



Hip Arthroscopy: Spatiotemporal Analysis in Three US States and Predictor of Revisit after a Procedure

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Abstract

Objective: The incidence of hip arthroscopy procedures has recently increased, current trends demonstrating a wide geographical variation and relatively similar functional outcomes among a wide age range. We aimed to evaluate spatio-temporal trends in state variation of hip arthroscopy procedures as well as the rate and determinants of 90-day hospital revisits.

Methods: This was a secondary spatiotemporal analysis of data on hip arthroscopy procedures from the Healthcare Cost and Utilization Project databases, including the State Inpatient Database (SID), the State Ambulatory Surgery Database and the State Emergency Department Database (SEDD) for Florida, Kentucky, and Maryland, spanning a total of six years (2009 - 2014). Revisit risk was only evaluated through Florida data.

Results: Out of 4,085 patients, the mean age was 40.7 years, 60.5% were female, 81.4% white, 77.7% had private insurance, and 96.5% were located in metropolitan areas. The average Charlson co-morbidity score was 0.11 (\pm 0.39), the Van Walraven score was 0.17 (\pm 1.51). Revisit rates progressively decreased during the study period, from 13.3% in 2009 to 6.2% in 2014 (p for trend < 0.001). Age >42 [OR: 2.13 (1.7, 2.69)] and a Charlson comorbidity score >0 [OR: 2.35 (1.73, 3.16)] were risk factors for a revisit. Paying mechanisms other than Medicare were protective. Most revisits (93.19%) occurred in the first 25 days after the procedure and the 90-day revisit rates for the State of Florida were centered on the major metropolitan areas such as West Palm Beach, Sarasota, Tampa, and Orlando. The incidence of hip arthroscopies increased in most parts of Florida, Kentucky, and Maryland over the study period.

Conclusion: Revisit rates may reflect the quality of care and highlight the need for improvement. Future registries should include patient factors like pre-operative function and social determinants of health that might influence outcomes and revisit rates.

Keywords: Hip arthroscopy procedures; Spatiotemporal analysis; Revisits; FAI and/or osteoarthritis (OA)

Introduction

Hip arthroscopy procedures have become more frequent in recent years [1,2]. Their spectrum of indications has widened [1] to include labral lesions, loose bodies, synovial diseases such as chondromatosis and pigmented villonodular synovitis, lesions resulting from underlying osteoarthritis, teres ligament rupture, acetabulum and proximal femur misorientation and "idiopathic" hip pain. Avascular necrosis of the femoral head, infectious arthritis, osteochondrosis dissecans, Perthes' disease, and complications after total hip replacement are less frequent indications [3]. Arthroscopy procedures are highly sensitive in identifying intra-articular pathologies including labral tears, loose bodies, osteochondral lesions and step deformities in traumatic injuries to the hip joint [4,5] and are thus valuable in treating these conditions [5]. Complications following arthroscopy procedures remain relatively rare [1] despite their widened range of application and include compression injury to the perineum, neurovascular traction injury, and scope trauma [6]. Severe complications like avascular necrosis, infections, intra-or postoperative fractures and vascular lesions are even rarer [1]. Fluid extravasation, where cool saline irrigation lowers a patient's body temperature, is yet another significant but rare complication [5]. Mild scope trauma to the femoral head has been reported to be the most frequent complication [6] while pudendal nerve neurapraxia has been described as the "classic" complication after traction on the fracture table [7]. As with adults, hip arthroscopy procedures in children and adolescents have been reported to be relatively safe, with low complication rates. In a case series of hip arthroscopy procedures performed on subjects 18 years old or younger, observed complications included instrument breakage, suture abscess and transient pudendal nerve palsy [8]. Particular attention given to

patient positioning, traction performing and portal establishing [1], the use of warmed irrigation solution [5,9], careful planning, attention to detail and effective postoperative rehabilitation [10,11] are factors that have been reported to mitigate these complications. Complication rates are also lower when hip arthroscopy procedures are performed by experienced surgeons [1,12]. Some of these complications, however, may require revision surgery, which is associated with some advantages: pain relief in patients with residual symptoms after primary surgery and improvement in patient-reported clinical and functional outcomes at short-term follow-up (modified Harris Hip Score) [13,14].

