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The Journal of Arthroplasty

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Miscellaneous

The Impact of COVID-19 on Total Joint Arthroplasty Fellowship Training

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ARTICLE INFO

Article history:

Received 24 February 2022

Received in revised form

29 March 2022

Accepted 30 March 2022

Available online 4 April 2022

Keywords:

arthroplasty
reconstructive
orthopedics
surgery
fellowship
COVID-19

ABSTRACT

Background: COVID-19 created unprecedented challenges in surgical training especially in specialties with high elective case volume. We hypothesized that case volume during total joint arthroplasty fellowship training would decrease by 25% given widespread economic shutdowns encountered during the fourth quarter of the 2019-2020 academic year.

Methods: Case logs from the Accreditation Council for Graduate Medical Education were obtained for accredited total joint arthroplasty fellowships (2017-2018 to 2020-2021). Case volumes were extracted and summarized as means \pm SD. Student's t tests were used for inter-year comparisons.

Results: One hundred and eighty three arthroplasty fellows from 24 accredited fellowships were included. There was a 14% year-over-year decrease in total case volume during the 2019-2020 academic year (390 ± 108 vs 453 ± 128 , $P < .001$). Case volume rebounded during the 2020-2021 academic year to 465 ± 93 (19% increase, $P < .001$). Case categories with the most significant percentage declines in 2019-2020 were primary total knee arthroplasty (TKA, -23%), revision total hip arthroplasty (THA, -19%), revision TKA (rTKA, -11%), and primary THA (-10%).

Conclusion: There was a 14% overall decrease in arthroplasty case volume during the 2019-2020 academic year, which correlated with the widespread economic shutdowns during the COVID-19 pandemic. Certain elective case categories like primary TKA experienced the greatest negative impact. Results from this study may inform prospective trainees and faculty during future national emergencies.

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In December 2019, the first patients with viral pneumonia caused by SARS-CoV-2 were reported in Wuhan, China [1–3]. The disease caused by this virus resulted in fever, dry cough, and shortness of breath, and was subsequently called COVID-19. By

No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to <https://doi.org/10.1016/j.arth.2022.03.083>.

Conflict of Interest Statement: The authors have no conflicts of interest to report.

Statement of Funding: The authors have no sources of funding to report.

Statement of Human and Animal Rights: This article does not contain any studies with human or animal subjects.

Statement of Informed Consent: This study received exemption status from the IRB authors due to the publicly available nature of all data.

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<https://doi.org/10.1016/j.arth.2022.03.083>

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March 11, 2020, the World Health Organization declared COVID-19 a global pandemic. In short order, state and local governments responded with proposed lockdowns to contain the spread of the virus. Correspondingly, professional societies like the American College of Surgeons responded with specific guidelines regarding the discontinuation of non-essential surgical procedures in accordance with federal mandates [1].

The COVID-19 pandemic led to unprecedented cancellations of elective surgeries, which created financial strains on health care systems as well as challenges in post graduate medical education in the United States [1–3]. The impact of COVID-19 on orthopedic resident and fellow training has been previously documented primarily through surveys, perspectives, and other qualitative insights [4–10]. Given the elective nature of total hip and knee arthroplasty, adult reconstructive orthopedics fellowship training has been particularly affected. COVID-19 has also catalyzed several paradigm shifts in the education of orthopedic surgeons including the widespread adoption of virtual platforms for didactics, grand rounds, and conferences [11–15].

Currently, objective data on the impact of the COVID-19 outbreak on total joint arthroplasty fellowship training is lacking. Previous reports have been limited to qualitative insights from surveys, which have generated concerns on the adequate exposure to cases during fellowship training. Given the ongoing nature of COVID-19 and its variants, it is important to understand the impact of widespread economic shutdowns on total joint arthroplasty fellowship training for future generations of trainees. Furthermore, given the relationship between case volume and clinical outcomes in total joint arthroplasty [16–23], the stakes are especially high for total joint arthroplasty fellows who must refine operative skills for complex cases encountered during autonomous practice.

