Abstract. Background/Aim: The Coronavirus disease 2019 (COVID-19) has led to significant disruptions in various medical specialties. We herein aimed to provide a systematic review of the published literature on the impact by the Covid-19 pandemic on orthopaedic and traumatological care by focusing on the number of clinical visits, surgeries and reasons for consultation. Materials and Methods: The published literature was reviewed using PubMed. Of 349 studies published between December 1, 2019 and October 1, 2020, 36 original articles met the inclusion criteria. Articles were selected on the basis of the PRISMA guidelines. October 1, 2020 was used as the concluding date of publication. Results: The number of elective visits declined by 50.0% to 74.0%. The number of emergency and trauma visits showed a decrease of 37.7% to 74.2%. Trauma surgery decreased by 21.2% to 66.7% and elective surgeries by 33.3% to 100%. Conclusion: Orthopaedic and trauma surgery is clearly influenced by the pandemic. It will be important to maintain treatment and surgical care of patients in order to avoid negative effects on treatment progress.

Since the first cases of a novel respiratory disease occurred in Wuhan, China in December 2019, Coronavirus disease 2019 (Covid-19) has spread worldwide (1). While the World Health Organization (WHO) classified Covid-19 as a public health emergency on January 30, 2020, it changed the classification on March 11, 2020 and rated Covid-19 as a pandemic (2). Since November 29, 2020, 61,866,635 people have been infected with the novel coronavirus. In addition, 1,448,990 infected people have died (3).

The Covid-19 pandemic and associated lockdowns have changed our daily lives dramatically, not only by exerting a major impact on our activities and the economy, but especially on our healthcare systems. The large number of infected persons in certain parts of the world has caused hospitals to restructure their departments in order to increase treatment capacity for Covid-19 patients. Angelico et al. reported a 25% decrease in organ transplantations in response to available intensive care unit capacity in the first four weeks in Italy, which was one of the first European countries to deal with the Covid-19 pandemic (4). Furthermore, fewer cases of colorectal carcinoma were diagnosed in Spain during the state of emergency compared to the previous year, probably due to a restriction in endoscopic and surgical procedures and a reduced number of cancer prevention screenings (5). In addition to these medical disciplines, the Covid-19 pandemic also affected orthopaedics and traumatology, where elective surgeries were postponed and nonurgent consultations cancelled to minimize the risk of infection for patients and medical staff (6, 7).

The aim of this systematic literature review was to provide an overview of the impact of the Covid-19 pandemic on orthopaedic and traumatologic care by comparing previously published reports from different countries, especially focusing on the number of clinical visits, surgeries and reasons for consultation.

Material and Methods

A comprehensive literature search was conducted covering a period from December 1, 2019 to October 1, 2020 to include all possible matching articles since the appearance of the new coronavirus. PubMed served as the primary database for the literature search. The search was performed using the following search string: “orthopaedics” OR “orthopedics” OR “traumatology” AND “covid-19” OR “sars-cov-2” OR “coronavirus”. The review was

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conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (8). In light of the fact that the Covid-19 pandemic began less than a year ago, we considered retrospective studies, survey-based studies and observational studies as well as case series and letters. Two authors independently screened the published studies by title and abstract. All publications focusing on a comparison of the number of visits, surgeries or reasons for consultation before and during the pandemic in an orthopaedic or trauma center were included, regardless of the age of the study group. Inclusion was also possible by only indicating the change in percent. Furthermore, publications in English and German were included. No study was excluded on the basis of its country or the type of study.

Results

In total, 349 studies were identified. Based on the inclusion and exclusion criteria, 36 publications were found to be eligible for analysis. Most of the included studies were conducted in Europe (n=25), followed by Asia (n=5) and North America (n=4). In addition, one study was from South America (n=1) and one from Australia (n=1). The European studies came from Italy (n=12), the UK (n=5), Spain (n=3), Belgium (n=1), France (n=1), Germany (n=1), Ireland (n=1) and Serbia (n=1). The Asian studies were conducted in China (n=2), India (n=2) and Hong Kong (n=1). Furthermore, three studies were performed in the United States of America (n=3), whereas one North American study was from Mexico (n=1). The remaining two trials were conducted in Brazil (n=1) and Australia (n=1). The literature selection process was conducted in accordance with the PRISMA guidelines (8) and is shown as a flow diagram in Figure 1. Table I presents detailed study characteristics of included publications.