Hip arthroscopy procedures are increasingly applied to manage injuries and conditions of the hip [2], especially for the indication of FAI and/or osteoarthritis (OA) [15]. Current trends indicate that the incidence of hip arthroscopy procedures is lower in the Midwest, Northeast, and South compared to the Western region of the United States, with a preponderance of cases being patients aged 20 to 39 years, with no gender-based differences [16]. Comparable functional

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outcomes have been observed among patients aged 25 years and younger [17], and 50 years and older [18]. However, the geographical dispersion over time for these outcomes, and the risk factors for revisits are yet to be established.

The incidence of hip arthroscopy procedures increased significantly from 1.20 cases per 10,000 patients in 2004 to 5.58 in 2009, and most of the cases were patients aged 20 to 39 years [16]. Between 2007 and 2011, the incidence increased by over 251% from 1.6 cases per 10,000 to 4.0 cases per 10,000, with the highest incidence observed among patients aged 40 to 49 years [19]. Femoracetabular impingement (FAI) and labral tears, and acetabuloplasty/femoral osteochondroplasty and labral treatments are reported to be the most common diagnoses and surgical techniques in hip arthroscopy procedures, respectively [12]. Hip arthroscopy procedures are advantageous over open surgery in that they are minimally invasive [1] and present a relatively short recovery period [20]. Also, they define a safer and less invasive diagnostic and therapeutic approach to hip pain [21,22]. In a case series, hip arthroscopy procedures yielded greater sensitivity compared to X-rays and CT scans in identifying intra-articular pathologic findings including labral tears, loose bodies, osteochondral lesions, and step deformities [4]. Despite advanced imaging techniques hip arthroscopy procedures are not exempt from complications. Risk factors for revisits and how these vary geographically, is to the best of our knowledge, unknown.

Although the spectrum of indications of hip arthroscopy procedures has grown broader, the procedure remains relatively safe in all age groups [8] with mainly minor complications [1,2,11]. Overall complication rates ranging from 1.4% [23] to 4.5% [11] and a major complication rate ranging from 0.3% [2] to 0.58% [12] have been reported. Iatrogenic chondrolabral injury and temporary neuropraxia are the two most common minor complications [10,12] while extra-articular fluid extravasation is the most commonly reported major complication [10]. Minor complications are purported to be technical and directly related to the learning curve of the procedure. Complications are expected to decline as the surgeon gains experience and the patient selection for the procedure becomes more refined improves [10-12]. Some complications may require re-operations such as revision hip arthroscopy, total hip arthroplasty (THA), or hip resurfacing. Residual FAI [14], labral tears, and chondral lesions are reported to be the most common indications for revision arthroscopy [13]. An overall re-operation rate of 6.3% has been reported, with conversion to THA being the most common reason for operation [12]. A conversion rate to THA or hip resurfacing of 2.4% has been reported [11]. Revision hip arthroscopy has been demonstrated to result in significant functional and clinical outcomes. However, a minimum of 2 years of follow-up is recommended since the majority of revision surgeries tend to occur within this interval [48]. Thus, improvement in clinical outcomes relies on identifying risk factors for revisits following hip arthroscopy procedures.

In view of this gap in the literature, our study aims to (1) evaluate the trend of hip arthroscopy over time using spatial time series, and (2) evaluate the rate of 90-day hospital revisits following the procedure as well as risk factors associated with revisits using three State Healthcare Cost and Utilization Project (HCUP) databases.

Materials and Methods

Study design

This is a secondary data analysis to evaluate spatio-temporal trends of hip arthroscopy across three US states as well as the rate of 90-day hospital revisits following the procedure for the state of Florida. This study is described per the STROBE (Strengthening the Reporting of

Observational studies in Epidemiology) guidelines [24].

Ethics

The Institutional Review Board of the University of São Paulo (Brazil) approved our study.