Given the high percentage of elective cases in adult reconstructive orthopedics, we hypothesized that total joint arthroplasty fellows would report significantly less cases during the 2019–2020 academic year during the initial outbreak of the COVID-19 pandemic. We provide objective data on the impact of widespread shutdowns resulting from the COVID-19 pandemic to inform surgical educators and the orthopedic community on the potential impact of future national emergencies like viral pandemics and their associated economic implications.

Materials and Methods

Surgical case logs were obtained from the Accreditation Council for Graduate Medical Education (ACGME) for the academic years of 2017–2018 to 2020–2021. With minimal variability, an academic year is defined as July 1 of the preceding year to June 30 of the subsequent year. Thus, the 2019 academic year would correspond from July 1, 2019 to June 30, 2020. As case logs span a single academic year, we designed a retrospective cohort study of total joint arthroplasty fellows to explore the impact of the COVID-19 outbreak on reported case volume, which corresponded to the last quarter of the 2019–2020 academic year.

ACGME case logs represent the collective surgical experience at the end of fellowship training. Case volumes are self-reported and audited by fellowship programs and the ACGME during accreditation processes. Importantly, ACGME case logs summarize reported case volumes for accredited fellowships only and thus exclude non-accredited fellowships. In 2014, ACGME accredited programs accounted for approximately 40% of total joint arthroplasty fellowship programs [24].

The ACGME defines case categories for total joint arthroplasty fellowships (Supplemental Table 1). For the 2017 academic year, case categories were refined from generic case categories used for orthopedic residency to more granular case categories for total joint arthroplasty fellowships. As such, temporal analyses were limited from 2017–2018 to 2020–2021 to facilitate multi-year comparisons.

The independent variable was academic year and the dependent variable was reported case volume. We hypothesized that the 2019–2020 academic year would experience an approximate 25% reduction in reported case volume corresponding to the widespread economic shutdowns beginning in mid-March of 2020 and lasting to the end of fellowship. This period approximated four months out of the twelve required months of fellowship training.

Case volume data were analyzed using D'Agostino-Pearson omnibus normality tests and presented as means and standard deviations (SDs). Student t tests were utilized to compare reported case volumes by year. Compound annual growth rates (CAGRs) were calculated to understand changes in reported case volumes over the study period. *P* values of <.05 were considered significant.

Results

One hundred and thirty two total joint arthroplasty fellows were included in this study (Table 1). 45 fellows in the 2019–2020 graduating class were in the primary cohort of interest (25% of total). The number of accredited fellowships increased from 20 to 24 over the study period. The annual number of fellows increased from 40 to 51 over the study period.

There was a 14% decrease in total annual reported case volume during the 2019–2020 academic year, which corresponded to the widespread lockdowns instituted at the start of the COVID-19 outbreak in March of 2020 (Fig. 1, *P* < .001). Reported case volume increased by 19% during the 2020–2021 academic year (*P* < .001).

Case categories with the most significant percentage declines in 2019–2020 were primary total knee arthroplasty (TKA, –23%), revision total hip arthroplasty (rTHA, –19%), revision TKA (rTKA, –11%), and primary THA (–10%). Unicompartmental knee arthroplasty (UKA) increased by 29% (Fig. 2).

Table 2 demonstrates the growth in reported case volume over the study period. Despite the COVID-19 pandemic, by the 2020–2021 academic year, reported case volumes increased for all case categories except for other.

Discussion

Elective surgeries were widely discontinued during the initial outbreak of the COVID-19 pandemic, thus negatively impacting operative training for orthopedic surgery residents and fellows [5–15]. This study demonstrated that total joint arthroplasty fellows reported an approximate 14% reduction in case volume during the 2019–2020 academic year, which was less than the anticipated 25% reduction. The greatest negative change was observed for primary TKA (–23%). These findings confirm the negative secondary effects on arthroplasty cases logged during widespread lockdowns from March through June 2020. Importantly, this study did not assess the clinical significance of fewer logged cases on surgical competency. Given the importance of surgical case volume on outcomes in total joint arthroplasty [16–23], these results may help inform trainees and faculty during future national emergencies like viral pandemics.

