The Use and Acceptance of Telemedicine in Orthopedic Surgery During the COVID-19 Pandemic

Eoghan T. Hurley, MB, BCh, MCh, Jonathan D. Haskel, MD, David A. Bloom, BA, Guillem Gonzalez-Lomas, MD, Laith M. Jazrawi, MD, Joseph A. Bosco, III, MD, and Kirk A. Campbell, MD

Division of Sports Medicine, Department of Orthopedic Surgery, NYU Langone Health, New York, New York, USA.

Abstract

Background: *A major byproduct of the recent coronavirus disease 2019 (COVID-19) pandemic has been the accelerated adoption of telemedicine within orthopedic practices.*

Introduction: *The purpose of the study is to evaluate satisfaction associated with telemedicine and to determine how telemedicine is used by orthopedic surgeons in response to social distancing efforts necessitated by the COVID-19 pandemic.*

Methods: *We developed a survey to evaluate surgeon's perception of telemedicine during the COVID-19 pandemic. The survey consisted of four major sections focusing on (1) surgeon characteristics and current use of telemedicine, (2) telemedicine for new patients, (3) telemedicine for routine follow-up patients, and (4) telemedicine for postoperative patients.*

Results: *We collected 268 survey responses. Overall, 84.8% of surgeons were using telemedicine, but only 20.5% of surgeons were using it before the COVID-19 pandemic. The overall satisfaction with telemedicine was 70.3% ± 20.9%. Of those who use telemedicine, 75% currently use it for new patients, 86.6% currently use it for routine follow-up patients, and 80.8% currently use it for postoperative patients ($p = 0.01$). Surgeons had higher satisfaction with building rapport and performing physical examination maneuvers for either routine follow-up or postoperative patients than for new patients ($p < 0.0001$ for both). However, satisfaction with obtaining imaging did not differ among the cohorts ($p = 0.36$). Surgeons felt they are more likely to continue to use telemedicine after the COVID-19 pandemic for either routine follow-up or postoperative patients than for new patients ($p < 0.0001$).*

Discussion: *Owing to challenges posed by the COVID-19 pandemic, telemedicine use has increased substantially among orthopedic surgeons in recent months.*

Conclusions: *Our study established that physician implementation of telemedicine has increased significantly as a result of the COVID-19 pandemic, with the majority of surgeons satisfied with its use in their practice, and plan on incorporating telemedicine in their practices beyond the pandemic.*

Keywords: *telemedicine, surgery, orthopedics, pandemic*

Introduction

Telemedicine has emerged as an innovative technology through which clinical care can be provided remotely. Telemedicine and telehealth are defined as the provision of a health care service to a patient from a provider who is at another location typically involving a video connection.[1] Although there has been a trend toward the increasing use of telemedicine by health care providers over the past decade, a major byproduct of the recent coronavirus disease 2019 (COVID-19) pandemic has been the accelerated adoption of telemedicine within orthopedic practices. This adoption has been fueled by relaxation of regulations governing telemedicine and the need for social distancing. The pandemic has unforeseeably changed the health care landscape and challenged clinical care delivery, prompting many patient–doctor interactions to occur remotely.

The first report of telemedicine within orthopedics took place in Finland in 1996, in which a videoconferencing system was used for patient examinations and transfer of radiographs between providers across three different locations.[2] In the United States, one of the first reports of the use of telemedicine for orthopedic evaluations was in 1998, in which telemedicine consultations took place for injuries and follow-up care based out of North Dakota.[3] Telehealth services have been increasingly utilized in orthopedic practices for injury consultations, postoperative evaluations, and general outpatient visits.[4–6] Early studies on the accuracy of using a mobile phone camera for the diagnosis of minimally displaced fractures resulted in a misdiagnosis rate of ~40%,[7] however, more recent studies performed using advanced photo technology have demonstrated improved accuracy and a higher rate of accurate

diagnosis.[8] Moreover, studies that have looked at patient satisfaction have found that, in general, an overwhelming majority of patients across multiple orthopedic subspecialties are highly satisfied with their telemedicine orthopedic consultations.[9–12]

By necessity, the COVID-19 pandemic has dramatically accelerated the rate at which telemedicine adoption has taken place within orthopedic practices. In some practices in regions with strict lockdown policies, patient visits have been enacted almost exclusively through telemedicine. Although it has become ubiquitous, physician satisfaction with telemedicine visits has not been fully investigated.

The purpose of the study is to evaluate satisfaction associated with telemedicine and to determine how telemedicine is used by orthopedic surgeons in response to social distancing efforts necessitated by the COVID-19 pandemic. We also aim to determine physician satisfaction with telemedicine technologies, and how they can possibly shape one's orthopedic surgery practice going forward. We hypothesized that the pandemic would lead orthopedic surgeons to rapidly incorporate telemedicine into their practices.

