



Orthopedic surgery residents reported increased shoulder procedure volumes during the COVID-19 pandemic



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Background: The purpose of this study is to evaluate the impact of the COVID-19 pandemic on shoulder procedure volumes reported to the Accreditation Council for Graduate Medical Education by orthopedic surgery residents.

Methods: We performed a retrospective review of Accreditation Council for Graduate Medical Education case logs reporting data from graduating orthopedic surgery residents during the academic years of 2006–2022. Data were queried for all patients for the following shoulder Current Procedural Terminology codes: incision, excision, intro or removal, repair/revision/reconstruction, fracture and/or dislocation, manipulation, arthroscopy, trauma, and total procedures performed. Individual *t*-tests were used to compare case log trends of graduating academic years before (classes of 2018 and 2019) and during (classes of 2020, 2021, and 2022) the COVID-19 pandemic. Statistical significance was established to be $P < .05$ for total procedure types, but at $P < .005$ during category comparisons to protect against alpha errors.

Results: Reported mean total shoulder procedures per resident steadily increased each year from 2017 to 2022, but the only significant increase was seen when comparing the graduating classes of 2020 to 2021 (157.9 vs. 165.7, $P = .02$). Stratification of these procedures by subgroup revealed a significant increase in manipulation procedures from 2021 to 2022 (7.3 vs. 8.8, $P = .001$).

Discussion/Conclusion: COVID-19 did not have a negative impact on logged shoulder procedure volume. Orthopedic surgery residents graduating during the COVID-19 pandemic reported more shoulder procedures than those graduating prepandemic. However, shoulder procedure log trends should be longitudinally investigated, as preceding years of procedural opportunities may underestimate the pandemic's impact.

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Responsible for 4.5 million physician visits each year, the shoulder is the second most common site for chronic musculoskeletal pain and was reported by more than 22 million US adults in 2015.^{24,15} As shoulder-related disability increases in correlation with the aging global demographic,¹⁰ considerable advancements have been made in surgical procedures, instrumentation, and technology to improve outcomes and deliver safe and cost-effective care.^{5,25} In order to provide such care, orthopedic surgery residency programs

must continue to ensure technical proficiency in their graduating residents.⁶

The Accreditation Council for Graduate Medical Education (ACGME) requires that residents participate in a minimum of 20 shoulder arthroscopy procedures prior to graduation. The ACGME's surgical Review Committee monitors the quantity of experiences through Current Procedural Terminology (CPT) codes that are logged by residents based on the procedures they perform. In 2013, the ACGME implemented new guidelines for how CPT codes are entered into the Resident Case Log System, dictating that one primary code be submitted per case, despite the possibility of more than one being applicable.¹ These case log minimums were the consensus of a Review Committee analysis spanning 2007–2010 orthopedic surgery resident data and included key case categories, such as shoulder arthroscopy. While intended to standardize the expectations for experience, resident opportunities that determine

There was no formal consent, informed consent, institutional review board approval, or ethical committee approval required for and/or applicable to this type of study as it did not require active human or animal participants.

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Table 1
Demographics and mean case volumes of graduating orthopedic surgery residency programs and trainees in the United States from 2006 to 2022.

Programs in nation	Residents in nation	Year	Incision	Excision	Intro/Removal	Repair/Revision/ Reconstruction	Trauma	Fracture and/or dislocation	Manipulation	Arthroscopy	Total
149	616	2006-2007	2.2	11.2	0.8	37.4		14.7	5.5	93.5	166.5
148	621	2007-2008	2.1	9.4	0.9	34.3	21.7	16	5.6	99.2	168.6
148	635	2008-2009	2.1	8.8	1	35.3	23.6	18.3	5.3	106.7	178.8
147	653	2009-2010	2.1	9.1	1	36.7	25.2	19.5	5.7	112.2	187.7
148	650	2010-2011	2.2	8.7	1.1	38.6	27.8	21.7	6.1	117.5	197.1
149	675	2011-2012	2.4	8.8	1.2	41.2	30.2	23.7	6.5	129.7	214.7
150	678	2012-2013	2.5	8.5	1.3	41	30.1	23.9	6.2	133.8	218.2
151	684	2013-2014	1.6	5.4	1	24.2	27.9	22.5	5.4	65.1	125.9
151	699	2014-2015	1.5	4.9	0.8	25.9	29.1	23.6	5.4	66.5	129.3
153	705	2015-2016	1.7	4.4	0.6	28.1	29.8	24.4	5.5	70.7	135.8
156	709	2016-2017	1.8	4	0.5	30.8		25	5.5	75.4	143.4
154	729	2017-2018	1.6	4.2	0.4	35		24.7	5.6	78.9	150.9
154	725	2018-2019	1.7	4.1	0.5	35.4		25.2	5.5	83.8	156.6
154	724	2019-2020	1.8	4	0.5	36.8		26.1	6.4	81.8	157.9
180	822	2020-2021	1.8	3.9	0.5	39.5		26.5	7.3	85.8	165.7
195	875	2021-2022	1.9	3.7	0.6	40.6		27.3	8.8	86.9	170.2
		2006-2013	2.2	9.2	1.0	37.8	26.4	19.7	5.8	113.2	190.2
		2014-2021	1.7	4.3	0.6	32.9	28.9	25.0	6.2	77.2	148.4
		P value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	.002	<.0001	<.0001

