

# Ankle Arthroscopy Procedural Volume Is Low Among Graduating Orthopaedic Surgery Residents



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**Purpose:** To evaluate graduating orthopaedic resident case volume and variability for ankle arthroscopy from 2016 to 2020. **Methods:** The Accreditation Council for Graduate Medical Education surgical case log data from 2016 to 2020 for graduating United States orthopaedic surgery residents was assessed. Arthroscopy procedures of the leg/ankle were categorized. The average number of cases performed per resident was compared from 2016 to 2020 to determine the percent change in case volume. The 10th, 30th, 50th, 70th, and 90th percentiles of case volumes from 2016 to 2020 were presented to demonstrate case volume variability. **Results:** There was no significant change in the average number of leg/ankle arthroscopy cases from 2016 to 2020 ( $6.2 \pm 5$  [range 0-35] vs  $6.1 \pm 6$  [range 0-76]  $P = .732$ ), despite a 19% increase in the average number of total leg/ankle procedures performed over time ( $168.4 \pm 47$  [range 55-414] in 2016;  $200.8 \pm 57$  in 2020 [range 67-601],  $P < .001$ ). There was wide variability in ankle arthroscopy case volume among residents. The 90th percentile of residents performed 13 cases in 2020, compared with 5 in 50th percentile, and 1 in the 10th percentile. **Conclusions:** Orthopaedic surgery resident exposure to ankle arthroscopy has remained low and highly variable over-time, despite an overall increase in the total number of leg/ankle procedures performed. **Clinical Relevance:** Understanding ankle arthroscopy in case volume and variability is important for programs to ensure that orthopaedic residents are gaining adequate exposure to increasingly popular procedures. Orthopaedic surgery residency programs should explore methods to increase resident exposure to ankle arthroscopy.

Profound changes in orthopaedic surgery residency education have occurred in the last decade. In 2013, the Accreditation Council for Graduate Medical Education (ACGME) implemented a new accreditation system for graduate medical education in the United

States,<sup>1</sup> which shifted focus to the monitoring of measurable outcomes of resident training.<sup>1,2</sup> Since then, orthopaedic surgery residents have been mandated to perform at least 1,000 surgical cases before graduation and specified case minimum requirements for 15 core procedural categories.<sup>3</sup>

Assessment of resident case logs have become an important measure of procedural experience and are frequently monitored by the ACGME to ensure adequate procedural volume and case variety among residents for their given year of training.<sup>4</sup> While overall case volume among orthopaedic surgery residents has increased by 17% upon implementation of case minimum requirements, wide variability was present.<sup>3</sup> Specifically, residents performing at the 90th percentile logged twice as many cases as residents performing at the 10th percentile.<sup>3</sup> Similar inconsistencies have been reported in studies assessing case volume and variability of specific orthopaedic procedures.<sup>5-11</sup> Continued analyses are critical for identifying procedures with growing public demand to which graduating orthopaedic residents may have limited exposure.<sup>12</sup>

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**Table 1.** CPT Codes With Description of Arthroscopy Procedures for the Leg/Ankle

29891	Arthroscopy, ankle, surgical, excision of osteochondral defect of talus and/or tibia, including drilling of the defect
29892	Arthroscopically aided repair of large osteochondritis dissecans lesion, talar dome fracture, or tibial plafond fracture, with or without internal fixation (includes arthroscopy)
29894	Arthroscopy, ankle (tibiotalar and fibulotalar joints), surgical; with removal of loose body or foreign body
29895	Arthroscopy, ankle (tibiotalar and fibulotalar joints), surgical; synovectomy, partial
29897	Arthroscopy, ankle (tibiotalar and fibulotalar joints), surgical; debridement, limited
29898	Arthroscopy, ankle (tibiotalar and fibulotalar joints), surgical; debridement, extensive
29899	Arthroscopy, ankle (tibiotalar and fibulotalar joints), surgical; with ankle arthrodesis

CPT, Current Procedural Terminology.