Methods

QUESTIONNAIRE DEVELOPMENT

A survey was developed to evaluate surgeon's perception of telemedicine during the COVID-19 pandemic. The survey consisted of four major sections focusing on (1) surgeon characteristics and current use of telemedicine, (2) telemedicine for new patients, (3) telemedicine for routine follow-up patients, and (4) telemedicine for postoperative patients. Surgeons were asked about their overall satisfaction, and about their satisfaction with building rapport, with carrying out elements of physical examination, and with obtaining imaging in a timely manner. In addition, they were asked why they were not currently using telemedicine if they were not, and whether they would continue to use telemedicine after the pandemic. The survey was created on REDCap.

SURVEY DISTRIBUTION

American and European orthopedic specialty societies that currently allowed for survey distribution among their members were contacted. The American Shoulder and Elbow Surgeons (ASES), American Orthopaedic Society for Sports Medicine (AOSSM), and European Society for Surgery of the Shoulder and the Elbow (SECEC) all approved the survey and distributed it to their members through REDCap. In addition, our institutional alumni society approved the survey, and sent it out to all former residents and fellows. Responses were kept anonymous and confidential.

STATISTICAL ANALYSIS

All statistical analyses were performed utilizing GraphPad Prism 8.3 (GraphPad, La Jolla, CA). Descriptive statistics were calculated for all continuous and categorical variables. Continuous variables were reported as weighted mean and estimated standard deviation, whereas categorical variables were reported as frequencies with percentages. Fisher's exact or chi-squared test was used to analyze categorical variables. The independent or paired t test for normally distributed variables, or the nonparametric Mann–Whitney U test or Wilcoxon signed-rank test was performed to compare continuous variables. A value of $p < 0.05$ was considered statistically significant.

Results

SURGEON CHARACTERISTICS

Overall, 268 surgeons responded to our survey. The full characteristics are given in *Table 1*.

CURRENT USE OF TELEMEDICINE

Overall, 20.5% of surgeons had been using telemedicine before the COVID-19 pandemic (*Table 2*). As a result of the pandemic, the number had increased dramatically to 84.8%. The overall satisfaction with telemedicine was 70.3% ± 20.9%. Rationale for not using telemedicine included logistical reasons (63.6%) and the difficulty in conducting a thorough physical examination or establishing physical rapport with patients (13.6%). There was a wide discrepancy in the amount of time taken for the average telemedicine visit, with the majority taking >21 min (40.3%) or 11–15 min (32.7%). The most common modality for conducting these video visits was hospital electronic medical record (40.1%).

TELEMEDICINE FOR NEW PATIENTS

Of those who used telemedicine, 75% used it for new patients (*Table 3*). The most commonly cited reason for surgeons not using telemedicine for new patients was lack of meaningful physical examination in 34%. The overall satisfaction with telemedicine for new patients was 63.3%, with the highest area of satisfaction being rapport with new patients (71.7%), and the lowest area of satisfaction being physical examination (40.5%). Overall, 72.9% of orthopedic surgeons planned to continue using telemedicine after the COVID-19 pandemic for new patient visits.

TELEMEDICINE FOR ROUTINE FOLLOW-UP PATIENTS

Of those who used telemedicine, 86.6% currently used it for routine follow-up patients (*Table 4*). The most commonly cited for surgeons not using telemedicine for postoperative patients was lack of physical examination (24.1%). The overall satisfaction rate with telemedicine for routine follow-up

Table 1. Surgeon Characteristics

N	268
Where is your practice based?	
North America	66.9%
Other	33.1%
Where in North America?	
Midwest	15.9%
Northeast	55.1%
South	17.6%
West	11.4%
What type of practice do you have?	
Academic	36.3%
Hospital	25.5%
Private	35.6%
Other	2.6%
Are you fellowship trained	91.0%
What is your subspecialty?	
Arthroplasty	11.3%
Foot and ankle	4.2%
General	2.3%
Hand	6.8%
Oncology	1.5%
Pediatrics	0.8%
Shoulder and elbow	37.0%
Spine	5.7%
Sports medicine	26.8%
Trauma	3.8%
How do you do your visits?	
Doximity	9.0%
Facetime	2.7%
Hospital EMR	40.1%
Other	31.1%
WebEx/skype/zoom	17.1%

EMR, electronic medical record.

patients was 76.5%, with the highest area of satisfaction being rapport with routine follow-up patients (79.4%), and the lowest area of satisfaction being physical examination (50.2%). Overall, 88% planned on using telemedicine after the COVID-19 pandemic for follow-up patients.

