0.396
	ASA 3 vs. ASA 1	3.03	1.631–5.630	< 0.001
	ASA 4 vs. ASA 1	8.562	1.942–37.739	0.005
Anesthesia Type				**0.002**
	Spinal vs. General	2.721	1.611–4.596	< 0.001
	Regional vs. General	0.96	0.224–4.107	0.956
	MAC vs. General	0.682	0.235–1.973	0.48

of the variables included in the final risk calculator model are presented in Table 2 for additional review.

Our model was developed using the derivation cohort of 40% of the population, through which we were able to achieve an area under the curve of the ROC of 0.685 (CI: 0.631, 0.738 $p<0.01$). The model was validated using 60% of the sample population; the accuracy of the model through the area under the curve of the ROC was reported at 0.655 (CI: 0.613, 0.698 $p<0.05$), which was higher than the AUC for the validated and widely used modified frailty index (mfi-5), as shown in Fig. 1; Table 3. We used the Youden's index to dichotomize the risk score as high or low; a cut-off of 0.06 was established for our model which was tested in 40% (derivation cohort) of the sample and validated in the remaining 60% (validation cohort). Scores equal to or less than 0.06 were considered low risk and those greater than 0.06 were considered high risk for having any postoperative complication. This is shown in Fig. 2a and b whereby in both the derivation and validation cohorts, we observed an increase in the incidence of complications from 2.90 to 10.70% and from 3.70 to 9.70%, respectively, as the Youden's Index increased from ≤0.06 to >0.06.

The final model is shown in the supplementary material (S-I) and available to use as a Microsoft Excel sheet. Enter the parameters pertinent to your patient and the model automatically calculates the predicted risk for incidence of any complications.

Discussion

A large group of Achilles tendon ruptures can be treated without surgery [20]; however, some patients opt for surgical treatment upon assessment and counselling by their physician. The most important reason to operate an Achilles tendon rupture is to reduce the risk of re-rupture [21]. Stavenuiter et al. investigated the complications that arise from repair of Achilles rupture and reported no statistically significant difference in overall complication

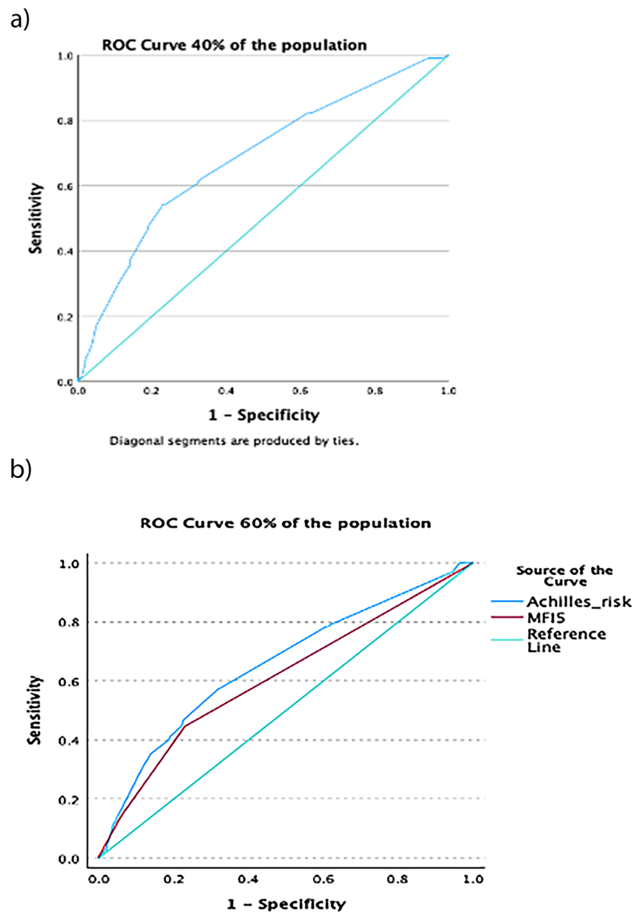

Fig. 1 Comparative receiver operating characteristic (ROC) curve. **a**. The receiver operating characteristic (ROC) curve of the predictive model in the derivation cohort. **b**. The ROC curve of the predictive model and the modified frailty index-5 (mFI-5) in the validation cohort