The incidence of ankle arthroscopy has risen considerably in recent years.<sup>13,14</sup> From 2007 to 2011, the number of ankle arthroscopy cases increased by 11.8%, which outpaced the growth of shoulder, knee, and elbow arthroscopy.<sup>14</sup> However, unlike shoulder and knee arthroscopy, a case minimum requirement for ankle arthroscopy among orthopaedic residents does not exist.<sup>15</sup> While previous studies have reported trends in ankle arthroscopy case volume among orthopaedic residents, these analyses were performed more than a decade ago.<sup>6,16</sup>

The purpose of this study was to evaluate graduating orthopaedic resident case volume and variability for ankle arthroscopy from 2016 to 2020. We hypothesized that case volume would remain low during this time, despite an overall increase in the number of ankle procedures performed. We also hypothesized wide variability in case volume among the 10th and 90th percentile of graduating residents.

## Methods

The ACGME case log reports from 2016 to 2020 for all graduating orthopaedic surgery residents were reviewed in January of 2022. Residents log surgical procedures using Current Procedural Codes (CPT). The ACGME groups CPT codes into anatomic categories and provides national averages for several resident-performed procedures. Procedures include incision, excision, intro or removal, repair/revision/reconstruction, trauma, fracture/dislocation, manipulation, arthrodesis, amputation, arthroscopy, and other. Anatomic categories include shoulder, humerus/elbow, forearm/wrist, hand/fingers, pelvis/hip, femur/knee, leg/ankle, and foot/toes. In this study, the mean number of total (adult and pediatric) arthroscopy cases performed per resident under the leg/ankle ACGME

**Table 2.** The Demographics of Orthopaedic Surgery ACGME Case Log Respondents

Year	Total Number of Residency Programs	Total Number of Residents
2016	153	705
2017	156	709
2018	154	729
2019	154	725
2020	154	724

ACGME, Accreditation Council for Graduate Medical Education.

case category from 2016 to 2020 was assessed to determine a percent change in case volume. The specific CPT codes and definitions for each arthroscopy procedure under the leg/ankle ACGME case category are listed in [Table 1](#). In addition, 10th, 30th, 50th, 70th, and 90th percentiles of case volumes from 2016 to 2020 were presented to examine case volume variability.

Comparisons of mean case volume reported per resident were examined using unpaired 2-tailed *t* tests. Statistical significance was designated a *P* < .05. Excel software, version 16.0 (Microsoft Corp., Redmond, WA) was used for data input and statistical tests.

## Results

The total number of orthopaedic surgery residency programs was 153 (705 residents) in 2016, 156 (709 residents) in 2017, 154 (729 residents) in 2018, 154 (725 residents) in 2019, and 154 (724 residents) in 2020 ([Table 2](#)).

The average number of total leg/ankle procedures performed per resident was  $168.4 \pm 47$  (median 163; range 55-414) in 2016, which increased to  $200.8 \pm 57$  in 2020 (median 195; range 67-601), representing a 19.2% increase (*P* < .001) ([Table 3](#)). The average number of leg/ankle arthroscopy procedures performed per resident was  $6.2 \pm 5$  (median 5; range 0-35) in 2016, which decreased to  $6.1 \pm 6$  in 2020 (median 5; range 0-76), representing a 1.6% decrease (*P* = .732) ([Table 3](#)). Case volume for the mean and median number of total leg/ankle procedures and the number of leg/ankle arthroscopy procedures performed per resident from 2016 to 2020 are depicted in [Figure 1](#).

There was a low level of variability in total case volume pertaining to the leg/ankle and a wide level of variability in the number of leg/ankle arthroscopy cases performed per resident over the study period ([Figure 2](#)). The average number of total leg/ankle procedures performed by the 10th and 90th percentile of residents was 113 and 228 in 2016, representing a 1.16-fold difference, compared with 130 and 270 in 2020, representing a 1.18-fold difference ([Table 4](#)).