Table 2. Current Use of Telemedicine

N	268
Do you use telemedicine?	84.8%
Did you use it before the COVID-19 pandemic?	20.5%
Overall satisfaction with telemedicine	70.3% (20.9)
Why do you not use telemedicine?	
Billing	6.8%
HIPAA compliant capabilities/liability	4.5%
Logistics	63.6%
Physical examination/rapport	13.6%
Other	11.4%
What average time it takes for a telemedicine visit?	
1–5 min	4.3%
6–10 min	7.1%
11–15 min	32.7%
16–20 min	15.6%
>21 min	40.3%
How do you do your visits?	
Doximity	9.0%
Facetime	2.7%
Hospital EMR	40.1%
Other	31.1%
WebEx/skype/zoom	17.1%

COVID, coronavirus disease.

TELEMEDICINE FOR POSTOPERATIVE PATIENTS

Of those who used telemedicine, 80.8% used it for postoperative patients (*Table 5*). The most commonly cited reason for surgeons not using telemedicine for postoperative patients was lack of physical examination (30%), with half noting suture removal/wound evaluation being the primary reason.

Table 3. Telemedicine with New Patients

Do you use telemedicine for new patients?	167 (75%)
Overall satisfaction with telemedicine for new patients	63.3% (23.8)
Satisfaction with rapport	71.7% (21.8)
Satisfaction with physical examination	40.5% (25.6)
Satisfaction with imaging	56.9% (27.7)
Do you plan to continue to use telemedicine post-COVID-19 for new patients?	72.9%

Table 4. Telemedicine with Routine Follow-up Patients	
Do you use telemedicine for routine follow-up patients?	193 (86.6%)
Overall satisfaction with telemedicine for routine follow-up patients	76.5% (16.8)
Satisfaction with rapport	79.4% (16.9)
Satisfaction with physical examination	50.2% (25.5)
Satisfaction with imaging	52.4% (29.3)
Do you plan to continue to use telemedicine post-COVID-19 for routine follow-up patients?	88%

The overall satisfaction with telemedicine for postoperative patients was 75.5%, with the highest area of satisfaction being rapport with postoperative patients (79.4%), and the lowest area of satisfaction being imaging (53.6%). Overall, 90% planned on using telemedicine after the COVID-19 pandemic for postoperative visits.

COMPARISON OF TELEMEDICINE FOR NEW PATIENTS, ROUTINE FOLLOW-UP PATIENTS, AND POSTOPERATIVE PATIENTS

Our findings show that surgeons are more likely to use telemedicine for routine follow-up and postoperative patients than for new patients (*Table 6*). In addition, we found that surgeons had higher satisfaction with building rapport and performing a virtual physical examination in these patients. Satisfaction with obtaining imaging did not differ among the cohorts. Surgeons also felt that they were more likely to use telemedicine after the COVID-19 pandemic for routine follow-up and postoperative patients than for new patients.

Discussion

Owing to challenges posed by the COVID-19 pandemic, we found that telemedicine use has increased substantially among orthopedic surgeons in recent months. This study also reports that the vast majority of orthopedic surgeons plan on utilizing telemedicine in their regular medical practice after social distancing measures have been relaxed. Furthermore, orthopedic surgeons felt that, through telemedicine, they were more likely to build rapport and perform meaningful physical examinations in established follow-up or postoperative patients than in new patients. These findings support our hypothesis.

Table 5. Telemedicine with Postoperative Patients	
Do you use telemedicine for postoperative patients?	180 (80.8%)
Overall satisfaction with telemedicine for postoperative patients	75.5% (17.4)
Satisfaction with rapport	79.4% (16.4)
Satisfaction with physical examination	56.5% (25.8)
Satisfaction with imaging	53.6% (30.7)
Do you plan to continue to use telemedicine post-COVID-19 for postoperative patients?	90.0%

After the World Health Organization's (WHO) declaration that the COVID-19 virus was a pandemic on March 11, 2020, many medical organizations made rapid changes to their practice recommendations. In North America, the American Academy of Orthopedic Surgeons (AAOS) recommended that elective surgeries be delayed as new information about the pandemic emerged. Significantly, the office for civil rights within the United States Department of Health and Human services supported the accelerated development of telemedicine services to aide in the response to the COVID-19 pandemic. Before the COVID-19 pandemic, the American Medical Association (AMA) recommended telemedicine as a supplemental visit modality but not a permanent substitute for in-person visits. Other previously reported barriers to the adoption of telemedicine had included (1) hardware/software challenges, (2) difficulty with workflow integration, and (3) hesitancy to change practice.[4,10,13] For the purposes of this study, we grouped all of these challenges under the rubric of a "logistics" barrier. This, in fact, was the most commonly reported (65%) barrier-to-entry among nontelemedicine providers in this survey.