Achieving operative competency is one of the primary objectives of fellowship training. During the onset of the COVID-19 pandemic, orthopedic trainees were largely excluded from operative room experiences, with the exception of trauma cases [5–10]. In particularly affected metropolitan cities like New York City, orthopedic trainees were re-assigned to screening facilities, critical care units, and emergency rooms where the need for medical staff in understaffed hospitals was the greatest [5,7]. Results from this national study demonstrate that case volume decreased by 14% during the 2019–2020 academic year, which corresponded with the widespread lockdowns from March to June of that year. Similarly, in a national study of Irish orthopedic

Table 1
Number of Fellows and Programs in ACGME Accredited Total Joint Arthroplasty Fellowship Training.

Academic Year	Total Joint Arthroplasty Fellowship	
	Number of Programs	Number of Fellows
2017–2018	20	40
2018–2019	23	47
2019–2020	22	45
2020–2021	24	51
Total	–	183

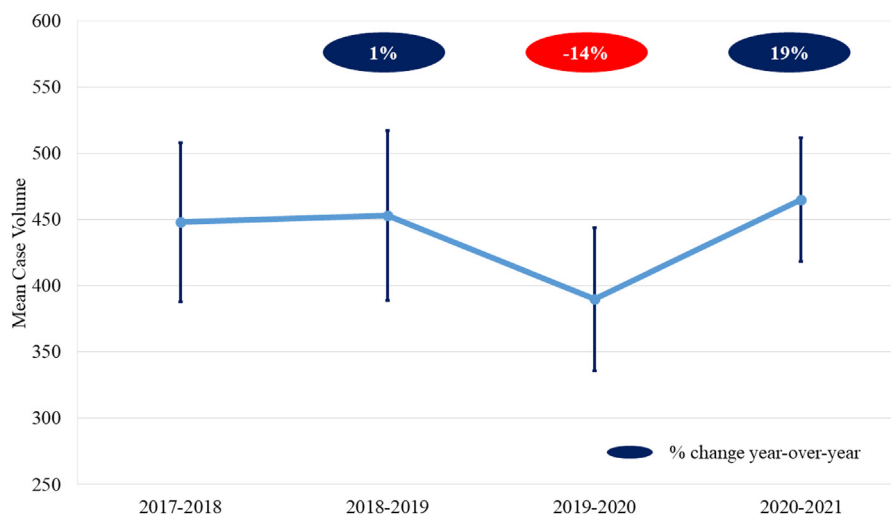


Fig. 1. Total case volume reported during total joint arthroplasty fellowship training. *ANOVA tests demonstrate significant decrease in reported case volume during the 2019-2020 academic year ($P < .05$); red bubbles indicate decreases in reported case volume in 2019-2020 and blue bubbles indicate increases in reported case volume over the same period.

trainees, case volumes for elective orthopedic procedures decreased by over 50% [25]. The authors concluded that in future pandemics, reassignment of orthopedic trainees to high-volume institutions might be an appropriate mitigation method. Ultimately, the most significant reduction in our study was 23% for primary TKA, which while significant, did not reach our expected reduction of 25%.

The COVID-19 pandemic created opportunities to improve surgical education largely via widespread adoption of electronic platforms for didactics and telemedicine for consultations [11–15]. Virtual attendance to didactics and national meetings can increase access to more learning opportunities for adult reconstructive orthopedics fellows. Emerging technologies like augmented reality platforms may create additional adjuncts to surgical education. If future national emergencies emerge like viral pandemics, then further restrictions and surgical suspensions can be expected. It is therefore necessary and imperative to understand the impact of COVID-19 on reported case volume during total joint arthroplasty fellowship training and propose methods to address these challenges.

The issue of procedure volume in total joint arthroplasty is a critical one facing orthopedic fellows, faculty, and the general public. In a multi-institutional study, higher surgeon volume was associated with a lower risk of complications including lower readmission rates, shorter lengths of stay, and higher chances of being discharged home after primary total joint arthroplasty surgery [16]. Low volume joint arthroplasty surgeons and centers have higher mortality rates [23]. A large European registry study found that the risk for adverse events decreases by 10% if annual primary THA volume increases by ten [17]. In high volume centers, both institutional and surgeon factors are implicated in favorable outcomes after total joint arthroplasty surgery [21,22]. Ultimately, the completion of total joint arthroplasty fellowship has become a prerequisite for credentialing privileges in many hospital systems, as many have pledged to eliminate low volume surgeons and centers [26,27].