The average number of leg/ankle arthroscopy procedures performed by the 10th and 90th percentile of residents was 1 and 13 in both 2016 and 2020,

**Table 3.** Mean Number of Leg/Ankle Arthroscopy Procedures per Graduating Orthopaedic Surgery Resident From 2016 to 2020

Procedure (Area)	2016			2017			2018			2019			2020			% change	P Value
	Mean ± SD	Median (Range)															
Arthroscopy (leg/ankle)	6.2 ± 5	5 (0-35)	6 ± 5	5 (0-31)	6.5 ± 6	5 (0-40)	6.5 ± 6	5 (0-38)	6.1 ± 6	5 (0-76)	6.1 ± 6	5 (0-76)	6.1 ± 6	5 (0-76)	-1.6%	.732	
Total (leg/ankle)	168.4 ± 47	163 (55-414)	176.5 ± 47	170 (55-388)	187.3 ± 54	181 (74-452)	195.3 ± 60	189 (63-527)	200.8 ± 57	195 (67-601)	200.8 ± 57	195 (67-601)	200.8 ± 57	195 (67-601)	19.2%	<.001	

SD, standard deviation.

representing a 13-fold difference, respectively (Table 4). About 1 in 10 graduating orthopaedic surgery residents performed only a single ankle arthroscopy case each year, and half performed 5 cases or less (Table 4).

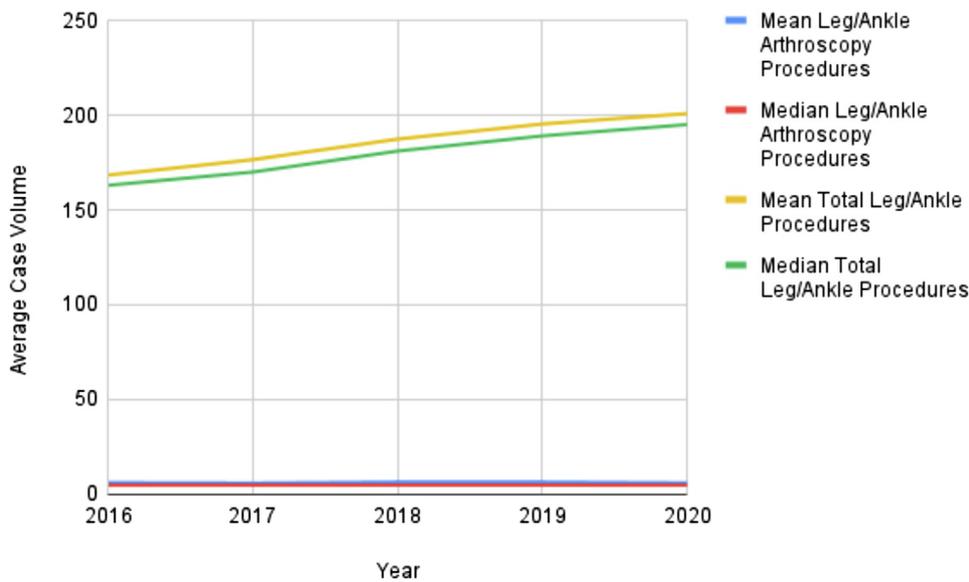
## Discussion

In this study, we found a statistically significant increase in the total number of leg/ankle procedures performed per graduating orthopaedic surgery resident from 2016 to 2020. Despite this, resident exposure to ankle arthroscopy remained low throughout the study period and highly variable, with a 13-fold difference in case volume among the 10th and 90th percentiles of performing residents.