Setting

We utilized data from the Healthcare Cost and Utilization Project (HCUP) databases which comprise patient data as reported by state, private data organizations, hospital associations, and the federal government, and is sponsored by the Agency for Healthcare Research and Quality (AHRQ). The three HCUP databases used include the State Inpatient Database (SID) [25], the State Ambulatory Surgery Database (SASD) [26] and the State Emergency Department Database (SEDD) [27] for Florida, Kentucky, and Maryland spanning six years (2009 - 2014). The SID comprises discharge records of all inpatients including those admitted through the emergency department. The SASD has data on ambulatory survey visits and releases. The SEDD includes records from emergency department visits. These databases contain de-identified discharge records for individual patients from all sources of coverage - Medicare, Medicaid, private insurance, and self-pay/uninsured. We analyzed data for the states of Maryland, Florida, and Kentucky between the years of 2009-2014. Only data from Florida were used for the analysis of risks of revisits since this was the only state with data allowing for this type analysis during the study period.

Participants

We included all patients who underwent any form of hip arthroscopy including arthroscopy with or without synovial biopsy (ICD-9 procedure Code 29860), femoroplasty (ICD-9 procedure Code 29914), acetabuloplasty (ICD-9 procedure Code 29915) and labral repair (ICD-9 procedure Code 29916). All patients included in this study were from Florida, Kentucky, and Maryland between 2009 and 2014.

Outcomes

Outcomes of interest were the occurrence of revisit within 90 Days after discharge as well as the time to that revisit.

These were analyzed using visit linkage variables across patient encounters. The time between a particular arthroscopy procedure and a hospital revisit in each of the three databases was used to calculate revisit rates. We defined a 90-day hospital revisit as a revisit to an ambulatory surgery center or inpatient hospital admission within 90 days from the index procedure. The second outcome was the geographical location where procedures were performed, evaluated through longitude and latitude obtained from the American Hospital Association survey.

Predictors

Our main predictors included injuries and conditions of the hip especially FAI and/or osteoarthritis (OA), age (>42), labral tears, and chondral lesions.

Statistical methods

An exploratory analysis evaluated the distributions, frequencies, and percentages for each of the numeric and categorical variables. Categorical variables for near-zero variation were assessed [28]. Extensive graphical displays were used for both univariate analysis and bivariate associations, accompanied by broader tests such as Maximal Information Coefficient [29] and Nonnegative Matrix Factorization [30] algorithms for numeric variables. Missing data were explored using a combination of graphical displays involving univariate, bivariate and

multivariate methods. Imputation was performed using a k-nearest neighbors algorithm (n=5) [31].

Categorical variables for near-zero variation were assessed [28] strategy involved the use of a series of generalized linear models with a binomial family, i.e., logistic regression models, to model the association between the rate of revisits and types of hip arthroplasty, adjusted for educational level, age, race, gender, and comorbidity status. To calculate measures of risk (Odds Ratio, OR) for the outcome rather than only obtaining less clinically-interpretable measures, Categorical variables for near-zero variation were assessed [28] types using median values. Also, to attain the most parsimonious model, we used backwards deletion based on a series of likelihood-ratio tests comparing nested models. Results are reported as OR with 95% confidence intervals, with results being interpreted as significant when the confidence intervals did not cross a value of 1.0. Survival curves were calculated from Kaplan-Meier plots.

To evaluate the trends of hip arthroscopy procedures over time using spatiotemporal analysis, Categorical variables for near-zero variation were assessed [28] and latitude of each hospital facility (available from the American Hospital Association Database) where patients received care, stratified by year. We displayed years in maps representing the procedure distribution per year. All analyses were performed using the R language [32].

Results

Participants

Our sample of subjects undergoing arthroscopy comprised 4,085 individuals with an average age of 40.7 (± 15.4) years, 60.5% being

female, 81.4% being White, 77.7% having their procedures paid through private insurance, and 96.5% located in metropolitan areas. The average Charlson co-morbidity score was 0.11 (± 0.39) while the Van Walraven score was 0.17 (± 1.51). Revisit rates progressively decreased during the study period, from 13.3% in 2009 to 6.2% in 2014 (p for trend <0.001) (Table 1).

