Partial thickness rotator cuff tears: Patient demographics and surgical trends within a large insurance database

Andrew Ardeljan^{a,*}, Joseph Palmer^b, Hans Drawbert^c, Amalia Ardeljan^a, Rushabh M. Vakharia^a, Martin W. Roche^a

^a Holy Cross Hospital, Orthopedic Research Institute, 5597 North Dixie Highway, Ft. Lauderdale, FL, 33308, USA

^b Broward General Medical Center, Department of Orthopedic Surgery, 1600 S Andrews Ave, Fort Lauderdale, FL, 33316, USA

^c Florida International University, Herbert Wertheim College of Medicine, 11200 SW 8th St, Miami, FL, 33199, USA

ARTICLE INFO

Keywords:

Shoulder surgery
Partial thickness rotator cuff tear
Arthroscopy
Patient demographics
Sports injury
Medicare

ABSTRACT

Introduction: Partial thickness rotator cuff tears (PTRCT) are a common injury reported in 13–32% of the population, yet most of the current literature focuses on full thickness rotator cuff tears. Therefore, the purpose of this study was to analyze trends among patients with PTRCT including: (1) demographics; (2) comorbidities; (3) cost of care; (4) setting of initial diagnosis; and (5) change in incidence of PTRCT or surgical approach over time.

Methods: A Medicare patient-population consisting of 44 million lives was retrospectively analyzed from 2007 to 2017 using International Classification of Disease, 9th Revision (ICD-9) codes. Patients were identified for PTRCT using ICD-9 code: 726.13. The query yielded a total of 44,978 patients all of which had been previously diagnosed with PTRCT. Primary trends analyzed included: demographics, comorbidities, cost of care, initial setting of diagnosis, and change in incidence of PTRCT or surgical approach over time.

Results: PTRCTs and surgical repair of PTRCTs were most common in patients ages 65 to 69 and least common in patients who were 85 and older. Incidence of PTRCT was greater in females (54.12%) than males (45.88%). Comorbidities found within the population included hypertension, hyperlipidemia, diabetes mellitus, tobacco use, obesity, rheumatoid arthritis, and osteoarthritis of the shoulder. The average cost per episode of care totaled \$9,923.26. PTRCTs were most commonly diagnosed in patients who resided in assisted living facilities (n = 27,106), making up 60% of the patient population. Reported incidence of PTRCT has increased substantially along with the surgical repair of PTRCT.

Conclusion: Reported cases of PTRCT and its surgical repair have both increased substantially over time. Approximately 11.70% of patients with PTRCT undergo either open or arthroscopic procedure as a means of surgical repair. With the growing popularity of arthroscopic procedures for rotator cuff repair, further investigation should be performed to analyze trends and risk factors for PTRCT, a seemingly underrepresented orthopedic condition.

1. Introduction

The rotator cuff consists of 4 tendons converging into the humeral head: the supraspinatus, infraspinatus, teres minor, and subscapularis. Both partial thickness rotator cuff tears (PTRCT) and full thickness rotator cuff tears (FTRCT) can occur as a result of an acute injury as typically seen in overhead and throwing athletes, or degenerative wear, most commonly a chronic condition observed in patients over 50 years of age.^{1–3} Causes of both full and partial thickness lesions in the rotator cuff are likely multifactorial in nature. Age related declines in tissue integrity and vascularity have been attributed to degenerative rotator

cuff injuries.^{4–6}

PTRCTs have been estimated to affect anywhere from 13 to 32% of the general population.^{4,5,7,8} While not all PTRCTs appear to be symptomatic, those that are can result in pain, decreased range of motion, crepitus, and positive impingement signs.^{9,10} Additionally, a significant proportion of PTRCTs eventually develop into full thickness rotator cuff tears, potentially worsening the pre-existing symptoms.¹¹

Despite the prevalence of PTRCTs, most of the literature on rotator cuff tears is focused on full thickness rotator cuff tears, with little to no present knowledge on the demographics and trends of patients with PTRCTs or their surgical repair.¹² Therefore, the purpose of the study

* Corresponding author.