surgical competence are heavily influenced by geography, emerging advancements in technology, and an increased demand for subspecialty care.^{6,11}

Studies have previously evaluated the trends of resident and early surgeon-reported shoulder case volumes,^{2,3,7,8,14,16,17,20,21} but there is a paucity of literature analyzing the breadth of shoulder case logs since case log reporting inception or the effect of the coronavirus disease 2019 (COVID-19) pandemic. Our objective is to analyze the 16 years of ACGME-reported shoulder case log data and to assess the impact of the COVID-19 pandemic on resident shoulder case log volumes. We hypothesized that there would be an increase in shoulder arthroscopy, repair/revision/reconstruction, fracture and/or dislocation, manipulation, and total procedures after the implementation of case minimums, even throughout the pandemic.

Methods

We performed a retrospective review of orthopedic surgery resident ACGME procedure logs from 2006 to 2022, which includes averages of graduating resident data accumulated during residency and reported by graduation year. Institutional review board approval was not required due to the public availability of this anonymized data. Data were queried for all patients (adult and pediatric) under twelve categories of shoulder CPT codes: incision, excision, intro or removal, repair/revision/reconstruction, fracture and/or dislocation, manipulation, arthrodesis, amputation, arthroscopy, trauma, other procedures, and total procedures performed. Procedures logged as trauma within the shoulder subset were only present from 2007 to 2016 and represented the sum of manipulation and fracture and/or dislocation categories.¹ Arthrodesis, amputation, and other procedures were excluded from analyses due to low sample sizes.

The trends of the average shoulder procedures completed were tabulated and statistically analyzed using Microsoft Excel spreadsheets (Excel; Microsoft Corporation, Redmond, WA, USA). The national resident average of all procedural groupings within the shoulder subset was assessed via analysis of variance to determine trends over the 16-year study period. Unpaired 2-tailed *t*-tests were used to compare case log trends of total procedures between residents who graduated before and during the COVID-19

pandemic. The level of significance used for each test was a *P* value of <.05; however, a *P* value of <.005 was set to protect against alpha errors when comparing multiple procedure categories with individual *t*-tests.¹³

Results

Sixteen years of ACGME-reported data were analyzed. From 2006 to 2022, the number of graduating orthopedic surgery programs increased from 149 to 195 and the number of residents increased from 616 to 875 (Table 1). The mean volumes of all shoulder procedure categories were examined at several time points throughout the COVID-19 pandemic. Reported mean total shoulder procedures per resident steadily increased each year from 2017 to 2022, but the only significant increase was seen when comparing the graduating classes of 2020 to 2021 (157.9 vs. 165.7, *P* =.02, Fig. 1). Stratification of these procedures by subgroup revealed a significant increase in manipulation procedures from 2021 to 2022 (7.3 vs. 8.8, *P* =.001, Fig. 2).

There were significant differences seen in the mean procedure volume of each of the remaining eight procedure categories logged by residents upon their graduation from 2006 to 2021 (*P* <.05). The mean procedure volume was calculated for the graduating years prior to (2006-2013) and after (2014-2022) minimum case log requirements were instituted (Fig. 3). Compared to before implementation, there was a significant reduction in the mean volume of shoulder cases per resident for incision (2.2 vs. 1.7, *P* <.0001), excision (9.2 vs. 4.3, *P* <.0001), intro/removal (1.1 vs. 0.6, *P* <.0001), repair/revision/reconstruction (37.9 vs. 33.3, *P* <.0001), arthroscopy (113.7 vs. 77.7, *P* <.0001), and total procedures (190.9 vs. 149.4, *P* <.0001). There was also a significant increase in the mean volume of shoulder cases per resident for fracture/dislocation (19.8 vs. 25.1, *P* <.0001), trauma (26.5 vs. 28.9, *P* <.0001), and manipulation dislocation (5.9 vs. 6.2, *P* =.002) procedures.