Visits. Overall, 25 of the 36 included studies reported the number of visits, broken down for emergency or elective and total (6, 7, 9-31). Sixteen studies (10-19, 25, 27-29, 31) described the change in total number of patient visits, whereby all 16 reported a decrease of between 20.9% and 90.1% during the Covid-19 pandemic (10, 12). The largest
decrease in patient visits was reported by Rizzi et al. with the total number of visits dropping from 4,228 in January to 417 in April (10). From April to May, Rizzi et al. were able to offer a telemedicine conference as a phone or video call in 612 cases, after which 92.2% of the patients stated that they would participate in a telemedical conference call again (10). Furthermore, ten studies (6, 7, 9, 11-15, 19, 23-25, 28, 29, 32-41) investigated the number of elective visits, showing a decrease ranging between 50.0% and 74.0% (6, 11-15, 19, 20, 23-25, 28, 29, 32-41). Of these 14 reported the total number of surgeries (12, 13, 15, 19, 23, 25, 28, 32, 33, 35, 37-39, 41). While most studies (n=13) showed a decrease between 5.4% and 88.8% in the total number of surgeries, an increase of 47.8% was observed in one trial (38). Furthermore, performed trauma surgery decreased by 21.2% to 66.7% in 11 studies (6, 11, 15, 20, 23-25, 29, 35, 36, 40). In contrast, three studies reported an increase of 32.1% to 94.2% in the number of trauma surgeries (32, 39, 41). In addition, all nine studies reporting the number of elective surgeries showed a decrease ranging between 33.3% and 100% (6, 14, 20, 23, 25, 29, 35, 39, 41).

Surgery. A total of 23 studies presented a comparison of the number of performed orthopaedic and trauma surgeries (6, 7, 9, 11-15, 19, 20, 23-25, 28, 29, 32-41). Of these 14 reported the total number of surgeries (12, 13, 15, 19, 23, 25, 28, 32, 33, 35, 37-39, 41). While most studies (n=13) showed a decrease between 5.4% and 88.8% in the total number of surgeries, an increase of 47.8% was observed in one trial (38). Furthermore, performed trauma surgery decreased by 21.2% to 66.7% in 11 studies (6, 11, 15, 20, 23-25, 29, 35, 36, 40). In contrast, three studies reported an increase of 32.1% to 94.2% in the number of trauma surgeries (32, 39, 41). In addition, all nine studies reporting the number of elective surgeries showed a decrease ranging between 33.3% and 100% (6, 14, 20, 23, 25, 29, 35, 39, 41).

Reasons for consultation. Of the included studies 21 reported the change in the reasons for consultation (6, 7, 11-13, 15-17, 22-24, 29-31, 36-40, 42). During the Covid-19 pandemic,
there was a decrease of between 5.6% and 77.1% in polytraumas (24, 29). Additionally, consultations due to traffic accidents decreased by 26.4% to 88.9% (23, 39). Moreover, sports injuries massively decreased by 59.3% to 100% (6, 23). In contrast, eight studies described different changes in the number of domestic accidents (6, 11, 17, 23, 29, 31, 36, 39). While in five studies (6, 17, 23, 29, 31) the number of domestic accidents decreased by 20% to 50%, three studies reported an increase ranging between 22% and 300% (11, 36, 39). The total number of fractures decreased between 3.9% and 63.1% (17, 40).

Discussion

Ever since the coronavirus spread throughout the world in early 2020, its impact on daily life has diminished only slightly. The objective of the present study was to analyze the current literature regarding the influence of the Covid-19 pandemic on orthopaedic and trauma surgery. Several studies from different countries reported on the impact of the pandemic by comparing pre-pandemic and pandemic data. We aimed to provide an overview of the influence on visits, surgeries and reasons for consultations in orthopaedic and trauma surgery during the Covid-19 pandemic.

The current literature shows a dramatic decline in nearly all aspects of orthopaedic and trauma surgery. The total number of patient visits as well as the number of emergency visits decreased by up to 90.1% and 74.2%, respectively (10, 25). In comparison, a similar high decrease (84.45%) was also observed in a multispecialty surgical emergency department in Italy (43). Many countries around the world have imposed quarantine and travel restrictions to slow the spread of infection and thereby ensure that the healthcare system does not collapse (7). Furthermore, the population was encouraged to stay home. This is also reflected in the reasons for consultations. Consequently, the number of traffic accidents decreased in some countries. For example, Nunez et al. reported a 78.6% reduction in traffic accident admissions at a tertiary trauma center in Spain (7). Other studies from Italy, the UK, India or the USA confirm these findings with similar data (6, 12, 13, 24). In addition, admissions due to sports injuries also decreased by up to 100% as team sports were prohibited in many countries (6). Reports on domestic accidents yielded different results (11, 29). While Giuntoli et al. reported a 57.2% decrease in domestic accidents, the number of domestic hand and wrist injuries tripled according to Andrea et al. (11, 29). It is important to remember that people spent more time at home because of government regulations, by the fear of possible exposure to Covid-19 might have kept people from seeking out a hospital. While there is no doubt that some injuries require immediate local treatment, telemedicine could be an option for providing safe and effective healthcare services in the outpatient setting (44). Rizzi et al. implemented telemedicine during the Covid-19 pandemic and conducted 612 orthopaedic telemicine conferences between April and May 2020, whereby 92.2% of these patients said they would participate in such a conference again (10).