The SD for total reported case volume in our study ranged between 93 and 128 total cases or about 20% of the average reported case volume. More research is needed to understand the clinical

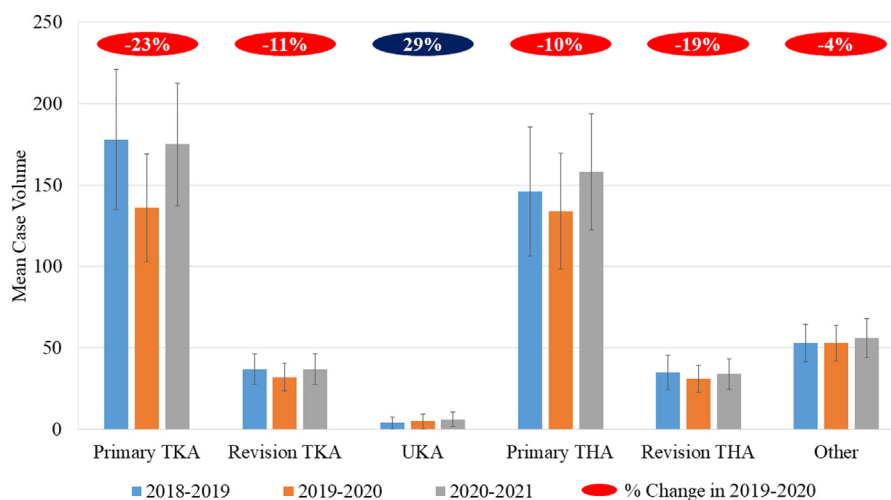


Fig. 2. Case volumes reported during total joint arthroplasty fellowship training. *Annual case volumes reported from 2018-2019 to 2020-2021; TKA, total knee arthroplasty; UKA, unicompartmental knee arthroplasty; THA, total hip arthroplasty; Other represents a mixture of non-hip and knee arthroplasty cases of which primary shoulder arthroplasty and rotator cuff open and arthroscopic cases formed the majority (Supplemental Table 1); red bubbles indicate decreases in reported case volume in 2019-2020 and blue bubbles indicate increases in reported case volume over the same period.

Table 2

Average Number of Cases Reported During ACGME Accredited Total Joint Arthroplasty Fellowship Training.

Case Categories	Average Number of Reported Cases ± SD				CAGR%
	2017–2018	2018–2019	2019–2020	2020–2021	
Primary Total Knee Arthroplasty	169 ± 80	178 ± 86	136 ± 66	175 ± 75	0.8%
Revision Total Knee Arthroplasty	35 ± 18	37 ± 19	32 ± 17	37 ± 19	1.3%
Unicompartmental Knee Arthroplasty	3 ± 5	4 ± 7	5 ± 9	6 ± 9	18.9%
Primary Total Hip Arthroplasty	149 ± 82	146 ± 79	134 ± 71	158 ± 71	1.6%
Revision Total Hip Arthroplasty	33 ± 19	35 ± 21	31 ± 17	34 ± 19	0.1%
Other	59 ± 25	53 ± 23	53 ± 22	56 ± 24	–1.3%
Total Key Procedures	448 ± 120	453 ± 128	390 ± 108	465 ± 93	0.9%

implications of variability in reported surgical volume during fellowship. A recent systematic review investigating the learning curve associated with the direct anterior approach for THA found decreasing mean operative times after the first (156.6 minutes), 30th (93.2 minutes), and 100th (80.5 minutes) case [28]. Furthermore, there was a decrease in mean complication rate from 20.8% to 7.6% between the early and late groups. Similarly, a recent systematic review of robot assisted TKA found up to 20 and 36 cases needed to supersede learning curves for robot assisted TKA and UKA, respectively [29]. In light of these studies, the volume of reported cases during total joint arthroplasty fellowship should be scrutinized. Even during COVID, total joint arthroplasty fellows reported an average of 134 primary THAs, although the breakdown of surgical approaches to the hip were not available.