Risk factors for revisit after arthroscopy were age >42 years old [OR: 2.13 (1.7, 2.69)]; paying mechanisms other than Medicare were protective against revisits; subjects with private insurance had an OR of 0.26 (0.2, 0.35), while individuals having their procedures reimbursed through Medicaid had an OR of 0.22 (0.0833, 0.48). A Charlson comorbidity score > 0 was a risk factor for revisit [OR: 2.35 (1.73, 3.16)] (Table 2).

As depicted in the Kaplan-Meier curve 93.19% of all revisits happened within the first 25 days after the procedure (Figure 1).

Figure 2 displays the 90-day revisit rates after the hip arthroscopy procedures for the State of Florida. We found that the revisits oscillated across the years, with most of them occurring in on major metropolitan areas such as West Palm Beach, Sarasota, Tampa, and Orlando. Beyond a focus on metropolitan areas where major hospitals are located, there was no consistent pattern regarding areas with higher revisit rates.

Mapping spatial trends of arthroscopy procedures over time

Kentucky

The frequency of hip arthroscopy procedures was higher in the Northern regions of the state and increased over time, especially in the Northern, Northwestern, and Western regions of Kentucky (Figure 3).

Variable [Missing]	Total (4,085)	2009 (173)	2010 (181)	2011 (674)	2012 (876)	2013 (1,017)	2014 (1,164)	p
Age (y) [0]	40.7 (± 15.4)	43.8 (± 16)	42.6 (± 15.4)	41.4 (± 14.7)	40.8 (± 15.6)	40.3 (± 15.5)	40 (± 15.3)	0.017
Female [0]	2,470 (60.5%)	99 (57.2%)	108 (59.7%)	383 (56.8%)	523 (59.7%)	639 (62.8%)	718 (61.7%)	0.164
Race [61]								0.01
- White	3,277 (81.4%)	146 (85.9%)	153 (85%)	523 (79.2%)	683 (78.8%)	836 (83.7%)	936 (81.5%)	
- Black	235 (5.8%)	10 (5.9%)	11 (6.1%)	35 (5.3%)	54 (6.2%)	53 (5.3%)	72 (6.3%)	
- Hispanic	385 (9.6%)	7 (4.1%)	15 (8.3%)	69 (10.5%)	99 (11.4%)	84 (8.4%)	111 (9.7%)	
- Asian or Pacific Islander	18 (0.4%)	2 (1.2%)	0 (0%)	1 (0.2%)	4 (0.5%)	3 (0.3%)	8 (0.7%)	
- Native American	3 (0.1%)	0 (0%)	0 (0%)	0 (0%)	1 (0.1%)	0 (0%)	2 (0.2%)	
- Other	106 (2.6%)	5 (2.9%)	1 (0.6%)	32 (4.8%)	26 (3%)	23 (2.3%)	19 (1.7%)	
Payment source [0]								0.911
- Medicare	344 (8.4%)	22 (12.7%)	17 (9.4%)	53 (7.9%)	75 (8.6%)	78 (7.7%)	99 (8.5%)	
- Medicaid	99 (2.4%)	5 (2.9%)	5 (2.8%)	19 (2.8%)	18 (2.1%)	23 (2.3%)	29 (2.5%)	
- Private insurance	3,174 (77.7%)	129 (74.6%)	134 (74%)	527 (78.2%)	696 (79.5%)	804 (79.1%)	884 (75.9%)	
- Self-pay	45 (1.1%)	1 (0.6%)	2 (1.1%)	6 (0.9%)	10 (1.1%)	11 (1.1%)	15 (1.3%)	
- No charge	7 (0.2%)	0 (0%)	0 (0%)	2 (0.3%)	1 (0.1%)	2 (0.2%)	2 (0.2%)	
- Other	416 (10.2%)	16 (9.2%)	23 (12.7%)	67 (9.9%)	76 (8.7%)	99 (9.7%)	135 (11.6%)	
Location [16]								0.335
- Non-CBSA	57 (1.4%)	0 (0%)	3 (1.7%)	9 (1.3%)	11 (1.3%)	13 (1.3%)	21 (1.8%)	
- Micropolitan Statistical Area	84 (2.1%)	7 (4.1%)	4 (2.2%)	12 (1.8%)	18 (2.1%)	14 (1.4%)	29 (2.5%)	
- Metropolitan Statistical Area	3,928 (96.5%)	165 (95.9%)	172 (96.1%)	651 (96.9%)	843 (96.7%)	987 (97.3%)	1,110 (95.7%)	
Median household income (percentile) [65]								< 0.001
- 0 to 25th	772 (19.2%)	25 (14.9%)	21 (11.8%)	116 (17.4%)	154 (17.9%)	211 (21.1%)	245 (21.3%)	
- 26th to 50th	1,192 (29.7%)	48 (28.6%)	42 (23.6%)	170 (25.5%)	227 (26.4%)	303 (30.3%)	402 (35%)	
- 51st to 75th	1,258 (31.3%)	49 (29.2%)	66 (37.1%)	223 (33.5%)	281 (32.7%)	315 (31.5%)	324 (28.2%)	
- 76th to 100th	798 (19.9%)	46 (27.4%)	49 (27.5%)	157 (23.6%)	197 (22.9%)	171 (17.1%)	178 (15.5%)	
Charlson comorbidity score [0]	0.11 (± 0.39)	0.21 (± 0.56)	0.13 (± 0.44)	0.13 (± 0.41)	0.1 (± 0.33)	0.1 (± 0.43)	0.09 (± 0.33)	0.02
Van Walraven comorbidity score [0]	0.17 (± 1.51)	0.53 (± 1.59)	0.51 (± 2.37)	0.17 (± 1.51)	0.12 (± 1.41)	0.1 (± 1.51)	0.16 (± 1.38)	0.01
Revisit [0]	347 (8.5%)	23 (13.3%)	23 (12.7%)	69 (10.2%)	84 (9.6%)	76 (7.5%)	72 (6.2%)	< 0.001

