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The Link between Pre-Existing Medical Conditions and Knee Meniscus Tear and Repair in Medically Underserved Community

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Abstract

Introduction: Menisci function primarily in shock absorption and load transmission and can be torn, in isolation or concomitantly, via various activities. Our primary objective in this study was to analyze patients in the unique RGV community with various pre-existing medical conditions and determine if there was an association with the risk of knee meniscus tear and repair surgery. *Methods*: We conducted a retrospective chart review using the University of Texas Rio Grande Valley (UTRGV) UTHealth electronic database utilizing medical charts during the period January 1, 2018, to January 1, 2025. We collected and analyzed medical charts of individuals who were diagnosed with various pre-existing medical conditions using ICD-10 codes, and individuals who underwent meniscus tear and repair surgery using current procedural terminology codes. Bivariate and multivariate analyses were conducted. Results were reported as odds ratios with 95% confidence intervals. All analyses were performed with R statistical software. *Results*: For bivariate analysis, T2DM, hypertension, obesity, and anemia showed statistically significant effects. T2DM, hypertension, and anemia showed decreased risk while obesity showed an increased risk of meniscus surgery. For multivariate analysis, T2DM and anemia show statistically significant decreased risk of meniscus surgery. *Conclusion*: This study shows that some potentially overlooked pre-existing medical conditions may decrease the risk for meniscus tears requiring meniscus repair surgery. If supported in future studies, physicians and other healthcare providers may use this knowledge to help evaluate the risk of surgery when caring for individuals with a meniscus tear, especially in this underserved community.

Keywords

Knee, Meniscus, Meniscus Repair, Rural, Underserved

1. Introduction

The menisci in each knee, lateral and medial, are fibrocartilaginous structures that make up around 70% of the articular surface of the tibial plateau [1]. They function primarily in shock absorption and load transmission while also acting as a secondary stabilizing mechanism within the knee joint [1]. The less mobile medial meniscus is attached firmly to the deep fibers of the medial collateral ligament (MCL) and the joint capsule while the lateral meniscus, being more mobile, connects loosely with the joint capsule and does not attach to the lateral collateral ligament (LCL) [1].

The menisci can undergo isolated or concomitant tears with other stabilizing ligaments or alongside bony lesions [1]. Isolated tears are typically due to the shearing and rotational forces of the tibiofemoral joint [1]-[3]. Rapid acceleration or deceleration, jumping, change of direction, lifting heavy weights, and positions with increased degrees of closed kinetic chain flexion such as squatting are activities with elevated risk of meniscus tears [1]-[3]. Traumatic impact is also common and can lead to concomitant or isolated tears in menisci [1]. The incidence rate of meniscal tears is around 61 per 100,000 people in the United States general population whereas active-duty military members suffer meniscal tears at an incidence rate of around 8.7 per 1000 [1]. This makes sense as activities that put high stress on the knees increase the risk of meniscus tears [1]. Military service, and sports such as soccer, football, skiing, basketball, rugby, and wrestling are some common activities involved in meniscus tears [1] [4]. Males and individuals over the age of 40 years (often concomitant with osteoarthritis) are also at increased risk of meniscus tear [1] [4]. Regarding the tear location, the medial meniscus is more likely to be torn, likely due to its decreased mobility compared to the lateral meniscus [1]. Regarding treatment, simple and degenerative tears may be able to heal on their own with rest and physical therapy, although persistent pain, swelling, and mechanical symptoms may indicate surgery is required [1]. One study found that around 22% of individuals with a meniscus tear underwent surgery [5].

The Rio Grande Valley (RGV) is an area with underserved communities embedded in unique cultural and socioeconomic conditions that may influence the health of the population. This population has a high prevalence of chronic conditions, such as obesity and diabetes [6]. This region is also impoverished, medically underserved, and has a large population of undocumented immigrants [7] [8]. The machismo construct may further contribute to the health of this region as this may deter Hispanic males from seeking medical care as it may be perceived as being feminine [9]. In this study, we chose not to analyze pre-existing musculoskeletal conditions (arthritis, connective tissue disorders, etc.) but instead chose to evaluate other conditions that are not necessarily musculoskeletal based and may be overlooked. Our primary objective in this study was to analyze patients in the RGV with various pre-existing medical conditions and determine if there was an association with the risk of knee meniscus tear and repair surgery. We hypoth-

esized that T2DM and obese individuals would have an increased frequency of knee meniscus tear and repair.