In 2013, the ACGME mandated case minimum requirements for 15 core procedural categories in attempt to standardize resident procedural experience.<sup>3</sup> With respect to the foot and ankle, residents are required to perform at least 5 ankle arthrodesis procedures and 15 ankle fracture open reduction internal fixation (ORIF) procedures.<sup>15</sup> Interestingly, there has been a recent interest in the concurrent use of ankle arthroscopy at the time of ankle ORIF.<sup>17</sup> In a retrospective study of 32,307 patients undergoing ankle ORIF from 2007 to 2011, there was a significant increase in the prevalence of simultaneous arthroscopic treatment and significant decrease in the prevalence of arthroscopic ankle treatments occurring after ankle ORIF.<sup>17</sup> The authors believe this to be a result of early arthroscopic detection and treatment of cartilaginous injury at the time of acute ankle fracture, as 22.4% of patients received concurrent microfracture treatment. This study suggests that resident exposure to ankle arthroscopically may increase in the near future as more surgeons aim to identify and treat cartilaginous defects at the time of ankle ORIF.

Similar national rates have been reported for arthroscopic arthrodesis of the ankle. According to a recent 17-year analysis, the incidence of outpatient arthrodesis performed with arthroscopic assistance increased by 858%.<sup>18</sup> Several advantages have been reported with this technique, including preservation of inherent ankle stability, fewer complications, and faster recovery when compared with open surgery.<sup>19</sup>

DeFroda et al.<sup>6</sup> previously evaluated foot and ankle case volume among orthopaedic surgery residents from 2009 to 2013. Within this study, a 23% increase in ankle arthroscopy (6 vs 7.4) cases was reported, with a 14.0- to 15.0-fold difference between the 10th and 90th percentile of graduating residents. Our study is unique in that it offers an updated analysis of ankle arthroscopy case volume over the preceding 5 years. We found that residents performed an average of 6.2 ankle arthroscopy cases in 2016, compared to 6.1 in 2020 (-1.6% change;  $P = .732$ ). In addition, a 13.0-fold difference in case volume was present among the 10th and 90th



**Fig 1.** Trends in the mean and median orthopaedic resident case volumes, for leg/ankle arthroscopy and total leg/ankle procedures from 2016 to 2020.

percentile of graduating residents. Interestingly, however, the total number of leg/ankle procedures from 2009 to 2013 and 2016 to 2020 significantly increased during both time periods, respectively. These data imply that resident exposure to ankle arthroscopy has remained low and highly variable over the preceding decade, despite a continued increase in the number of leg/ankle procedures being performed.

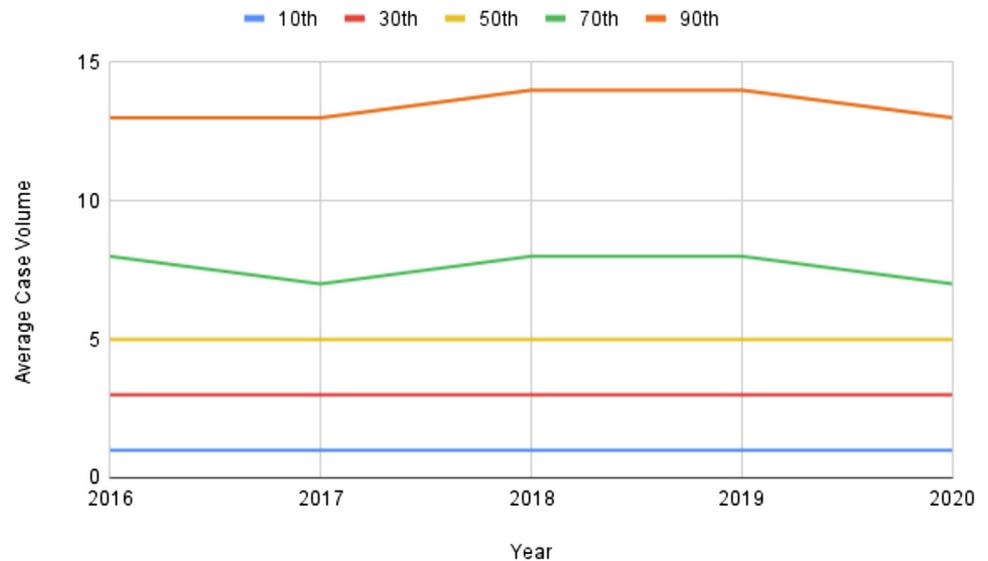
Foot and ankle surgery has become a prominent focus of orthopaedic surgery residency curricula.<sup>20</sup> A major contributor to this finding is thought to be the growing number of foot and ankle subspecialist faculty affiliated with academic teaching programs.<sup>20</sup> In 2003, only 80 of 148 (54.1%) orthopaedic residency programs had a single foot and ankle surgeon on faculty and 10.1% of programs had no dedicated rotation for foot and ankle surgery.<sup>20</sup> However, according to a recent follow-up study, 91.3% of programs have at least 1 foot and ankle surgeon on faculty and 80% have dedicated foot and ankle rotations.<sup>21</sup> However, within this study, data regarding the case volumes of ankle arthroscopy among academic foot and ankle surgeons were not provided. Therefore, while this increase in academic foot and ankle faculty is likely to explain the increases in total leg/ankle exposure among orthopaedic residents, it is difficult to determine the stagnation in ankle arthroscopy.