Table 1: Sample characteristics of subjects with hip arthroscopy categorized by year.

	Revisit
Age (y) ≤ 42	1 [Reference]
Age (y) >42	2.13 (1.7, 2.69)
Female FALSE	1 [Reference]
Female TRUE	1.1 (0.88, 1.38)
Race White	1 [Reference]
Race Black	0.88 (0.52, 1.41)
Race Hispanic	1.24 (0.86, 1.73)
Race Asian or Pacific Islander	0 (1,998)
Race Native American	0 (7.651883e+41)
Race Other	0.42 (0.13, 1.01)
Payment source Medicare	1 [Reference]
Payment source Medicaid	0.22 (0.0833, 0.48)
Payment source Private insurance	0.26 (0.2, 0.35)
Payment source Self-pay	0 (0, 0.94)
Payment source No charge	0.57 (0.0299, 3.4)
Payment source Other	0.31 (0.2, 0.48)
Median household income (percentile) 0 to 25th	1 [Reference]
Median household income (percentile) 26th to 50th	1.08 (0.79, 1.48)
Median household income (percentile) 51st to 75th	0.97 (0.71, 1.33)
Median household income (percentile) 76th to 100th	0.72 (0.5, 1.05)
Charlson comorbidity score ≤ 0	1 [Reference]
Charlson comorbidity score >0	2.35 (1.73, 3.16)

Table 2: 90-day revisit odds ratio for hip arthroscopy.