2. Materials and Methods

Study Design and Data Collection

We conducted a retrospective chart review using the University of Texas Rio Grande Valley (UTRGV) UTHealth electronic database and Institutional Review Board approval was obtained prior to starting this study. We utilized data from medical charts during the period January 1, 2018, to January 1, 2025. We collected and analyzed medical charts of individuals who were diagnosed with various pre-existing medical conditions, including immunodeficiency, type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), hypertension, obesity/overweight, tobacco use, alcohol misuse, vascular disorders, and anemia. These conditions were obtained by the following ICD-10 diagnosis codes: immunodeficiency (D80 - D84), T1DM (E10), T2DM (E11), hypertension (I10), obesity/overweight (E66), tobacco use (Z72.0), alcohol misuse (F10), vascular disorders (I70, I73, I77 - I79), and anemia (D62 - D64). Immunodeficiency was defined as immunodeficiencies with predominant antibody defects, other major defects, combined immunodeficiency, and other immunodeficiencies. We also collected and analyzed the charts of individuals who had undergone a meniscus repair. These individuals were obtained using the current procedural terminology (CPT) codes 29881, 29882, 29883. Various demographics were also collected for each medical chart, including age at diagnosis, sex, BMI, and race/ethnicity. All data were reviewed for completeness and accuracy, with consistency checks and validation procedures applied prior to analysis to ensure data quality.

Inclusion and Exclusion Criteria

Individuals that were not seen by a UTRGV associated institution were not included in our study. If there were duplications of an individual's medical chart, such as an individual having multiple provider visits, the earliest date, the date the patient was originally diagnosed with any of the evaluated conditions, was used. The patient medical record ID was used to find the earliest date and get rid of any duplicate charts. If an individual was diagnosed with multiple conditions, all conditions were included and analyzed based on the date of diagnosis and demographics of the patient at the time of each particular diagnosis.

Statistical Analysis

Bivariate analyses were performed to assess the associations between each pre-medical condition variable and the outcome of meniscus repair surgery. For categorical variables (e.g., Immunodeficiency, T1DM, T2DM, and Anemia, etc.), we used Chi-square tests with Yates' correction to evaluate statistical independence with meniscus repair surgery. Fisher's exact test was used when expected cell counts were less than five to ensure accurate p-value estimation.

To identify factors associated with meniscus repair surgery, we performed a binary logistic regression analysis. This model controlled for age, sex, and ethnicity.

The binary logistic regression model included conducting meniscus repair surgery as the dependent variable and the pre-medical conditions as predictors. The logistic regression model was used to estimate the log odds of having meniscus repair surgery, producing coefficients (log odds) for each predictor. Results were reported as odds ratios (OR) with 95% confidence intervals (CI). Statistical significance was defined at the 0.05 level. All analyses were performed with R statistical software (Version: 4.2.2 R Core Team, 2022).

3. Results

There were 45,350 individuals analyzed in this study. Males represented 44.3% of the population, while females made up 55.7%. Most participants were Hispanic or Latino (66.1%), and notably, 22.9% of ethnicity declined to be reported. Of this study population, 102 (0.2%) individuals underwent meniscus repair surgery.

Bivariate analysis

Bivariate analysis showed that T2DM, hypertension, anemia, and vascular disease all had significantly reduced odds of having a meniscus tear and surgery. However, on the other hand, obesity was associated with four times increase in odds of having a meniscus tear and surgery (very strong risk) (Table 1).

Table 1. Summary of Chi Square/Fisher's exact test results for assessing the relationship between meniscus surgery vs. medical conditions.

	Meniscus	
	Odds Ratio (95% CI)	p-value
Immunodeficiency	Ref 1.017 (0.044, 4.481)	0.632*
T1DM	Ref 1.178 (0.051, 5.195)	0.624*
T2DM	Ref 0.243 (0.094, 0.509)	<0.001
Hypertension	Ref 0.460 (0.260, 0.764)	0.004
Obese	Ref 4.151 (2.502, 7.359)	<0.0001
Tobacco Use	Ref 0.482 (0.074, 1.515)	0.330*
Alcohol Misuse	Ref 0.516 (0.123, 1.370)	0.288*
Vascular Disease	Ref 0.293 (0.045, 0.921)	0.048*
Anemia	Ref 0.293 (0.045, 0.921)	<0.0001

Note: 95% CI represents the 95% confidence interval for crude Odds Ratio. The p-values based on Fisher's Exact tests are denoted by *. The significant p-values are italicized.

Multivariate Analysis

Multivariate analysis showed that T2DM (OR = exp (−1.115) ≈ 0.33, p = 0.013) and anemia (OR = exp (−2.164) ≈ 0.115, p < 0.001) had significantly reduced odds of having a meniscus tear and surgery (Table 2). Individuals with T2DM had 67% reduced odds of surgery compared to individuals without T2DM (Table 2). Individuals with anemia had 89% reduced odds of surgery compared to individuals without anemia (Table 2).

Table 2. Binary logistic regression model estimating the log odds of having meniscus repair surgery.