In view of the reduced number of emergency visits and cancelled elective procedures in some places, it does not seem surprising that the total number of surgeries performed also decreased in most hospitals (13, 25, 28). Paradoxically, Ghermandi et al. showed increased surgical activity at a department of oncology and spinal surgery in Italy, probably due to the fact that oncological spinal pathologies or degenerative disease with functional and neurological deficits cannot be postponed in the course of treatment (38). Even though the primary mode of transmission is respiratory tract shedding, several studies revealed that the virus was isolated in blood samples of patients infected with Covid-19 (45-47). It is well known that the use of power drills and saws, as common in orthopaedic and trauma surgery, is an aerosol-generating procedure, resulting in a significant risk of the infection being transmitted to the theatre staff (48, 49). On the other hand, postponed surgeries lead to prolonged pain and possibly a worsening of the patient outcome (50, 51). Kariakis et al. followed 71 patients over ten years and reported that patients who underwent a late anterior cruciate ligament reconstruction needed significantly more meniscectomies at index surgery and showed more osteoarthritis on the medial side of the knee ten years after reconstruction than did those with early reconstruction (50). Furthermore, after ten years Moosmayr et al. observed a significantly poorer outcome in patients with rotator cuff tears and delayed repair than in those who underwent early tendon repair (51). Strategies should therefore be developed to enable these patients to be treated promptly, even in the event of a continuing pandemic. At the same time, proper protection of the staff is required.

The primary limitations of this systematic literature review are the minimized exclusion criteria as well as the low level of evidence of included studies. In addition, most of the studies particularly refer to the first large wave of the Covid-19 pandemic. As a result, the impact may appear overestimated in relation to the current situation. The main strength is the heterogeneous origin of the included literature, which gives a good overall view of the global impact had by the Covid-19 pandemic on orthopaedics and trauma surgery.

Conclusion

Although orthopaedics and trauma surgery does not appear to be in the front line of the pandemic, this specialty is clearly influenced by it. The majority reported a clear decrease in the number of cases in all areas examined. In the future, despite the pandemic, it will be important to maintain treatment and especially surgical care of patients in order to
avoid negative effects on treatment progress. In addition, an analysis of the situation during the second wave at the end of 2020 should be attempted.

Conflicts of Interest
The Authors declare that there are no conflicts of interest.

Authors’ Contributions
P. Blum: Literature research, data analysis, editing and writing of the article. D. Putzer: Data analysis and proofreading. M. Liebensteiner: co-editing and proofreading of the article. D. Dammerer: study protocol, study design, literature research, editing, writing and proofreading of the article. All Authors made pertinent contributions to the article, proofread and approved the final article before submission.