E-mail address: Aarde005@fiu.edu (A. Ardeljan).

<https://doi.org/10.1016/j.jor.2019.08.027>

Received 25 June 2019; Accepted 13 August 2019

Available online 14 August 2019

0972-978X/ © 2019 Professor P K Surendran Memorial Education Foundation. Published by Elsevier B.V. All rights reserved.

was to analyze trends among patients with PTRCT including: (1) demographics; (2) comorbidities; (3) cost of care; (4) setting of initial diagnosis; and (5) change in incidence of PTRCT or surgical approach over time.

2. Methods

2.1. Database

A retrospective review of the Humana patient population database from 2007 to third quarter of 2017 was performed using the PearlDiver (Pearl Diver Technologies, Fort Wayne, Indiana) supercomputer. PearlDiver is compliant with the Health Insurance Portability and Accountability (HIPPA) act and contains the records of over 100 million de-identified patient records. Patients and complications were queried using International Classification of Disease, ninth revision (ICD-9) coding. Since patient records are de-identified, the study was exempt from our institution's Institutional Review Board (IRB) approval.

2.2. Study population

A Medicare patient-population consisting of 44 million lives was retrospectively analyzed from 2007 to 2017 using International Classification of Disease, 9th Revision (ICD-9) codes. Patients with PTRCT were identified for PTRCT using ICD-9 code: 726.13. Patients with PTRCT who underwent open procedure surgical repair were identified using CPT codes: 23410, 23412, and 23420. Patients with PTRCT who underwent arthroscopic repair were identified using CPT code: 29827. The query yielded a total of 44,978 patients, 5,263 of which had undergone either open procedure or arthroscopic surgical repair.

2.3. Primary assessments

Primary trends analyzed included: demographics, comorbidities, cost of care, setting of initial diagnosis, and change in PTRCT incidence or surgical approach over time.

2.4. Data analysis

Statistical analysis was primarily descriptive and was performed using the PearlDiver computing software. A p-value less than 0.05 was considered statistically significant.

3. Results

3.1. Patient demographics and comorbidities

PTRCTs were most common in patients ages 65 to 69 ($n = 13,876$; 30.85%), followed by 70–74 (10,279; 22.85%), and 75 to 79 (6,255; 13.90%). PTRCTs were least common in patients who were 85 and older ($n = 2,280$; 5.07%). Incidence of PTRCT was greater in females (24,342; 54.12%) than males (20,636; 45.88%). Comorbidities found within the patient population included: hypertension (35,807; 79.61%), hyperlipidemia (31,112; 69.17%), diabetes mellitus (16,704; 37.13%), tobacco use (8,761; 19.47%), obesity (4,102; 9.12%), rheumatoid arthritis (3,545; 7.88%), and osteoarthritis of the shoulder joint (237; 0.53%) (Table 1).

3.2. Cost and setting of initial diagnosis

The average cost per episode of care totaled \$9,923.26. Reported incidence of PTRCT within the Medicare population has increased substantially, with 12.8 times growth from 2011 to 2014 and 1.77 times increase from 2012 to 2014. PTRCTs were most commonly diagnosed in patients who resided in assisted living facilities (27,106; 60.26%),

Table 1

Demographics of age and comorbidities of patients with partial thickness rotator cuff tears within the medicare population. BMI = Body mass index.