Variable	Estimate	Std. Error	z value	p-value (>|z|)	Significance
(Intercept)	−5.8883	0.368	−15.999	<2e−16	***
Immunodeficiency	−13.2178	467.2149	−0.028	0.97743	
T1DM	0.2901	1.0268	0.283	0.777549	
T2DM	−1.1145	0.4469	−2.494	0.012633	*
Hypertension	−0.3934	0.3183	−1.236	0.216472	
Obese/Overweight	0.4739	0.3584	1.322	0.186072	
Tobacco Use	−0.8404	0.7284	−1.154	0.248563	
Alcohol Misuse	−0.6536	0.6223	−1.05	0.293541	
Vascular Disease	−0.9671	0.743	−1.302	0.193025	
Anemia	−2.1641	0.6144	−3.522	0.000428	***

Although all * symbols indicate statistical significance, an increased number of symbols (e.g. **, **) indicates lower p-values, reflecting stronger statistical significance.

4. Discussion

For multivariate analysis, T2DM and anemia show statistically significant decreased risk indicating robust associations. Immunodeficiency, T1DM, hypertension, overweight/obesity, tobacco use, alcohol misuse, and vascular disease did not show any significant risk.

Individuals with T2DM having decreased risk of meniscal tears does not agree with current literature [10]. A study by Kuo YK *et al.* showed that individuals with either T1DM or T2DM had increased risk of tears or reduced tear function [10]. However, this was only seen in individuals who had poor glycemic control, indicating that proper control of blood glucose can decrease risk of tears [10]. With the RGV having high rates of diabetes, it does not correlate with our results showing a decreased risk of meniscus tear and repair in individuals with T2DM [6]. If anything, one might expect an increased risk of tear and repair due to poor medical care of their diabetes as a large number of the population are impoverished, lack health insurance, are undocumented, and follow the machismo construct [7]-[9]. The machismo construct states that males in Latino cultures may avoid partaking in acts that may be seen as feminine, and seeking healthcare may have that feminine perception [9]. However, one explanation for the obtained results is that

surgeons may have advised against or refused to perform surgery on various diabetic patients who were at significant risk of surgical complications. Further studies should evaluate the relationship between T2DM and meniscus tear and repair in this community and other underserved populations.

Regarding anemia, we were unable to find current literature analyzing the effect of anemia on meniscal tear and repair. However, studies show that anemia may decrease the systemic inflammatory response and decrease injury healing [11] [12]. The potential for cytokines to increase extracellular matrix synthesis by meniscal cells, suggesting the ability to improve meniscus healing has been shown in previous literature [11] [12]. Taking this into account, dysfunction of the systemic inflammatory response may impair healing of menisci via limiting cytokine number and function [11] [12]. This could indicate an increased need for meniscus repair in individuals with a meniscus tear. These studies do not agree with our results that anemia is associated with a decreased risk of meniscus tear and repair. One explanation for the obtained results is that surgeons may have advised against or refused to perform surgery on many anemic patients due to the significant risk of surgical complications. Further studies should analyze the relationship and possible factors between anemic individuals and meniscus tear and repair in individuals of the RGV and other medically underserved areas.

Regarding the other medical conditions that did not show an increased or decreased risk of meniscus tear and repair, the results for obesity (no risk effect) do not agree with current literature. Previous studies have shown that individuals classified as overweight or obese have an increased risk of meniscal tear and repair surgery compared to normal BMI individuals [13]-[15]. A possible explanation for the lack of meniscus tear and repair in our study population is the large number of impoverished individuals, undocumented individuals, individuals without health insurance, and the machismo construct [7]-[9]. These factors may prevent individuals from seeking care, therefore decreasing the number of meniscal tear diagnoses and meniscus repair surgeries.

The limitations of this study are as follows. Individuals must have been seen at a UTRGV associated institution, which may limit the generalizability of the study results. Although not an insufficient sample size, this study had a limited number of individuals who underwent meniscus repair, limiting the statistical power in the study. This study also only included surgically treated meniscal tears which may bias risk estimates toward treatment patterns rather than true injury incidence. Further studies should focus on obtaining data from a larger, more generalizable population to increase the statistical power and the generalizability of the study results.

5. Conclusion

This study shows that some potentially overlooked pre-existing medical conditions may decrease the risk for meniscus tears requiring meniscus repair surgery. If supported in future studies, physicians and other healthcare providers may use

this knowledge to help evaluate the risk of surgery when caring for individuals with a meniscus tear, especially in this underserved community. Future studies should be conducted to further evaluate possible relationships between pre-existing medical conditions and meniscus tears requiring repair surgery, especially in the RGV and other medically underserved populations.

Fundings

Not applicable.

Data Availability

The data may be made available upon request with permission from the University of Texas Rio Grande Valley School of Medicine.

Author Contributions

BCM contributed to the conceptualization, data curation, investigation, methodology, project administration, validation, visualization, writing of the original draft, reviewing and editing the manuscript. MP contributed to the conceptualization, formal analysis, methodology, validation, writing of the original draft, review and editing of the manuscript. MDS contributed to the conceptualization, investigation, validation, review and editing of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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