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References
1 Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W and China Novel Coronavirus Investigating and Research Team.: A novel Coronavirus from patients with pneumonia in China, 2019. N Engl J Med 382(8): 727-733, 2020. PMID: 31978945. DOI: 10.1056/NEJMoa2001017
2 Timeline of WHO’s response to Covid-19. Geneva, World Health Organization, 2020. Available at: https://www.who.int/news/item/29-06-2020-covidtimeline [Last accessed on 15th November 2020]
3 Coronavirus - Situation reports. Geneva, World Health Organization, 2020. Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20201020-weekly-epi-update-10.pdf [Last accessed on 4th December 2020]
4 Angelico R, Trapani S, Manzia T M, Lombardi L, Tisone G and Cardillo M: The COVID-19 outbreak in Italy: Initial implications for organ transplantation programs. Am J Transplant. 20(7): 1780-1784, 2020. PMID: 32243677. DOI: 10.1111/ajt.15904
5 Suárez J, Mata E, Guerra A, Jiménez G, Montes M, Arias F, Ciga MA, Urcia E, Ederra M, Arín B, Laias L, Sanz A and Vera R: Impact of the COVID-19 pandemic during Spain’s state of emergency on the diagnosis of colorectal cancer. J Surg Oncol 123(1): 32-36, 2021. PMID: 33078425. DOI: 10.1002/jso.26263
6 Benazzo F, Rossi SMP, Maniscalco P, Moretti B, Vaienti E, Ruggieri P, Massè A, Medici A, Formica A, Di Maggio B, Caiaffa V, Mosconi M, Murenna L, D’Angelo F, Belluati A, Mazza EL, Rivera F, Castelli A, Ghiaia M, Rosolani M, Cioffi R, Pezzella R, Scaravilli G, Bove G, Stissi P, Mazzacane M, Quattrini F, Ciatti C, Travarelli G, Pala E, Angelini A, Sanna F, Nonne D, Colombelli A, Raggini F, Puzzo A, Canton G, Maritan G, Iuliano A, Randelli P, Solarino G, Moretti L, Vicenti G, Garofalo N, Nappi V, Ripanti S, Chinni C, Pogliacomi F, Visigalli A, Bini N, Aprato A and Perticarini L: The orthopaedic and traumatology scenario during Covid-19 outbreak in Italy: Chronicles of a silent war. Int Orthop 44(8): 1453-1459, 2020. PMID: 32591960. DOI: 10.1007/s00264-020-04637-3
7 Nuñez JH, Sallent A, Lakhan K, Guerra-Farfan E, Vidal N, Ekhtiar S and Minguell J: Impact of the COVID-19 Pandemic on an Emergency Traumatology Service: Experience at a tertiary trauma centre in Spain. Injury 51(7): 1414-1418, 2020. PMID: 32405089. DOI: 10.1016/j.injury.2020.05.016
8 Moher D, Liberati A, Tetzlaff J, Altman DG and PRISMA Group.: Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 6(7): e1000097, 2009. PMID: 19621072. DOI: 10.1371/journal.pmed.1000097
9 Gumina S, Proietti R, Villani C, Carbone S and Candela V: The impact of COVID-19 on shoulder and elbow trauma in a skeletally immature population: An Italian survey. JSES Int 5(1): 3-8, 2021. PMID: 32984859. DOI: 10.1016/j.jseint.2020.08.003
10 Rizzi AM, Polacheck WS, Dulas M, Strelzow JA and Hynes KK: The new ‘normal’: Rapid adoption of telemedicine in orthopaedics during the COVID-19 pandemic. Injury 51(12): 2816-2821, 2020. PMID: 32951916. DOI: 10.1016/j.injury.2020.09.009
11 Poggetti A, Del Chiaro A, Nucci AM, Suardi C and Pfanner S: How hand and wrist trauma has changed during covid-19 emergency in Italy: Incidence and distribution of acute injuries. What to learn? J Clin Orthop Trauma 22(1): 22-26, 2021. PMID: 32921952. DOI: 10.1016/j.jcot.2020.08.008
12 Lubbe RJ, Miller J, Rooeh CA, Allenback G, Nelson KE, Bear J and Kubiak EN: Effect of statewide social distancing and stay-at-home directives on orthopaedic trauma at a southwestern level 1 trauma center during the COVID-19 pandemic. J Orthop Trauma 34(9): e343-e348, 2020. PMID: 32815849. DOI: 10.1097/BOT.0000000000001890
13 Dhillon MS, Kumar D, Saini UC, Bayhana H, Gopinathan NR and Aggarwal S: Changing pattern of orthopaedic trauma admissions during COVID-19 pandemic: Experience at a tertiary trauma centre in India. Indian J Orthop: 1-6, 2020. PMID: 32873987. DOI: 10.1007/s43465-020-00241-0
14 Greenhalgh M, Dupley L, Unsworth R and Boden: Where did all the trauma go? A rapid review of the demands on orthopaedic services at a UK Major Trauma Centre during the COVID-19 pandemic. Int J Clin Pract: e13690, 2020. PMID: 32852851. DOI: 10.1111/ijcp.13690
15 Sugand K, Park C, Morgan C, Dyke R, Aframian A, Hulme A, Evans S, Sarraf KM, Baker C, Bennett-Brown K, Simon H, Bray E, Li L, Lee N, Pakroo N, Rahman K and Harrison A: Impact of the COVID-19 pandemic on paediatric orthopaedic trauma workload in central London: A multi-centre longitudinal observational study over the “golden weeks”. Acta Orthop 91(6): 633-638, 2020. PMID: 32835573. DOI: 10.1080/17453674.2020.1807092
16 Luceri F, Morelli J, Accetta R, Mangiavini L, Maffulli N and Peretti GM: Italy and COVID-19: The changing patient flow in an orthopedic trauma center emergency department. J Orthop Surg Res 15(1): 323, 2020. PMID: 32795347. DOI: 10.1186/s13018-020-01816-1
17 Maryada VR, Mulpur P, Guravreddy AV, Pedamallu SK and Vijay Bhasker B: Impact of COVID-19 Pandemic on Orthopaedic Trauma Volumes: a Multi-Centre Perspective From
trauma did not quarantine in one hundred and twelve adults and twenty eight children and the “tsunami of recommendations” could not lockdown twelve elective operations. Int Orthop 44(8): 1473-1480, 2020. PMID: 32451655. DOI: 10.1007/s00264-020-04619-5