Discussion

Sixteen years (2006-2022) of ACGME orthopedic surgery resident case logs were reviewed to identify trends in shoulder procedure volumes and the impact of the COVID-19 pandemic. The principle finding of this study was a significant increase in mean

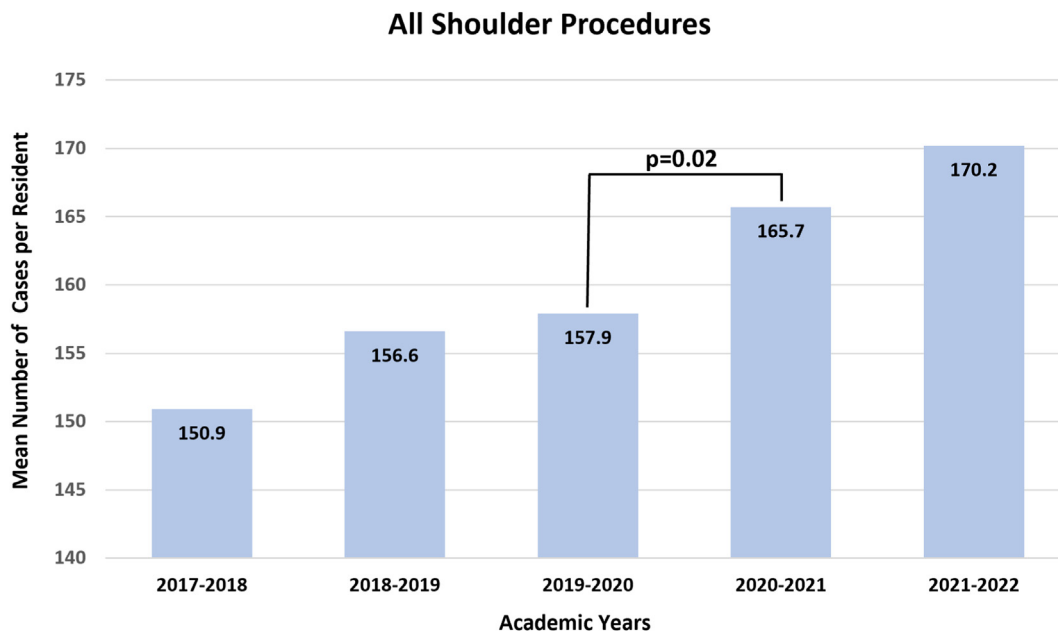


Figure 1 Mean total case volume of all shoulder procedures per resident from 2017 to 2022.

total procedures reported by graduating residents from 2020 to 2021 and manipulation procedures from 2021 to 2022, implying that the overall shoulder caseloads performed by residents were unaffected by the COVID-19 pandemic. Reported mean total procedures showed a steady, although nonsignificant increase each year from 2017-2018 until 2021-2022. Stratification by category revealed that this was primarily driven by manipulation procedures at the end of the pandemic. While there were no significant contributors identified in the subgroup analysis from 2019-2020 to 2020-2021, the overall increase is likely due to a collective effect of nonsignificant increases from these categories.

To lessen the unprecedented impact of the COVID-19 pandemic on overburdened hospital systems, many shoulder arthroplasties were either canceled or performed in outpatient surgical centers.¹⁹ Prior to this, Sudah et al reported that the mean adult shoulder repair/revision/reconstruction procedure volumes significantly increased by 31% ($P < .001$) from 2016 to 2020 with unchanged rates of fracture/dislocation. The authors related this finding to the substantial rise in reverse total shoulder arthroplasties and expanding indications for treatment of proximal humerus fractures.²¹ However, the volume of manipulation procedures significantly increased and fracture/dislocation trends were maintained despite the pandemic. The ACGME also groups closed treatment/reductions of the shoulder girdle under the manipulation category,¹ which is further consistent with the association of high acuity, nonoperative presentations being more accessible experiences for residents to perform/and log.¹⁶ However, although there are differences in reported operative vs. nonoperative procedural opportunities during this time, we are unable to draw a conclusion on the necessity of these treatments or outcomes in patient care due to the lack of clinical data provided by the ACGME.¹