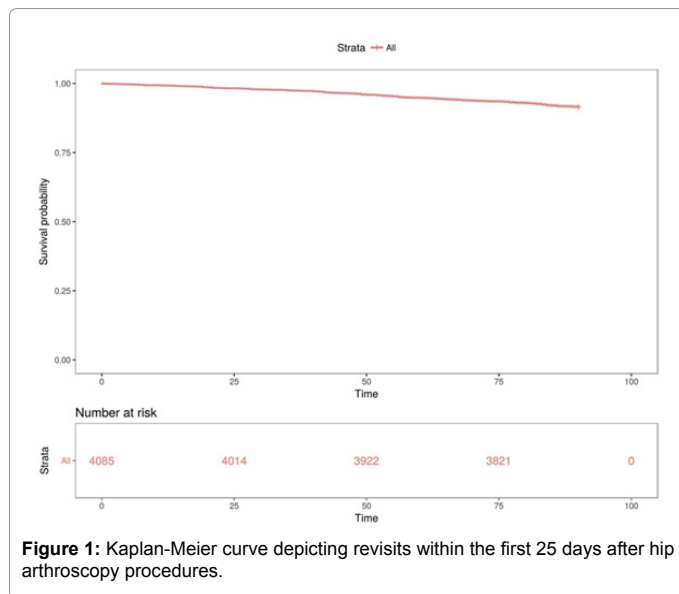


Figure 1: Kaplan-Meier curve depicting revisits within the first 25 days after hip arthroscopy procedures.

Maryland

In the state of Maryland, hip arthroscopy procedures were most prevalent in Baltimore and surrounding regions, reaching a peak in 2012 with the incidence progressively rising through the study period. On the other hand, the Northeastern and the Northwestern parts of the state did not experience significant changes over time (Figure 4).

Florida

A North-to-South pattern was observed concerning the incidence of hip arthroscopies, with regions in the coast having a higher prevalence than those in the inner state. Of importance, there was an increase in the incidence of hip arthroscopy procedures during the studied period in most of the regions across the state (Figure 5).

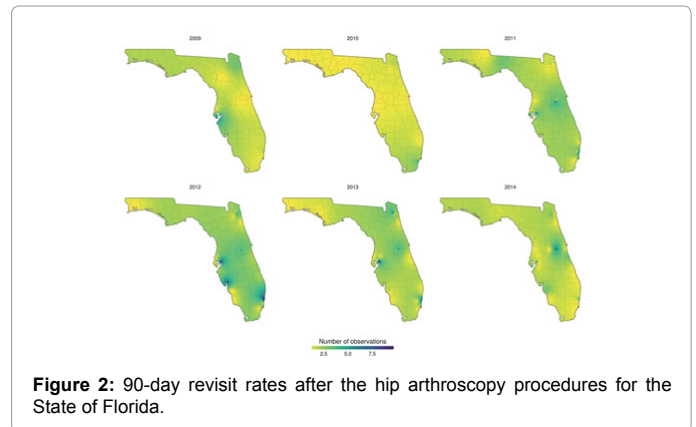


Figure 2: 90-day revisit rates after the hip arthroscopy procedures for the State of Florida.

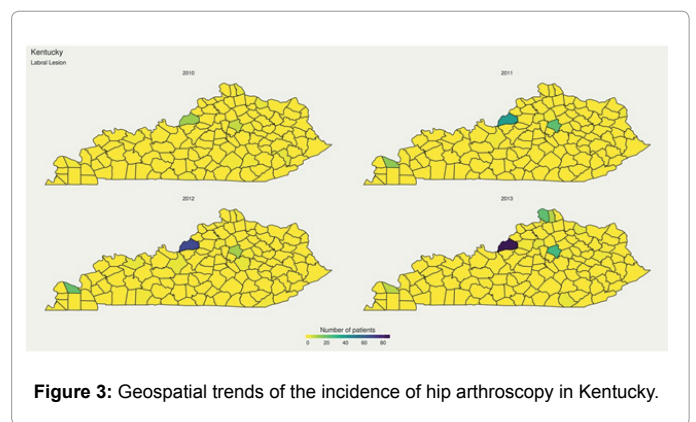


Figure 3: Geospatial trends of the incidence of hip arthroscopy in Kentucky.

