Trends in Meniscal Allograft Transplantation in the United States, 2007 to 2011

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Purpose: The purpose of this study was to investigate the incidence of meniscal allograft transplantation (MAT) in the United States from 2007 to 2011 and to analyze trends in MAT using a large database of privately insured non-Medicare patients. **Methods:** Patients who underwent MAT (Current Procedural Terminology [CPT] code 29868) from 2007 to 2011 were identified using the PearlDiver Private Payer Database. Demographic and use data available in the database were extracted for patients who underwent MAT. Statistical analysis involved Student *t* tests, χ-square tests, and linear regression analyses, with statistical significance set at $P < .05$. **Results:** The PearlDiver database allowed analysis of approximately 25.4 million patients per year during the years 2007 to 2011 (approximately 9% of the US population younger than 65 years). From 2007 to 2011, there were a total of 302 MAT procedures, for an incidence of 0.24 MAT procedures per year per 100,000 patients. There was no statistically significant increase in MAT procedures over time ($P = .36$). There was a higher incidence of MAT in male patients (0.26) than in female patients (0.19) ($P = .001$). There was a higher incidence of MAT in patients aged 25 to 34 years (0.40) and in those younger than 25 years (0.30) compared with older patients ($P < .001$), with 9.7% of MAT procedures being performed in patients younger than age 35 years. **Conclusions:** MAT was an uncommon procedure, with no change in its incidence from 2007 to 2011. MAT procedures were performed more commonly in patients younger than 35 years and in male patients. **Level of Evidence:** Level IV, descriptive epidemiology study.

Meniscal tears are common injuries that may result from trauma or degenerative processes.[1,2] The menisci are critical for normal knee function, including shock absorption and load distribution and minimizing tibiofemoral articular cartilage forces.[3,4] When nonoperative treatment fails, surgical treatment options for meniscal tears include partial meniscectomy, subtotal meniscectomy, and meniscal repair. The surgical goal is to repair meniscal tears when feasible, and if meniscectomy is performed to preserve as much intact meniscal tissue as possible, because meniscal deficiency increases the risk of osteoarthritis.[5,6]

Patients with meniscal deficiency caused by complete or subtotal meniscectomy may experience continued symptoms, including recurrent effusions, pain, and instability.[7,8] Meniscal allograft transplantation (MAT) is used as a surgical option for young patients with symptomatic meniscal deficiency.[7,8] Surgical treatment principles for successful MAT include addressing malalignment, knee instability (e.g., anterior cruciate ligament reconstruction), and articular cartilage pathologic conditions.[9] Clinical outcomes of MAT from the recent literature with short-to medium-term follow-up have shown improvements in outcome scores, although some authors have identified a tendency for outcomes to decline over time.[10-17] A recent systematic review of MAT found a 81.6% patient satisfaction rate and a 10.6% complication rate, with the most common complication being acute tearing of an incorporated allograft.[18]

A PubMed search for the phrase "meniscal allograft transplantation" yielded 50 results from 2009 to 2013, compared with 21 results from 1999 to 2003. Despite the increased number of publications on MAT in recent

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Table 1. Annual Trends in Number of Meniscal Allograft Transplantation Procedures Performed from 2007 to 2011 in PearlDiver US Private Insurance Database, With Estimates of Total Number of MAT Procedures for US Population

Year	No. of MAT Procedures	No. of Patients in Database	Incidence (per 100,000 Patients)	Estimated No. of MAT Procedures for US Population
2007	60	25,525,000	0.24	640
2008	55	26,345,000	0.21	574
2009	62	24,625,000	0.25	697
2010	62	24,810,000	0.25	699
2011	63	25,870,000	0.24	675
Total	302	127,175,000	0.24	3,295
P value	NA	.38	.36	NA

MAT, meniscal allograft transplantation.

years and the promising clinical results, the rate at which MAT procedures are being performed and the epidemiologic trends in MAT in the United States have not been reported, and the use of this procedure is unknown.

The purpose of this study was to investigate the incidence of MAT in the United States from 2007 to 2011 and to analyze trends in MAT, using a large database of privately insured non-Medicare patients. We hypothesized that the number of MAT procedures would increase from 2007 to 2011 and that the majority of these procedures would be performed in patients younger than 35 years.