Demographics	n (%)
SEX	
Male	20,636 (45.88)
Female	24,342 (54.11)
AGE	
64 and Under	9,405 (20.91)
65–69	13,876 (30.85)
70–74	10,279 (22.85)
75–79	6,255 (13.90)
80–84	3,336 (7.41)
85 <	2,280 (5.06)
COMORBIDITIES	
Hypertension	35,807 (79.61)
Hyperlipidemia	31,112 (69.17)
Diabetes Mellitus	16,704 (37.13)
Tobacco Use	8,761 (19.47)
Obesity (BMI > 30 kg/m ²)	4,102 (9.12)
Rheumatoid Arthritis	3,545 (7.88)
Arthritis of Shoulder	237 (0.53)

Table 2

Initial setting of diagnosis in patients with partial thickness rotator cuff tears within the medicare population.

Setting of Initial Diagnosis	n (%)
Assisted Living Facility	27,106 (60.26)
Office	5,250 (11.67)
Outpatient Hospital	2,345 (5.21)
Ambulatory Surgical	1,732 (3.85)
Public Health Clinic	1,091 (2.42)
Emergency Room	715 (1.58)
Group Home	377 (.83)
Impatient Hospital	222 (.50)
Independent Laboratory	79 (.17)
Home	71 (.16)
Urgent Care Facility	17 (0.037)
Hospice	12 (0.026)
Unassigned/Unknown Facility (Aggregate)	5,976 (13.287)

followed by doctor's office (5,250; 11.67%) and outpatient hospital settings (2,345; 5.21%). A significant portion of patients (5,976; 13.287%) were diagnosed in either unassigned or unknown facilities (Table 2).

3.3. Surgical trends

Of the 44,978 identified patients who were diagnosed with PTRCT, 5,263 had undergone surgical repair (11.70%) by either an open or arthroscopic procedure. Of the patients who had undergone surgical approaches, a total of (1,515; 28.77%) patients underwent open procedure, while (3,748; 71.22%) patients underwent an arthroscopic approach. Among both open and arthroscopic procedure groups, patients aged 65 to 69 had the highest rates of surgical repair (1,778; 33.78%), followed by 70–74 (1,336; 25.38%) and 64 and under (1,216; 23.11%) (Table 3). The open method of surgical repair for PTRCT had shown a large increase in prevalence from 2011 to 2013, with a downward trend from 2013 to 2014. Arthroscopic approaches to PTRCT repair increased substantially from 2011 to 2014 and maintained a positive trend throughout (Fig. 1).

4. Discussion

Despite their relatively high incidence, information regarding partial thickness rotator cuff tears (PTRCT) appears to be underrepresented in the literature. Cadaveric studies suggest PTRCTs effect up to 32% of

Table 3

Demographic analysis of patients with partial thickness rotator cuff tears undergoing surgical repair within the medicare population. OP= open wound procedure, AP = arthroscopic procedure, PTRCT= partial thickness rotator cuff tear.

Demographics	OP, n (%)	AP, n (%)	Total Surgically Repaired PTRCTs
AGE			
64 and Under	354 (6.73)	862 (16.38)	1,216 (23.11)
65-69	504 (9.57)	1,274 (24.21)	1,778 (33.78)
70-74	366 (6.95)	970 (18.43)	1,336 (25.38)
75-79	206 (3.91)	463 (8.80)	669 (12.71)
80-84	67 (1.27)	150 (2.85)	217 (4.12)
85 and Over	18 (0.34)	29 (0.55)	47 (.89)
Total	1,515 (28.77)	3,748 (71.22)	5,263 (100)

the population.^{3,4,8,10} The purpose of this study was to analyze reported trends, demographics, comorbidities, cost of care, setting of initial diagnosis, and change in incidence of PTRCT or surgical approach over time in patients with PTRCT within the Medicare population.

While our study has the advantages of being adequately powered with large sample sizes, there are limitations that should be acknowledged. Using an administrative database to acquire patient records relies on ICD-9 procedural and diagnosis codes not intended for research purposes.¹³ Due to the nature of ICD-9 diagnosis and procedural coding, we were unable to assess the severity of PTRCTs, limiting the degree of granulation to our data. Additionally, while age groups from 64 to 85 were reported in brackets of 5 years, the age group “64 and under” was reported as one large sum, further limiting our demographic assessment. Despite these limitations, this is the first study to our knowledge, that analyzes reported trends, demographics, comorbidities, cost of care, setting of initial diagnosis, and change in incidence of PTRCT or surgical approach over time, in a population of this magnitude among patients with PTRCTs.