Previous research has demonstrated benefits associated with telemedicine in orthopedic surgery.[4,10,13] In a randomized controlled trial, published on telemedicine for orthopedic patients, Buvik et al.[10] demonstrated that telemedicine did not negatively impact patient-reported outcome measures, and that patient satisfaction was generally high after these visits. In a separate randomized controlled trial, Buvik et al.[13] also demonstrated that physician satisfaction with their own evaluation ability was equivalent between telemedicine and in-person visits. Telemedicine has also been shown to be cost-effective in orthopedic clinics, both for patients, in saving them commuting time, and for orthopedic surgeons, when utilized enough to compensate for the initial setup cost. Although this study did not analyze physician perception of cost-effectiveness, prior results have demonstrated that patients are generally happy with effectiveness of telemedicine with respect to reduced overall travel and visit time.[5]

Patient satisfaction after telemedicine visits in orthopedic surgery is high. Sharereh and Schwarzkopf[12] demonstrated

Table 6. Comparison of Telemedicine for New Patients, Routine Follow-Up Patients, and Postoperative Patients

	TELEMEDICINE W/NEW PATIENTS VS. ROUTINE FOLLOW-UP (*p*-VALUE)	TELEMEDICINE W/NEW PATIENTS VS. POSTOPERATIVE PATIENTS (*p*-VALUE)	TELEMEDICINE W/ROUTINE FOLLOW-UP VS. POSTOPERATIVE PATIENTS (*p*-VALUE)	OVERALL COMPARISON (*p*-VALUE)
Do you use telemedicine?	0.003	0.13	0.15	0.01
Overall satisfaction with telemedicine	<0.0001	0.0001	0.66	<0.0001
Satisfaction with rapport	0.0002	0.0002	0.95	<0.0001
Satisfaction with physical examination	0.0002	<0.0001	0.006	<0.0001
Satisfaction with imaging	0.17	0.32	0.73	0.36
Do you plan to continue to use telemedicine post-COVID-19?	0.0001	<0.0001	0.73	<0.0001

that patients who had telemedicine visits after total joint arthroplasty had superior satisfaction to those who had office-based visits. Sathiyakumar et al.[14] demonstrated that orthopedic trauma patients had satisfaction similar to those who engaged in more traditional office-based visit formats. In addition, Kane et al.[5] demonstrated that patients may prefer telehealth follow-up after arthroscopic rotator cuff repair. Although our study did not ask physicians about their perceptions regarding patients' satisfaction regarding telehealth visits, our results do suggest that physicians feel it satisfactorily preserves the doctor–patient relationship. In addition, we found that telemedicine visit satisfaction rates among physicians were higher in those who involved established patients.

In a recent study on the utilization of telehealth among orthopedic surgeons in response to COVID-19, Parisien et al. demonstrated that 63.1% of Electronic Residency Application Service participating orthopedic institutions were currently providing telehealth accommodations whereas another 22.5% of programs were in the process of setting up telehealth services.[15] These findings are corroborated by our study, wherein we found a similar proportion offering telemedicine services. Geography has previously acted as both an incentive and barrier to the implementation of telehealth services. Although this study did not analyze responses on the basis of geography, Parisien et al.[15] demonstrated that the majority of recently developed telehealth services in the orthopedic community have occurred in regions where COVID-19 has been more prevalent in the general population, with widespread implementation occurring in states such as California and New York. Our survey reached a wide-ranging audience, with all subspecialties represented, and a wide geographic spread. Thus, although we were unable to analyze data based on these demographic factors, we feel that our survey is representative of the general orthopedic surgeon population.

LIMITATIONS

This study has potential limitations. First, it is a survey-based study, subject to responder bias inherent to all survey-based research. Second, it may be biased in its focus on the sports medicine subspecialty, as sports medicine societies provided circulation and exposure for our survey. Third, the survey we utilized was a novel nonvalidated survey tool utilized for ascertaining physician usage of telemedicine. We believe, nevertheless, that the survey questions we posed were pragmatic in nature and that the answers to them faithfully reflected surgeon sentiment. Last, the study asked providers to predict/hypothesize their future habits. These may ultimately not be put into actual practice. We do believe, however, that it is crucial to document these expectations, as they will color the orthopedic landscape vis a vis telemedicine in the immediate future. We also believe that our large study size and degree of statistical significance make our results compelling.