Shoulder arthroscopy is the most common procedure performed by recent graduates in early clinical practice.¹² A survey taken in mid-2020 additionally showed that more than 80% of sports medicine fellows reported a greater than 50% reduction of procedure volumes as a result of elective surgery cancellations.²² While there were no significant changes in reported arthroscopic procedures from 2017 to 2022, we observed a slight decrease

during the early pandemic (mean: 81.8 in 2019–2020 vs. mean: 83.8 in 2018–2019) for the first time since the implementation of new procedure log guidelines in 2013. Multiple studies have analyzed resident exposure and shoulder procedure log reporting before and after the implementation of case minimums, and several of which have identified a decrease in resident-reported arthroscopic case volumes.^{2,10,14,21,25} While the indication for these procedures is not provided by the ACGME data sets, this may be due to the shifting of the limited opportunities during the pandemic from residents to fellows, as they generally have less time allotted to develop mastery of a difficult visuospatial skill.^{6,9} Prior to 2019–2020 academic year, orthopedic sports medicine fellows performed approximately 275% more shoulder ($P < .0001$) surgeries than residents.^{6,9}

Additionally, Sabharwal et al compared the ratio of shoulder arthroscopy procedures reported by residents with caseloads in the 90th vs. the 10th percentile and demonstrated a significant reduction in the gap between the two over time ($P < .001$).¹⁷ This may infer that resident education in shoulder arthroscopy is becoming more uniform or that fewer cases than anticipated are required to attain procedural proficiency.^{12,21} A recent survey of 727 orthopedic residents sitting for the American Board of Orthopaedic Surgery Part I Examination revealed a discrepancy between ACGME (20 minimum) and resident (32.5 minimum) recommendations for mean cases to achieve independence in performing shoulder arthroscopies. However, the mean number of arthroscopic cases for the 89.7% of independently practicing participants (mean: 37.8 cases) and those in our 16-year study (mean: 92.9 cases) were both sufficiently above the recommended minimums.¹²

Compared to before the implementation of ACGME reporting guidelines (2006–2013), there was a significant reduction in the mean volume of shoulder cases per resident for incision, excision, intro/removal, repair/revision/reconstruction, arthroscopy, and total procedures during 2014–2022. These results are likely multifactorial, as residents may underreport procedures taking place outside of the operating room.¹⁸ Standardizing procedure logs could have also shifted resident priorities toward underrepresented experiences to comply with minimum requirements.¹⁷ The latter may explain why excision and intro/removal procedures

Shoulder Manipulation Procedures

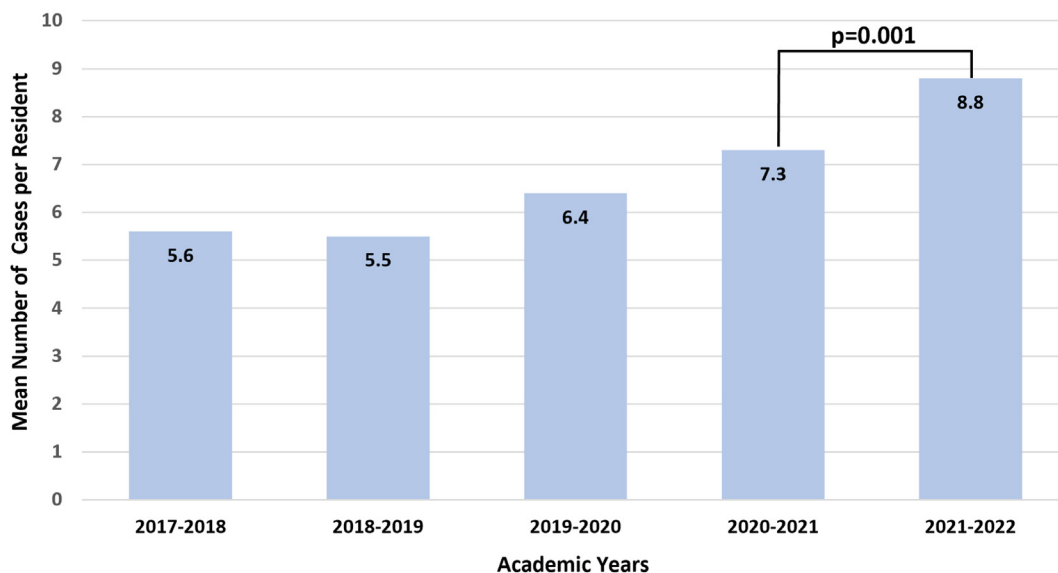


Figure 2 Mean case volume per resident stratified by manipulation procedures from 2017 to 2022.