41 Zagra L, Faraldi M, Pregliasco F, Vinci A, Lombardi G, Otaiano I, Accetta R, Perazzo P and D’Apulito R: Changes of clinical activities in an orthopaedic institute in North Italy during the spread of COVID-19 pandemic: A seven-week observational analysis. Int Orthop 44(8): 1591-1598, 2020. PMID: 32449043. DOI: 10.1007/s00264-020-04590-1

42 Mitkovic MM, Bumbasirevic M, Milenkovic S, Gajdobranski D, Bumbasirevic V and Mitkovic MB: Influence of coronavirus disease 2019 pandemic state of emergency in orthopaedic fracture surgical treatment. Int Orthop: 2020. PMID: 32728928. DOI: 10.1007/s00264-020-04750-3

43 Vanni G, Legramante JM, Pellicciaro M, DE Carolis G, Cotesta M, Materazzo M, Buonomo C, Farinaccio A, Santori F, Saraceno F, Ielpo B, Aiello F, Paganelli C, Grande M, DE Andreis G, Chiocchi M, Palombi L and Buonomo OC: Effect of lockdown in surgical emergency accesses: Experience of a COVID-19 hospital. In Vivo 34(5): 3033-3038, 2020. PMID: 32871849. DOI: 10.21873/invivo.12137

44 Sood S, Mbarika V, Jugoo S, Dookhy R, Doarn CR, Prakash N and Merrell RC: What is telemedicine? A collection of 104 peer-reviewed perspectives and theoretical underpinnings. Telemed J E Health 13(5): 573-590, 2007. PMID: 17999619. DOI: 10.1089/tmj.2006.0073

45 Wang W, Xu Y, Gao R, Lu R, Han K, Wu G and Tan W: Detection of SARS-CoV-2 in Different Types of Clinical Specimens. JAMA 323(18): 1843-1844, 2020. PMID: 32159775. DOI: 10.1001/jama.2020.3786

46 Zhang W, Du RH, Li B, Zheng XS, Yang XL, Hu B, Wang YY, Xiao GF, Yan B, Shi ZL and Zhou P: Molecular and serological investigation of 2019-nCoV infected patients: Implication of multiple shedding routes. Emerg Microbes Infect 9(1): 386-389, 2020. PMID: 32065057. DOI: 10.1080/22221751.2020.1729071

47 Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z, Yu T, Xia J, Wei Y, Wu W, Xie X, Yin W, Li H, Liu M, Xiao Y, Gao H, Guo L, Xie J, Wang G, Jiang R, Gao Z, Jin Q, Wang J and Cao B: Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 395(10223): 497-506, 2020. PMID: 31986264. DOI: 10.1016/S0140-6736(20)30183-5

48 Sobti A, Fathi M, Mokhtar MA, Mahana K, Rashid MS, Polyzois I, Narvani AA and Imam MA: Aerosol generating procedures in trauma and orthopaedics in the era of the Covid-19 pandemic: What do we know? Surgeon: 2020. PMID: 32883580. DOI: 10.1016/j.surge.2020.08.001

49 Geevarghese NM and Haq RU: Aerosol generating procedures in orthopaedics and recommended protective gear. J Clin Orthop Trauma 12(1): 40-42, 2021. PMID: 32863676. DOI: 10.1016/j.cot.2020.08.019

50 Karikis I, Åhlén M, Sernert N, Ejerhed L, Rostgård-Christensen L and Kartus J: The Long-Term Outcome After Early and Late Anterior Cruciate Ligament Reconstruction. Arthroscopy 34(6): 1907-1917, 2018. PMID: 29523374. DOI: 10.1016/j.arthro.2018.01.026

51 Moosmayer S, Lund G, Seljom US, Haldorsen B, Svege IC, Hennig T, Pripp AH and Smith HJ: At a 10-year follow-up, tendon repair is superior to physiotherapy in the treatment of small and medium-sized rotator cuff tears. J Bone Joint Surg Am 101(12): 1050-1060, 2019. PMID: 31220021. DOI: 10.2106/JBJS.18.01373

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