This study demonstrates that most of the PTRCTs in the Medicare patient population occur over the age of 65. This is consistent with the current findings in the literature regarding both partial and full thickness rotator cuff tears. In a prospective ultrasonographic study of 411 patients, Tempelhof et al. demonstrated an age dependent trend among patients with nonspecific rotator cuff tears.¹⁴ Similarly, in a magnetic

resonance imaging study of 96 asymptomatic individuals, Sher et al. reported that 28% and 26% of individuals over the age of 60 had FTRCTs and PTRCTs, respectively.⁸ These reports support the findings of this study and demonstrate the need for further investigation in elderly patients with PTRCTs.

Additionally, comorbidities were assessed in all patients diagnosed with PTRCTs regardless of whether they had undergone any form of surgical repair. Incidence of hypertension was the greatest, followed by hyperlipidemia, diabetes mellitus, and tobacco use. In a case control study of 401 patients, Gumina et al. demonstrated that hypertensive patients were 2 times more likely to experience a rotator cuff large tear (OR: 2.09, 95%CI: 1.39–3.16) and 4 times more likely to experience a massive rotator cuff tear (OR: 4.30, 95%CI: 2.44–7.58).¹⁵ Similarly, a systematic review by Yang et al. suggests an association between dyslipidemia and rotator cuff tears.¹⁶ In a retrospective longitudinal population-based cohort study, Huang et al. demonstrated that diabetes mellitus increased risk of rotator cuff repair surgery (HR: 1.33, 95%CI: 1.05–1.68, $p < 0.001$).¹⁷ The literature suggests that diabetes mellitus may play a role in the development of musculoskeletal degeneration as commonly seen in rotator cuff tears due to nonenzymatic glycosylation of collagen, inflammation, and reduced tissue vascularity.^{18–20} Furthermore, in a study conducted on 586 orthopedic patients with atraumatic shoulder pain, Baumgarten et al. observed a strong association between cigarette smoking within 10 years of presentation and rotator cuff tears (OR: 4.24, 95%CI: 1.75–10.25, $p = 0.0004$).²¹ Tobacco use likely plays a role in the rotator cuff disease by decreasing collagen production, impairing bone to tendon healing, and reducing vascularity.^{22–24} These reports support our findings of these comorbidities among patients who suffer from PTRCTs. Further research should be conducted to assess PTRCT risk associated with each of these conditions.

Despite the large volume of data on age related factors for unspecified rotator cuff tears in the elderly, there is paucity in the literature regarding incidence and trends of surgical treatment for PTRCT. The study analyzed the incidence and trends among open and arthroscopic procedures as means of PTRCT repair. Both open and arthroscopic procedures declined with age, with the highest incidence of either being in the 65–69 age group, followed by the 70–74 age group. These results vary slightly from recent reports among patients with FTRCTs. Zhang et al. demonstrated that while arthroscopic rotator cuff repairs decreased with age, open rotator cuff tears increased with age.²⁵ We hypothesize the differences in our findings may be due to unique

Fig. 1. Surgical trends among patients with partial thickness rotator cuff tears undergoing surgical repair within the medicare population. OP= open wound procedure, AP = arthroscopic procedure.

approaches or risk factors involved with varying rotator cuff severity. Further research should be performed to determine the cause of discrepancy between open wound procedure trends in PTRCT vs FTRCT patients. Furthermore, both arthroscopic and open procedure utilization for PTRCTs increased substantially from 2011 to 2013. From 2013 to 2014, open procedure approaches decline, whereas arthroscopic approaches continue to trend upwards. These findings are consistent with the overall upward trend of arthroscopic utilization for rotator cuff repairs.²⁶

5. Conclusion

The study illustrates that reported cases of PTRCT and its surgical repair have both increased substantially over time. It is important to consider the results of the study in the context of the study design and limitations. Orthopedic surgeons should be aware of these trends and demographics among patients with PTRCTs and consequent surgical repair of PTRCTs. With the growing popularity of arthroscopic procedures for rotator cuff repair, further investigation should be performed to analyze trends and risk factors for PTRCT, a seemingly under-represented orthopedic condition.