Methods

The PearlDiver Patient Record Database (PearlDiver, Fort Wayne, IN) was queried for the years 2007 to 2011 on February 12, 2014. The PearlDiver database is a Health Insurance Portability and Accountability Act–compliant national database available by subscription service. It uses supercomputer technology to rapidly and accurately query large medical databases, including tracking patient medical records. The PearlDiver database is, to our knowledge, the largest private payer database in the United States, with UnitedHealth Group (Minneapolis, MN) representing the largest contributing individual health plan. The database has more than 2 billion individual patient records and contains Current Procedural Terminology (CPT) and International Classification of Diseases, 9th Revision codes related to orthopaedic procedures, as well as demographic data such as age and sex. There were no Medicare claims data included in the current data set. From 2007 to 2011, the database captured 24.6 to 26.3 million patients (~9% of the US population younger than 65 years of age and ~13% of the US population with private insurance, using data from the US Census Bureau) for each year. The PearlDiver database has been used in a variety of recent studies to analyze trends in sports medicine and orthopaedic procedures.[19-22]

Patients having a record of CPT code 29868 (arthroscopy knee surgical; meniscal transplantation [includes arthrotomy for meniscal insertion] medial or lateral) were included. No patients were excluded, because all included patients had complete data for the other demographic parameters in the PearlDiver database. Demographic parameters analyzed were age (< 25, 25 to 34, 35 to 44, 45 to 54, and > 55 years) and sex (male and female). Incidence values were calculated based on overall PearlDiver database patient characteristics to be used for comparison of MAT procedure demographics with overall database norms.

Linear regression was used to compare trends in MAT from the years 2007 through 2011. Student *t* tests and χ-square tests were used to compare the proportion of patients based on the other demographic parameters in the PearlDiver database. Statistical significance was set at $P < .05$.

Results

Using the PearlDiver database for the years 2007 to 2011, an average of 25.4 million patients were analyzed per year (Table 1). There was no significant change in the number of patients in the database over the study period ($P = .38$). From 2007 to 2011, there were a total of 302 MAT procedures in the database, for a mean annual incidence of 0.24 MAT procedures per 100,000 patients. Using the number of patients in the PearlDiver database for each year and data from the US census on the overall US population younger than 65 years, we calculated an estimated number of MAT procedures performed in the United States as a whole. There was no statistically significant increase in MAT procedures over time ($P = .36$) (Table 1).

MAT was performed more frequently in male patients (53.8%; incidence, 0.26 per 100,000 patients) than in female patients (46.2%; incidence, 0.19 per 100,000 patients) (Table 2) ($P = .001$). MAT was most frequently performed in patients aged 25 to 34 years (incidence, 0.40 per 100,000 patients), followed by patients younger than 25 years of age (incidence, 0.30 per 100,000) ($P < .001$), with 69.7% of MAT procedures being performed in patients younger than age 35 years (Table 3, Fig 1).

Table 2. Correlation of Patient Sex With Incidence of Meniscal Allograft Transplantation in PearlDiver Database

Sex	No. of MAT Procedures	% of MAT Procedures	% of PearlDiver Population by Sex	Incidence by Sex (per 100,000 Patients)
Female	138	46.2	54.10	0.19
Male	161	53.8	45.90	0.26
				$P = .001$

MAT, meniscal allograft transplantation.

Discussion

We found no significant change in the number of MAT procedures performed during the 2007 to 2011 study period. A total of 302 MAT procedures were identified in the database for a mean annual incidence of 0.24 MAT procedures per 100,000 patients. Based on the patients included in the database and the US population younger than 65 years as a whole, we estimate that approximately 3,295 MAT procedures were performed in the United States from 2007 to 2011 (mean of 650 MAT procedures annually). MAT procedures were performed more commonly in patients younger than age 35 years and in male patients.

Using the PearlDiver database, we analyzed trends in MAT procedures in the United States. Available clinical studies of MAT have been predominantly small series with level IV evidence without any randomized controlled data available.[14,23] A recent systematic review identified 14 studies published from 2000 to 2007 with a total of 323 patients (although some patients may have been counted multiple times, according to this systematic review's discussion).[23] Similar to the finding of this study that MAT procedures were performed most commonly in patients younger than age 35 years, this review found that the mean patient age was 33.9 years (range, 14 to 58 years). Our study reports on trends in MAT procedures over time, finding no change in the incidence of MAT between 2007 and 2011. The reason for stagnant rates of MAT procedures during the study period is not clear from our study. Factors could include lack of embracement of MAT for treatment of meniscal deficiency by the orthopaedic community, difficulties obtaining insurance approval and reimbursement for this relatively uncommon and expensive procedure, or bias related to the patients available for analysis in the PearlDiver database (see Limitations section for further discussion).

Comparison with data recently published by Abrams et al.[19] on the incidence of meniscal repair and meniscectomy during the same period from the PearlDiver database reveals that MAT procedures were performed far less commonly than other meniscal procedures. For instance, from 2007 to 2011 in patients younger than 25 years, 119 MAT procedures were identified in the PearlDiver database, compared with 8,680 meniscal repairs and 25,998 meniscectomies. This reflects the different clinical roles for meniscal repair and partial meniscectomy as primary procedures for the patient with a symptomatic meniscal tear compared with the role of MAT as a secondary salvage procedure indicated for young patients with symptomatic meniscal deficiency (who have typically already undergone meniscal repair or partial meniscectomy).