Teaching arthroscopic ankle surgery to orthopaedic residents is difficult, given the high level of dexterity, hand–eye coordination, triangulation, and anatomic understanding required.<sup>22</sup> This may hinder a surgeon's readiness to adopt this procedure in an academic setting, as resident involvement may slow efficiency. Even at the attending surgeon level, a prolonged learning curve for ankle arthroscopy has been reported<sup>23</sup> and may require advanced training.<sup>24</sup> As such,

a lack of highly specialized ankle arthroscopists associated with academic institutions may be contributing to the variability in case exposure that we found.

The addition of a standardized ankle simulation curriculum has been shown to improve arthroscopic proficiency, anatomic recognition, and safety when compared with traditional apprenticeship teaching models.<sup>25</sup> Martin et al.<sup>25</sup> performed a prospective comparative study that randomized trainees into either a simulation or standard practice group. Those in the simulation group received 4 one-on-one, 15-minute simulation training sessions over a 4-month period, whereas the standard practice group received no additional simulation or exposure. After intervention, the simulation group outscored the control group in total Arthroscopic Surgery Skill Evaluation Tool score and achieved nearly expert Arthroscopic Surgery Skill Evaluation Tool Safety scores upon cadaveric testing. While similar studies have reported improved ankle arthroscopy skills among orthopaedic residents with practice on cadaveric and simulator models,<sup>22,25</sup> most residents find live surgery to be the most advantageous learning environment.<sup>26,27</sup> Furthermore, arthroscopic case experience has been proven to be more specific of surgical skill for a given task.<sup>28</sup> As such, it is vital for trainees to achieve intraoperative ankle arthroscopy experience throughout their residency training and residency programs should explore methods to increase exposure to this procedure.

Resident case volume for ankle arthroscopy don't seem to reflect the national increases in the incidence of this procedure. According to a recent nationwide database study,<sup>14</sup> the incidence of ankle arthroscopy has outpaced the use of shoulder, knee, and elbow arthroscopy in recent years. However, upon review of



**Fig 2.** Trends in the mean case volume for leg/ankle arthroscopy procedures among the 10th through 90th percentiles of graduating orthopaedic residents from 2016 to 2020.

recent ACGME case log studies,<sup>16,29,30</sup> it seems that orthopaedic resident case exposure to ankle arthroscopy is lower than many other areas of arthroscopic surgery. For example, from 2016 to 2020, the average number of shoulder arthroscopy cases performed increased from 69 to 79.7, representing a 15.5% increase.<sup>29</sup> Over this same time period, the average number of knee arthroscopy cases decreased by 2.6%.<sup>30</sup> However, knee arthroscopy appears to be the most commonly performed arthroscopic procedure among residents, as the average number of cases performed in 2020 was 111. Similar to ankle arthroscopy, resident case exposure to elbow arthroscopy and hip arthroscopy is relatively low and stagnant.<sup>12,29</sup> Specifically, the average number of elbow arthroscopy cases performed in 2016 and 2020 was only 1.6, signifying that no change in case volume has occurred over the last 5 years.