Disclosure of funding related to current work

This research did not receive any grant funding.

Ethical review committee statement

This study was exempt from our institution's International Review Board (IRB) approval.

Conflicts of interest outside submitted work

None.

References

- Shaffer B, Huttman D. Rotator cuff tears in the throwing athlete. *Sports Med Arthrosc.* 2014;22(2):101–109. <https://doi.org/10.1097/JSA.0000000000000022>.
- Clement ND, Nie YX, McBirnie JM. Management of degenerative rotator cuff tears: a review and treatment strategy. *Sport Med Arthrosc Rehabil Ther Technol.* 2012;4(1):48. <https://doi.org/10.1186/1758-2555-4-48>.
- Boyer Martin I. AAOS comprehensive orthopaedic review 2. Google Books https://books.google.com/books?hl=en&lr=&id=WkNsDwAAQBAJ&oi=fnd&pg=PP55&ots=LkB_pWh_vm&sig=d6wLhmpW5wLBWhv5gvotujkm3_o#v=onepage&q&f=false, Accessed date: 11 June 2019.
- Lohr JF, Uhthoff HK. The microvascular pattern of the supraspinatus tendon. *Clin Orthop Relat Res.* 1990;254:35–38.
- Sano H, Ishii H, Trudel G, Uhthoff HK. Histologic evidence of degeneration at the insertion of 3 rotator cuff tendons: a comparative study with human cadaveric shoulders. *J Shoulder Elb Surg.* 1999;8(6):574–579. [https://doi.org/10.1016/S1058-2746\(99\)90092-7](https://doi.org/10.1016/S1058-2746(99)90092-7).
- Rudzki JR, Adler RS, Warren RF, et al. Contrast-enhanced ultrasound characterization of the vascularity of the rotator cuff tendon: age- and activity-related changes in the intact asymptomatic rotator cuff. *J Shoulder Elb Surg.* 2008;17(1 Suppl):96S–100S. <https://doi.org/10.1016/j.jse.2007.07.004>.
- Fukuda H. Partial-thickness rotator cuff tears: a modern view on Codman's classic. *J Shoulder Elb Surg.* 2000;9(2):163–168.
- Sher JS, Uribe JW, Posada A, Murphy BJ, Zlatkin MB. Abnormal findings on magnetic resonance images of asymptomatic shoulders. *J Bone Joint Surg Am.* 1995;77(1):10–15. <https://doi.org/10.2106/00004623-199501000-00002>.
- Edwards P, Ebert J, Joss B, Bhabra G, Ackland T, Wang A. Exercise rehabilitation in the non-operative management of rotator cuff tears: a review of the literature. *Int J Sports Phys Ther.* 2016;11(2):279–301.
- Ozaki J, Fujimoto S, Nakagawa Y, Masuhara K, Tamai S. Tears of the rotator cuff of the shoulder associated with pathological changes in the acromion. A study in cadavers. *J Bone Joint Surg Am.* 1988;70(8):1224–1230.
- Yamanaka K, Matsumoto T. The joint side tear of the rotator cuff. A followup study by arthrography. *Clin Orthop Relat Res.* 1994;304:68–73.
- Matthewson G, Beach CJ, Nelson AA, et al. Partial thickness rotator cuff tears: current concepts. *Adv Orthop.* 2015;2015:458786 <https://doi.org/10.1155/2015/458786>.
- Yoshihara H, Yoneoka D. Understanding the statistics and limitations of large database analyses. *Spine.* 2014;39(16):1311–1312. <https://doi.org/10.1097/BRS.0000000000000352>.