There were several limitations to this study. First and foremost, only ACGME accredited fellowships were included in this study. There are many non-accredited fellowships, but overall orthopedic subspecialty fellowship training has been trending toward ACGME accreditation [24]. Second, data are summarized by academic year, which typically begins the first week of July. More granular weekly or monthly data are not released by the ACGME. However, we were interested in understanding the impact of COVID-19 on total annual case volume during joint arthroplasty fellowship training. Third, ACGME case logs are self-reported and susceptible to bias and misreporting [30,31]. However, given the increasing importance of accuracy for these case logs in accreditation and job placement after fellowship, there is high scrutiny on this data. Fourth, while the number of ACGME accredited programs remains largely stable from year-to-year, small changes occur as programs gain and lose accreditation. In our sample, this amounted to a one program difference between the 2018–2019 and 2019–2020 academic years. Lastly, while case volume has been correlated with surgical outcomes, the clinical impact of a ~25% reduction in case volume during fellowship is unknown. Presumably, the impact is negative, but future studies are needed to validate this impact, preferably in the context of arthroplasty volume needed to achieve clinical competency for independent practice.

In summary, COVID-19 had a negative impact on reported case volume during total joint arthroplasty fellowship training. Certain case categories like primary TKA experienced the greatest declines, which was expected given its elective nature. Ultimately, more research is needed to understand the impact of case volume on surgical training in total joint arthroplasty.

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Appendix

Supplemental Table 1

Current Procedural Terminology (CPT) Codes for ACGME Accredited Total Joint Arthroplasty Fellowship Training.

Case Category	CPT Code	CPT Code Description
Primary Total Knee Arthroplasty	27445	Arthroplasty, knee, hinge prosthesis
	27446	TKA Arthroplasty, knee, condyle and plateau; medial OR lateral compartment
	27447	TKA Arthroplasty, knee, condyle and plateau; medial AND lateral compartments with or without patella resurfacing (total knee arthroplasty)
Revision Total Knee Arthroplasty	27486	Revision of total knee arthroplasty, with or without allograft; 1 component
	27487	TKA Revision of total knee arthroplasty, with or without allograft; femoral and entire tibial component
Unicompartmental Knee Arthroplasty	27437	Arthroplasty, patella; without prosthesis
	27438	Arthroplasty, patella; with prosthesis
	27440	Arthroplasty, knee, tibial plateau
	27441	Arthroplasty, knee, tibial plateau; with debridement and partial synovectomy
	27442	Arthroplasty, femoral condyles or tibial plateau(s), knee
	27443	Arthroplasty, femoral condyles or tibial plateau(s), knee; with debridement and partial synovectomy
Removal of Prosthesis for Infection (Hip or Knee)	27030	Arthrotomy, hip, with drainage (eg, infection)
	27090	Removal of hip prosthesis (separate procedure)
	27091	Removal of hip prosthesis; complicated, including total hip prosthesis, methylmethacrylate with or without insertion of spacer (eg, prostalac)
	27310	Arthrotomy, knee, with exploration, drainage, or removal of foreign body (eg, infection)
	27488	Removal of prosthesis, including total knee prosthesis, methylmethacrylate with or without insertion of spacer, knee
Primary Total Hip Arthroplasty	27125	Hemiarthroplasty, hip, partial (eg, femoral stem prosthesis, bipolar arthroplasty)
	27130	THA Arthroplasty, acetabular and proximal femoral prosthetic replacement (total hip arthroplasty), with or without autograft or allograft
Revision Total Hip Arthroplasty	27236	Hemiarthroplasty for fracture
	27132	THA Conversion of previous hip surgery to total hip arthroplasty, with or without autograft or allograft
	27134	THA Revision of total hip arthroplasty; both components, with or without autograft or allograft
	27137	THA Revision of total hip arthroplasty; acetabular component only, with or without autograft or allograft
Osteotomy Knee	27138	THA Revision of total hip arthroplasty; femoral component only, with or without allograft
	27448	Osteotomy, femur, shaft or supracondylar; without fixation
Osteotomy Hip	27450	Osteotomy, femur, shaft or supracondylar; with fixation
	27457	Osteotomy, proximal tibia, including fibular excision or osteotomy; after epiphyseal closure
	27120	Hip acetabuloplasty
Primary Shoulder Arthroplasty	27122	Acetabuloplasty; resection, femoral head (eg, Girdlestone procedure)
	27146	Repair, Revision, and/or Reconstruction Procedures on the Pelvis and Hip Joint, Surgery
	23470	Arthroplasty, glenohumeral joint; hemiarthroplasty
Revision Shoulder Arthroplasty	23472	Arthroplasty, glenohumeral joint; total shoulder [glenoid and proximal humeral replacement (eg, total shoulder)]
	23472	Reverse Shoulder Arthroplasty
	23333	Removal of foreign body, shoulder; deep (subfascial or intramuscular)
	23334	Removal of prosthesis, includes debridement and synovectomy when performed; humeral or glenoid component
	23335	Removal of prosthesis, includes debridement and synovectomy when performed; humeral and glenoid component (eg, total shoulder)
	23470	Arthroplasty, glenohumeral joint; hemiarthroplasty
	23473	Revision of total shoulder arthroplasty, including allograft when performed, humeral or glenoid component
	23474	Revision of total shoulder arthroplasty, including allograft when performed, humeral and glenoid component
Rotator Cuff Open and Arthroscopic	23395	Muscle transfer shoulder or upper arm; single
	23397	Muscle transfer shoulder or upper arm; multiple
	23410	Repair of ruptured musculotendinous cuff (eg, rotator cuff) open; acute
	23412	Repair of ruptured musculotendinous cuff (eg, rotator cuff) open; chronic
	23420	Reconstruction of complete shoulder (rotator) cuff avulsion, chronic (includes acromioplasty)
Bony Procedures for Shoulder Instability	29827	Arthroscopy, shoulder, surgical; with rotator cuff repair
	29828	Arthroscopy, shoulder, surgical; biceps tenodesis
	23460	Capsulorrhaphy, anterior, any type; with bone block
	23462	Capsulorrhaphy, anterior, any type; with coracoid process transfer
	23465	Capsulorrhaphy, glenohumeral joint, posterior, with or without bone block
Soft Tissue Procedures for Shoulder Instability	23455	Capsulorrhaphy, anterior, with labral repair (eg, Bankart procedure)
	23466	Capsulorrhaphy, glenohumeral joint, any type multi-directional instability
	29806	Arthroscopy, shoulder, surgical; capsulorrhaphy