Table 3 Summary of the values shown in the graph of Fig. 1b, highlighting the area under the ROC for our model in comparison to the validated MFI-5 (modified Frailty Index-5)

	Our Model	MFI-5	*P*-value
Area Under ROC	0.655 ± 0.022	0.606 ± 0.020	0.014

rates (11.6% vs. 13.2%, $p = 0.658$) or wound concerns (5.0% vs. 7.6%, $p = 0.346$) comparing open and minimally invasive procedures, respectively [22]. The most common of these for both techniques were surgical wound issues, symptomatic venous thromboembolism, and sural nerve injury. In another meta-analysis by Yang et al., commonly reported complications also included sural nerve injury, infection, and re-rupture [23]. This signifies the importance of assessing the risk of developing complications in every case to minimize their occurrence.

We aimed to develop a simplified, yet comprehensive, model for assessing the risk of incidence of any complications following the repair of the Achilles tendon. The parameters included in our final model were hypertension requiring treatment, preoperative dialysis, chronic use of steroids, type of anesthesia, wound and ASA classification. Our model provided dichotomous values of high or low risk for the incidence of postoperative complication.

Factors included in the risk calculator

Elevated blood pressure increases the likelihood of postoperative complications such as impaired wound healing, infections, and prolonged recovery. Hypertension emerged as a major independent risk factor for 30-day complications (OR = 1.2; $p < 0.01$) and for the need for revision surgery within 2 years (OR 1.3; $p < 0.01$) [24]. Chronic steroid usage has been highly associated with an increased incidence of complications, as it suppresses the immune system, making patients more prone to infections. The increased infection risk is due to decrease in local inflammatory response and collagen formation, both of which impair normal tissue repair [25, 26]. The intrinsic interplay between surgical outcomes and use of steroids emphasizes the importance of including this parameter in our model. Another factor that was assessed and included was the type of anesthesia and pain management. Combining different pain-relief treatments can boost efficacy while minimizing the need for opioids and their undesirable side effects [27, 28]. Although regional anesthesia has minimal influence on postoperative mortality, it has been shown to reduce pulmonary complications after major abdominal surgery and enhance orthopedic rehabilitation. Wound classification is also a crucial element to be considered; clean wounds are associated with significantly lower infection rates and postoperative complications, along with improved healing rates [29]. The ASA classification system is widely used and important in determining if a patient is fit for surgery and in anticipating perioperative hazards [30]. A higher ASA classification (such as ASA III or IV) corresponds to a higher risk and a greater likelihood of postoperative complications (OR = 2.08; CI, 1.21–3.57) [31]. In a thorough analysis of 2,297,629 patients (2005 to 2012) from the NSQIP database, Hackett et al. revealed a significant correlation between the ASA class and the risk of complications. The odds ratios (OR) increased considerably when the ASA class went from II to V: the ORs for complications varied from 2.05 to 63.25 ($p < 0.001$), while the ORs for mortality ranged from 5.77 to 2011.92 ($p < 0.001$) [30]. The impact of dialysis and end-stage renal disease (ESRD) has also been studied, but whether a direct correlation exists between those risk factors and their impact on Achilles repair surgery is still unclear. This is due to the numerous associated co-morbidities and medications, including corticosteroids [32].

It is important to note that different factors may play a more significant role than others, hence it is necessary to individualize care for patients. For instance, unclean wounds