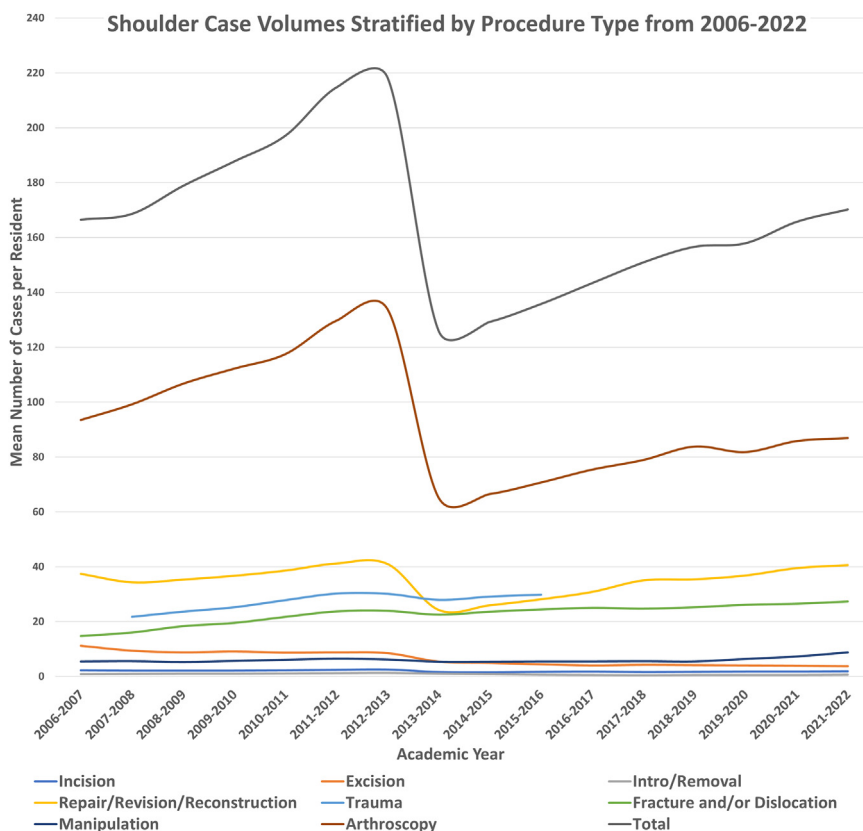


Figure 3 Mean case volumes per resident stratified by significant procedure types from 2006 to 2022.

demonstrated largely negative trends from 2014 to 2022, while the mean volume of incision, repair/revision/reconstruction, arthroscopy, and total procedures all displayed more positive trends.

This study is inherently limited due to the examination of self-reported and manually entered resident data. Several contributing factors impact the possibility of inaccuracies in procedure

volumes. There was a sharp drop in mean procedure volume after the implementation of ACGME case minimums followed by another steady increase after 2013. Reporting procedures to the ACGME was largely inconsistent prior to 2013 and may have been artificially inflated due to differing reporter interpretations.^{7,17,18} Orthopedic surgery residents have the highest reporting accuracy compared to

other specialties, the reason for which is unknown, but more information about the specifics of the performed procedures is needed to better identify deficiencies in the operative experience of trainees.⁴ Continued improvement in the standardization of resident reporting behaviors and practices may also provide a more accurate representation of resident exposures for future studies. Additionally, the lack of clinical data and information about the specific procedure locations/indications limits the opportunity for subgroup analyses that could correlate caseloads to variation in geography and outcomes. Finally, a Bonferroni correction was applied to reduce alpha errors when comparing multiple stratified categories, but this may have increased our risk of making type II (beta) errors.¹³

In 2020, the ACGME merged with the Association of American Colleges of Osteopathic Medicine and the American Osteopathic Association to simplify the accreditation system for graduate medical programs. The effect of this change on procedure log reporting has yet to be determined but may confound results for the 2020–2021 academic year, as both allopathic and osteopathic orthopedic programs had data coded in the same system for the first time.²³ While the case log data published by the ACGME does not provide CPT codes, the procedural exposure for graduating residents can still be assessed by the current system. Inclusion of specific CPT codes may improve the understanding of resident operative experiences in future iterations of ACGME published procedure logs. Future research should focus on the longitudinal assessment of the COVID-19 pandemic impact on resident shoulder exposures, given that our data suggests heterogeneous reporting of these procedures both before and during the pandemic.

Conclusion

Orthopedic surgery residents graduating during the pandemic reported more shoulder procedures than those graduating pre-pandemic, demonstrating that the COVID-19 pandemic did not have a negative impact on logged shoulder procedure volumes. Residents graduating during 2020 and 2021 had multiple years unaffected by the pandemic, which may underestimate the pandemic's impact on procedure volume. Inclusion of specific CPT codes in ACGME-reported data may allow for improved understanding of orthopedic surgical training. Shoulder procedure log trends should be longitudinally investigated.

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