Discussion and Conclusion

The main finding of this study was that a higher comorbidity (Charlson comorbidity score >0), Medicare insurance, and age above 42 years old were found to be risk factors for revisit after arthroscopic hip procedures. Over 90% of all revisits occurred within 25 days from the initial procedure and revisit rates progressively decreased during the study period, from 13.3% in 2009 to 6.2% in 2014 (p for trend <0.001). Older subjects were also more likely to have revisits after discharge. The 90-day revisit rates for the State of Florida were centered on the major metropolitan areas such as West Palm Beach, Sarasota, Tampa, and Orlando. The incidence of hip arthroscopy procedures was higher in the northern regions of Kentucky, in Baltimore and surrounding areas in Maryland, as well as in the coastal areas of the state of Florida. To the best of our knowledge, this was the first study evaluating the trend of arthroscopic hip procedures over time using spatiotemporal analysis and risk factors associated with 90-day hospital revisits.

To the best of our knowledge, this was the first study evaluating the trend of arthroscopic hip procedures over time using spatiotemporal analysis and risk factors associated with 90-day hospital revisits. Higher comorbidity (Charlson comorbidity score >0), Medicare insurance, and age above 42 years old were risk factors associated with revisit after arthroscopic hip procedures. Over 90% of all revisits occurred within 25 days from the initial procedure and revisit rates progressively decreased during the study period, from 13.3% in 2009 to 6.2% in 2014 (p for trend <0.001). Older subjects were also more likely to have revisits after discharge. The 90-day revisit rates for the State of Florida were centered on the major metropolitan areas such as West Palm Beach, Sarasota, Tampa, and Orlando. Finally, the incidence

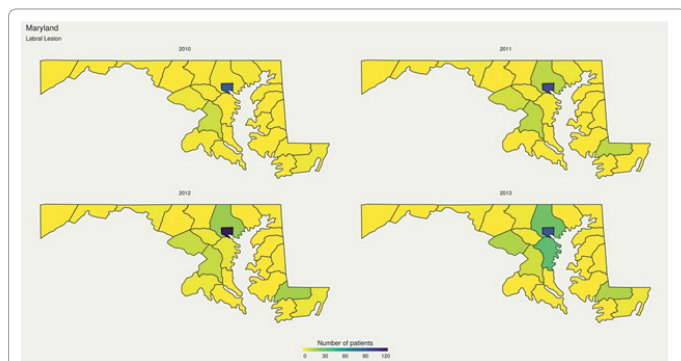


Figure 4: Geospatial trends of the incidence of labral lesions in Maryland.

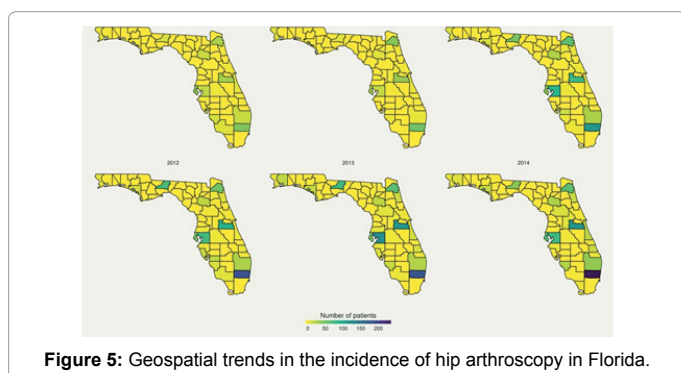


Figure 5: Geospatial trends in the incidence of hip arthroscopy in Florida.

of hip arthroscopy procedures was higher in the northern regions of Kentucky, in Baltimore and surrounding areas in Maryland, as well as in the coastal areas of the state of Florida.

Increased co-morbidity indices were equally associated with high revisit rates. In support of our results, previous studies have demonstrated an increased risk of revisits across a wide range of primary diagnoses and procedures for patients with co-morbidities such as infection, diabetes, pulmonary disease, renal failure, cardiac arrhythmias, congestive heart failure, high body mass index, and high American Society of Anesthesiologist scores [18,33]. Patients with co-existing medical conditions present an increased risk of revisits due to reduced functional status [34]. The increased risks also reflect the patients' overall medical condition, with untreated comorbidities often being aggravated during the postoperative period [35]. Identifying and addressing medical and rehabilitation issues before discharge is, therefore, prominent to minimize the risks of revisits.