Conclusions

Our study established that physician implementation of telemedicine has increased significantly as a result of the COVID-19 pandemic, with the majority of surgeons satisfied with its use in their practice, and plan on incorporating telemedicine in their practices beyond the pandemic.

Disclosure Statement

Drs. E.T.H., J.D.H., and G.G.-L. and Mr. D.A.B. have no conflicts to disclose.; J.A.B., III MD, reports stock or stock options in Genovel, MyarthritisRX; and Proventus.; L.M.J., MD, reports research support from Arthrex, Inc., Mitek, and

Smith and Nephew; and publishing royalties, financial or material support from Wolters Kluwer Health—Lippincott Williams and Wilkins.; K.A.C., MD, reports board or committee membership with AAOS and Arthroscopy Association of North America; and paid consultancy with Samumed.

Funding Information

No funding was received.

REFERENCES

1. Wongworawat MD, Capistrant G, Stephenson JM. The opportunity awaits to lead orthopaedic telehealth innovation: AOA critical issues. *J Bone Joint Surg Am* **2017;**99:e93.
2. Lamminen H, Nevalainen J, Alho A, et al. Experimental telemedicine in orthopaedics. *J Telemed Telecare* **1996;**2:170–173.
3. Lambrecht CJ, Canham WD, Gattey PH, McKenzie GM. Telemedicine and orthopaedic care. A review of 2 years of experience. *Clin Orthop Relat Res* **1998;**348:228–232.
4. Buvik A, Bergmo TS, Bugge E, et al. Cost-effectiveness of telemedicine in remote orthopedic consultations: Randomized controlled trial. *J Med Internet Res* **2019;**21:e11330.
5. Kane LT, Thakar O, Jamgochian G, et al. The role of telehealth as a platform for postoperative visits following rotator cuff repair: A prospective, randomized controlled trial. *J Shoulder Elbow Surg* **2020;**29:775–783.
6. Russell TG, Buttrum P, Wootton R, Jull GA. Internet-based outpatient telerehabilitation for patients following total knee arthroplasty: A randomized controlled trial. *T J Bone Joint Surg Am* **2011;**93:113–120.
7. Chandhanayingyong C, Tangtrakulwanich B, Kiriratnikom T. Teleconsultation for emergency orthopaedic patients using the multimedia messaging service via mobile phones. *J Telemed Telecare* **2007;**13:193–196.
8. Elkaim M, Rogier A, Langlois J, et al. Teleconsultation using multimedia messaging service for management plan in pediatric orthopaedics: A pilot study. *J Pediatr Orthop* **2010;**30:296–300.
9. Marsh J, Bryant D, MacDonald SJ, et al. Are patients satisfied with a web-based followup after total joint arthroplasty? *Clin Orthop Relat Res* **2014;**472:1972–1981.
10. Buvik A, Bugge E, Knutsen G, et al. Patient reported outcomes with remote orthopaedic consultations by telemedicine: A randomised controlled trial. *J Telemed Telecare* **2019;**25:451–459.
11. Sinha N, Cornell M, Wheatley B, et al. Looking through a different lens: Patient satisfaction with telemedicine in delivering pediatric fracture care. *J Am Acad Orthop Surg Glob Res Rev* **2019;**3:e100.
12. Sharareh B, Schwarzkopf R. Effectiveness of telemedical applications in postoperative follow-up after total joint arthroplasty. *J Arthroplasty* **2014;**29:918–922e1.
13. Buvik A, Bugge E, Knutsen G, et al. Quality of care for remote orthopaedic consultations using telemedicine: A randomised controlled trial. *BMC Health Serv Res* **2016;**16:483.
14. Sathiyakumar V, Apfeld JC, Obremskey WT, et al. Prospective randomized controlled trial using telemedicine for follow-ups in an orthopedic trauma population: A pilot study. *J Orthop Trauma* **2015;**29:e139–e145.
15. Parisien RL, Shin M, Constant M, Saltzman BM, Li X, Levine WN, Trofa DP. Telehealth utilization in response to the novel coronavirus (COVID-19) pandemic in orthopaedic surgery. *J Am Acad Orthop Surg* **2020;**28:e487–e492.

Address correspondence to:
Eoghan T. Hurley, MB, BCh, MCh
Division of Sports Medicine
Department of Orthopedic Surgery
NYU Langone Health
301 E 17th Street
New York, NY 10003
USA

E-mail: eoghan.hurley@nyulangone.org

Received: June 30, 2020
Revised: August 5, 2020
Accepted: August 19, 2020
Online Publication Date: September 15, 2020