Initially used as a diagnostic tool, this procedure is now widely indicated for the management of intra-

articular ankle pathology.<sup>31</sup> While ankle arthroscopy is most commonly used to treat soft tissue and bony impingement,<sup>23,32,33</sup> osteochondral defects,<sup>34-36</sup> and intra-articular loose bodies,<sup>31</sup> many surgeons now advocate for concomitant or staged arthroscopic intervention during the treatment of lateral ankle instability.<sup>14</sup> For example, the combined use of ankle arthroscopy and peroneal tendon retinacular repair has increased by 50% from 2007 to 2011.<sup>14</sup> In addition, surgeons are now using arthroscopic techniques to perform all-inside ankle ligament reconstruction,<sup>37-43</sup> arthroscopic-assisted ankle fracture fixation,<sup>17,44</sup> and arthrodesis,<sup>18,19</sup> with favorable results.

In addition, multiple studies have demonstrated favorable clinical outcomes when comparing open and arthroscopic ankle procedures. A meta-analysis performed in 2021 found that patients undergoing arthroscopic ankle arthrodesis for the treatment of advanced tibiotalar osteoarthritis experienced a greater fusion rate, lower fusion time, lower intraoperative blood loss, decreased hospital length of stay, and an overall lower rate of postoperative complications when compared to those undergoing open surgery.<sup>45</sup> In addition, a separate meta-analysis performed in 2022 comparing outcomes of arthroscopic versus open Brostrom repair showed significantly less time to weight-bearing and decreased pain scores in the arthroscopic groups.<sup>24</sup> Perhaps the use of ankle arthroscopy within academic settings will rise overtime as the evidence supporting its indications continue to grow.

### Limitations

The present study is not without limitations. The ACGME case log data does not specify the types of procedures within the leg/ankle category. Therefore,

**Table 4.** Variability in Leg/Ankle Arthroscopy Case Volume Between the 10th and 90th Percentiles of Graduating Orthopaedic Surgery Residents

Procedure (Area)	Year	10th	30th	50th	70th	90th
Arthroscopy (leg/ankle)	2016	1	3	5	8	13
	2017	1	3	5	7	13
	2018	1	3	5	8	14
	2019	1	3	5	8	14
	2020	1	3	5	7	13
Total (leg/ankle)	2016	113	141	163	192	228
	2017	122	149	170	196	238
	2018	127	155	181	207	251
	2019	130	164	189	217	270
	2020	137	173	195	222	272

while case volume and variability for arthroscopic procedures of the leg/ankle were provided, these findings are not applicable to specific CPT procedural codes. Next, the ACGME case log data accuracy may be influenced by bias due to underreporting or overreporting among residents. Next, the ACGME case log data accuracy for all arthroscopic procedures including hip, ankle, knee, and shoulder may be influenced by bias due to under-reporting or over-reporting among residents due to the fact that there are several unbundled CPT codes that can be included in a single arthroscopic surgical procedure.<sup>46</sup> Finally, the degree of resident participation within each case cannot be determined and may be subject to reporting bias, which may also threaten the accuracy of the data.

### Conclusions

Orthopaedic surgery resident exposure to ankle arthroscopy has remained low and highly variable overtime, despite an overall increase in the total number of leg/ankle procedures performed. Implementing minimum case requirements for ankle arthroscopy during orthopaedic residency may be helpful to increase exposure to ankle arthroscopy and reduce variability in experience.

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