These rates are on the rise [37,38], being the revisit rates among Medicare beneficiaries approximately 20% higher nowadays than they were in 2002.

Per our results, Medicare beneficiaries are associated with an increased risk of revisits to the hospital after a hip arthroscopy. This is consistent with previous research demonstrating that Medicare beneficiaries are associated with an elevated risk of revisits in a variety of hospital-related procedures [36]. These rates are on the rise [37,38], revisit rates among Medicare beneficiaries being approximately 20% higher nowadays than they were in 2002. Also, not only are hospital revisits common in the month after discharge, but they often result in inpatient hospitalizations. These findings are likely explained by patients' comorbidities and lack of access to important resources after discharge, including social support and primary care [36]. Specifically, Medicare covers all re-hospitalization charges, except those where re-

hospitalization occurs within 24 hours from discharge for the same primary condition associated with the initial hospitalization [37].

Individuals older than 42 years presented an elevated risk of revisit after hip arthroscopy. Although a small series of patients over 50 years old demonstrated remarkable improvements after hip arthroscopy for femoroacetabular impingement [19,39], other studies in alignment with our results associated increased age with an elevated risk of hospital revisits across a range of hospital procedures and diagnoses [18,19,40–44]. One previous study specifically reported that after discharge, the 14-day revisit rate among elderly patients was 29%, which is in contrast with a 15% rate among younger individuals [43]. It has been recorded that the highest rate occurs during the first month following the index visit, decreasing over the next one to two months, after which a steady state is attained [44]. Likely explanations for this increased risk of revisit with age include a lack of primary quality of care, pre-existing medical conditions, continued symptoms or recurrence of chronic medical problems, and depression [44]. Decreased muscle mass, limited activity [42], alcohol abuse [45], and lack of social support [44] are also risk factors for a protracted postoperative recovery.

The geospatial analysis demonstrated a non-uniform increase in the incidence of hip arthroscopy procedures across Florida, Kentucky, and Maryland. This increase was most prominent around the Baltimore region in Maryland, the northern regions of Kentucky, and the coastal regions in Florida. Most of the regions across all three states experienced a significant increase in the incidence of hip arthroscopy procedures over time except for the northeastern and the northwestern parts of Maryland. One study revealed that the rate of hip arthroscopy among those aged 20 years or older in the United States increased by 49% between 1996 and 2006, and was more than twofold (404 per 100,000 people) higher than in England or Canada [46]. Likely reasons for this increase include greater skill among orthopedic surgeons related to physical evaluation tests for identifying patients with hip conditions, as well as the increment of sports medicine fellowships with surgical mentoring in hip arthroscopy [47].

Another study cites the increase in the number of AAOS (American Academy of Orthopaedic Surgeons)/AANA (Arthroscopy Association of North America) learning center programs as well as cadaver laboratories offered by orthopedic instrument companies, which have helped increase proficiency in hip arthroscopy [16,47].

This study has limitations associated with its observational design. First, despite our best efforts to control for missing rates, some of our variables presented missing observations. To address this issue, we used imputation algorithms and then sensitivity analyses to ensure the validity of our conclusions under different assumptions. Also, the evaluated sample constitutes a small number of orthopedic patients in the US and is thus not a true cross-section of the entire population. As a result, because our analyses were limited to the states of Maryland, Florida, and Kentucky, it may not be representative of the entire USA. Despite these limitations, our sample is not atypical for its setting, making our conclusions valid for similar populations.

An 8.6% revisit rate should point to a call to quality of care efforts. Over 90% of revisits occur within the first 25 days from the index procedure, while older age, co-morbidity and Medicaid insurance increase the risks of revisits. Future prospective registries should focus on shedding light on patient factors such as pre-operative function and social determinants of health that might influence outcomes and revisit rates.

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