A major strength of this study is the use of a large database of non-Medicare diagnosis and billing codes that allowed us to analyze a large patient sample ($\sim$9% of the US population younger than 65 years and $\sim$13% of the privately insured US population) to determine broad trends in clinical practice of MAT across the US population. This PearlDiver database has recently been used to study trends in a variety of surgical procedures in the United States[19-22] and, to our knowledge, it is the largest available database for addressing nationwide trends in the privately insured US population. Moreover, the data were acquired in a blinded fashion, which reduces the possibility of bias in this study's results. Future studies could confirm and expand on our findings through other medical databases that may cover a different set of patients or by contacting allograft tissue providers.

Limitations

Limitations to this study include the fact that the database did not provide us with important patient data

Table 3. Correlation of Patient Age With Incidence of Meniscal Allograft Transplantation in PearlDiver Database

Age, yr	No. of MAT Procedures	% of MAT Procedures	% of PearlDiver Population by Age	Incidence by Age (per 100,000 Patients)
< 25	119	39.7	24.9	0.30
25-34	90	30.0	14.2	0.40
35-44	65	21.7	18.9	0.22
45-54	26	8.7	22.3	0.07
> 55	0	0.0	19.7	0.00
				$P < .001$

MAT, meniscal allograft transplantation.

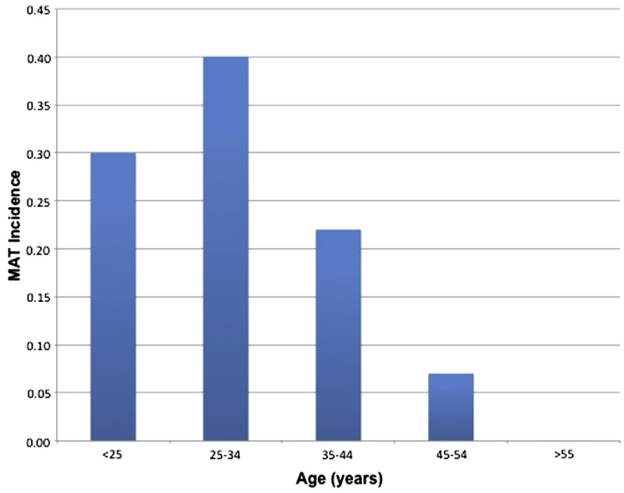

Fig 1. Meniscal allograft transplantation (MAT) incidence by age group per 100,000 patients per year in PearlDiver database.

such as type and location of meniscal tear, activity level, height and weight, previous surgical procedures, surgery concurrent with MAT, subsequent surgical procedures, and patient outcome measures. For instance, the database did not allow determination of the compartment (medial *v* lateral) for the MAT. This is relevant because authors have reported different rates of success for medial and lateral MAT procedures. Cole et al.[10] reported a trend toward greater success for lateral MAT, whereas Verdonk et al.[24,25] reported a trend toward greater success for medial MAT. Second, this study's results depend on the accuracy of coding and billing in the PearlDiver database. In addition, this database provides no information regarding trends in requests for insurance authorization of MAT procedures but only on the procedures themselves. Insurance authorization for relatively uncommon and expensive procedures such as MAT could have considerable variation between insurance companies. Finally, because the database consists of private insurance only, representing about 9% of the US population younger than age 65 years and 13% of the privately insured patients during this time frame, the results may not generalize to the practice of MAT procedures in the United States as a whole. We used the number of MAT procedures in the database, the number of patients in the database, and the US population younger than age 65 years to determine estimates of the incidence of MAT procedures in the United States and the total number of MAT procedures in the United States during the study period. This estimate is limited by the assumption that patients covered by the PearlDiver database and those not covered by the database are undergoing MAT at equal rates. The PearlDiver database covers multiple private insurance companies, the largest of which is United Health Group. It does not cover other insurance companies or Workers' Compensation, which may differ in insurance approval and authorization processes for MAT procedures. Thus, the use of this database could introduce a selection bias because the patients captured by the database may not be generalizable to the broader US population. This limits the accuracy of our estimate of overall number of MAT procedures being performed nationwide in the United States. Many of these limitations are inherent to any retrospective database investigation, because the authors are limited by the information provided by the database.

Conclusions

MAT was an uncommon procedure with no change in the incidence from 2007 to 2011. MAT procedures were performed more commonly in patients younger than age 35 years and in male patients.

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