- Tempelhof S, Rupp S, Seil R. Age-related prevalence of rotator cuff tears in asymptomatic shoulders. *J Shoulder Elb Surg.* 1999;8(4):296–299.
- Gumina S, Arceri V, Carbone S, et al. The association between arterial hypertension and rotator cuff tear: the influence on rotator cuff tear sizes. *J Shoulder Elb Surg.* 2013;22(2):229–232. <https://doi.org/10.1016/j.jse.2012.05.023>.
- Yang Y, Qu J. The effects of hyperlipidemia on rotator cuff diseases: a systematic review. *J Orthop Surg Res.* 2018;13(1):204. <https://doi.org/10.1186/s13018-018-0912-0>.
- Huang S-W, Wang W-T, Chou L-C, Liou T-H, Chen Y-W, Lin H-W. Diabetes mellitus increases the risk of rotator cuff tear repair surgery: a population-based cohort study. *J Diabetes Complicat.* 2016;30(8):1473–1477. <https://doi.org/10.1016/j.jdiacomp.2016.07.015>.
- Dutta U, Cohenford MA, Guha M, Dain JA. Non-enzymatic interactions of glyoxylate with lysine, arginine, and glucosamine: a study of advanced non-enzymatic glycation like compounds. *Bioorg Chem.* 2007;35(1):11–24. <https://doi.org/10.1016/j.bioorg.2006.07.005>.
- Nho SJ, Yadav H, Shindle MK, Macgillivray JD. Rotator cuff degeneration: etiology and pathogenesis. *Am J Sports Med.* 2008;36(5):987–993. <https://doi.org/10.1177/0363546508317344>.
- Chen AL, Shapiro JA, Ahn AK, Zuckerman JD, Cuomo F. Rotator cuff repair in patients with type I diabetes mellitus. *J Shoulder Elb Surg.* 2003;12(5):416–421. <https://doi.org/10.1016/S1058274603001721>.
- Baumgarten KM, Gerlach D, Galatz LM, et al. Cigarette smoking increases the risk for rotator cuff tears. *Clin Orthop Relat Res.* 2010;468(6):1534–1541. <https://doi.org/10.1007/s11999-009-0781-2>.
- Jorgensen LN, Kallehave F, Christensen E, Siana JE, Gottrup F. Less collagen production in smokers. *Surgery.* 1998;123(4):450–455. [https://doi.org/10.1016/S0039-6060\(98\)70167-9](https://doi.org/10.1016/S0039-6060(98)70167-9).
- Galatz LM, Silva MJ, Rothermich SY, Zaegel MA, Havlioglu N, Thomopoulos S. Nicotine delays tendon-to-bone healing in a rat shoulder model. *J Bone Joint Surg Am.* 2006;88(9):2027–2034. <https://doi.org/10.2106/JBJS.E.00899>.
- Abate M, Vanni D, Pantalone A, Salini V. Cigarette smoking and musculoskeletal disorders. *Muscles Ligaments Tendons J.* 2013;3(2):63–69. <https://doi.org/10.11138/mltj/2013.3.2.063>.
- Zhang AL, Montgomery SR, Ngo SS, Hame SL, Wang JC, Gamradt SC. Analysis of rotator cuff repair trends in a large private insurance population. *Arthroscopy.* 2013;29(4):623–629. <https://doi.org/10.1016/j.arthro.2012.11.004>.
- Colvin AC, Egorova N, Harrison AK, Moskowitz A, Flatow EL. National trends in rotator cuff repair. *J Bone Joint Surg Am.* 2012;94(3):227–233. <https://doi.org/10.2106/JBJS.J.00739>.