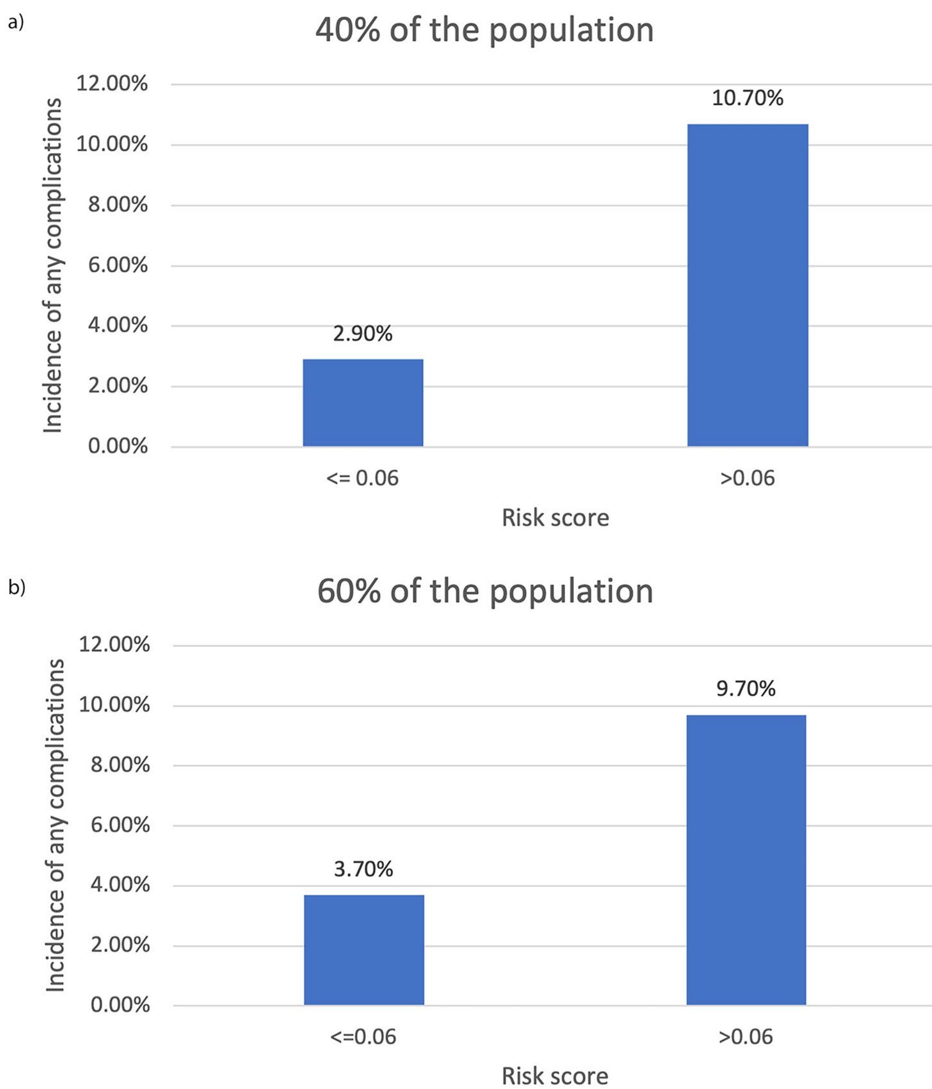

Fig. 2 **a**, **b**: Incidence of complications based on the Youden's index cut off on the derivation and validation cohort

in certain patients may alone be a reason for a physician to choose not to operate or manage the rupture surgically; this is also the case for a high ASA status (III or IV). This is highlighted statistically in our model as these parameters raise the risk more than others. For instance, an ASA III or IV entry classifies the patient as high risk alone even if all other parameters are normal. As such, the score received in this model may assist physicians in the management of patients with a ruptured Achilles tendon; however, this must be paralleled with the patient's clinical picture and the physician's judgment.

Other factors

We assessed numerous other factors that were independently important, but were excluded from the final model for different reasons. Demographic Factors (age, gender, ethnicity), BMI, and diabetes were not included.Although it is well-established in the literature that these factors impact the healing process and outcomes of surgery, correlations of gender and ethnicity might be influenced by a variety of confounding social, cultural, and genetic factors. Given the intertwined influence demographic factors have on other parameters and the difficulty in assessing without the incorporation of the other, demographic factors were excluded from the risk calculator.

Moreover, the wound-healing process in individuals on both ends of the BMI spectrum may be hindered by macronutrient and micronutrient deficiencies, which can limit the body's ability to repair wounded tissues efficiently, so we found no significant clear correlation that directly exists between BMI and postoperative complications [33, 34]. Finally, anemia and bleeding disorders may be increase the requirement for blood transfusion and consequent DVT risk; however, this does not apply to

Achilles tendon repair, which entails minimal blood loss [35].

Developing a new risk calculator based on the mentioned characteristics represents a viable tool for analysing patient risk profiles and personalizing treatment approaches. Overall, this discussion emphasizes the need to have a thorough grasp of patient-specific characteristics in order to enhance surgical results, as well as the continued need for more research to refine and understand risk assessment in this sector.