(continued on next page)

Supplemental Table 1 (continued)

Case Category	CPT Code	CPT Code Description	
Open Acromioplasty	23130	Acromioplasty or acromionectomy, partial, with or without coracoacromial ligament release	
Other Upper Limb Arthroscopic Procedures	29807	Arthroscopy with repair of slap lesion	
	29824	Arthroscopy, shoulder, surgical; distal claviclectomy, including distal articular surface (Mumford procedure)	
	29826	Arthroscopy, shoulder, surgical; decompression of subacromial space with partial acromioplasty, with coracoacromial ligament (ie, arch) release, when performed (list separately in addition to code for primary procedure)	
	29828	Arthroscopy, shoulder, surgical; biceps tenodesis	
	29830	Arthroscopy, elbow, diagnostic, with or without synovial biopsy (separate procedure)	
	29834	Arthroscopy, elbow, surgical, with removal of loose body or foreign body	
	29835	Arthroscopy, elbow, surgical; synovectomy, partial	
	29836	Arthroscopy, elbow, surgical; synovectomy, complete	
	29837	Arthroscopy, elbow, surgical; debridement, limited	
	29838	Arthroscopy, elbow, surgical; debridement, extensive	
	29840	Arthroscopy, wrist, diagnostic, with or without synovial biopsy (separate procedure)	
	29843	Arthroscopy, wrist, surgical; for infection, lavage and drainage	
	29844	Arthroscopy, wrist, surgical; synovectomy, partial	
	29845	Arthroscopy, wrist, surgical; synovectomy, complete	
	29846	Arthroscopy, wrist, surgical; excision and/or repair of triangular fibrocartilage and/or joint debridement	
	Arthrodesis Shoulder	29847	Arthroscopy, wrist, surgical; internal fixation for fracture or instability
		29848	Endoscopy, wrist, surgical, with release of transverse carpal ligament
23800		Arthrodesis glenohumeral joint	