Limitations

While the present study has numerous strengths, it is not without limitations. One limitation that exists due to the study design being a retrospective cohort is the issue with generalizability because of the reliance on the specific data sets. Despite these limitations, retrospective cohort studies remain valuable sources of clinical data and for expanding clinical knowledge. The study recognizes limitations related to the variables analyzed, which were confined to those documented and reported by NSQIP, encompassing over 150 variables. Unfortunately, crucial information such as the chronicity of the injury, graft usage, the type of graft utilized, the quality of the tendon, and the tendon gap were unavailable for analysis. For instance, Mzeihem et al. demonstrated a notable rise in complication rates associated with the utilization of a graft during primary repair of Achilles tendon ruptures compared to procedures where a graft was not employed [36]. Additionally, factors like age, ethnicity, diabetes, and smoking status, vital in assessing surgical risk, couldn't be incorporated into the risk calculator due to their failure to reach statistical significance. Another limitation related to the dataset used was the inability to determine causation. Although NSQIP employs a prospective collection of data, our model can only highlight associations and correlations rather than causation, which may be influenced by disparities in database collection methods. Furthermore, follow-up data that was available is limited to only 30 days following surgery. However, some post-operative complications, such as deep vein thrombosis or pulmonary embolisms, may occur after this time range. As such, careful consideration must be taken when interpreting results from our model to the incidence of long-term complications. Additionally, the current predictive model does not account for the impact of complications on treatment outcomes. Assessing the effects of complications, such as re-rupture, on treatment results and the ability to return to sport is crucial for making informed treatment recommendations. Re-rupture is particularly significant, as it has the most detrimental effect on returning to sport [37]. Furthermore, individuals at high risk for an initial Achilles tendon rupture are also at elevated risk for a subsequent re-rupture [38]. Factors such as male gender, younger age, and traditional immobilizing rehabilitation contribute to this heightened risk of re-rupture. Given these insights, it is important to consider these complications when evaluating and developing future predictive models [38]. Despite these inherent limitations, the risk calculator developed in this study provides surgeons with a valuable tool for more informed patient counselling, thereby contributing to clinical decision-making.

Conclusion

In conclusion, our study explored the risks involved in the repair of ruptured Achilles tendons over a 16-year period and assessed the incidence of any complications, as well as emphasizing the mechanisms behind their significance. We highlighted that chronic Steroid use, wound classification, ASA classification, anesthesia type, preoperative dialysis, and HTN requiring medication all played a substantial role in the risk of post-operative complications. This study not only illustrates the complex nature of Achilles tendon repair issues, but it also allowed for the development of a novel and practical risk calculator that may assist patients having this intervention in identifying and managing their risks. This has the potential to improve patient outcomes and guide therapeutic decision-making in the realm of Achilles tendon repair.

Abbreviations

ASA	American Scientists of Anesthesiologists physical status
AUC	Area under the curve
BMI	Body Mass Index
CHF	Congestive Heart Failure; HTN: Hypertension
COPD	Chronic Obstructive Pulmonary Disease
CPT	Current Procedural Terminology
DM	Diabetes Mellitus
HTN	Hypertension
INR	International Normalized Ratio
MAC	Monitored anesthesia care
Min	Minutes
NSQIP	National Surgical Quality Improvement Project
PTT	Partial Thromboplastin Time
ROC	Receiver operating characteristic
SD	Standard Deviation

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13018-024-04921-7.

Supplementary Material 1

Supplementary Material 2

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Author contributions

All authors contributed to the concept of the study. Author MH made substantial contributions to the concept of the study, helped the co-others in writing the manuscript and interpretation of the results, and coordinated all the work to ensure a smooth flow of research work. MH, MM, and AEZ participated in conducting the literature review and writing the different sections of the manuscript. All authors reviewed all versions and contributed to its numerous revisions. MM, AEZ, and HT participated in the statistical analysis and the technical aspects related to developing the risk calculator model. MN is the corresponding author. MN also followed up on the work to ensure that it was original and complied with the research ethics and guidelines of this journal. All authors are accountable for all the contributions and integrity of the work. All authors have read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Ethical review was not required because the study is a review of literature.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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