Impact of the COVID-19 pandemic and its related psychological effect on orthopedic surgeries conducted in different types of hospitals in Taiwan

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Abstract
Aim: Taiwan’s response to the coronavirus disease 2019 (COVID-19) differed in that it successfully prevented the spread without having to shutdown or overburden medical services. Patients’ fear regarding the pandemic would be the only reason to reduce surgeries, so Taiwan could be the most suitable place for research on the influence of psychological factors. This study aimed to assess the impact of patients’ fear on orthopedic surgeries in Taiwan amid the peak period of the COVID-19 pandemic. Patients and Methods: The investigation period included the COVID-19 pandemic (March 2020 to April 2020) and the corresponding period in the previous year. The following data on patients with orthopedic diseases were collected: outpatient visits, hospital admission, and surgical modalities. Results: The COVID-19 pandemic led to a 22%–29% and 20%–26% reduction in outpatients, 22%–27% and 25%–37% reduction in admissions, and 26%–35% and 18%–34% reduction in surgeries, respectively, at both hospitals. The weekly mean number of patients was significantly smaller during the COVID-19 pandemic for all types of surgery and elective surgeries at the university hospital, and for all types of surgery, elective surgeries, and total knee arthroplasties at the community hospital. Further, patients visiting the community hospital during the pandemic were significantly younger, for all types of surgery, elective surgeries, and total knee arthroplasties. Conclusions: The reduction in orthopedic surgeries in Taiwan’s hospitals during COVID-19 could be attributed to patients’ fear. Even without restriction, the pandemic inevitably led to a reduction of about 20%–30% of the operation volume.

Keywords
COVID-19, orthopedic surgery, pandemic, total knee arthroplasty

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Introduction
The World Health Organization declared the 2019 coronavirus disease (COVID-19) as a worldwide pandemic on March 12, 2020. COVID-19 cases were first found in Wuhan, China, in December 2019, possibly owing to the purchase, slaughtering, and consumption of exotic live animals in the Huanan seafood and animal market.¹ COVID-19 is an infectious disease that can cause pneumonia. It has spread rapidly and has infected several individuals globally. To date (November 23, 2020), a cumulative total of over 57 million cases has been confirmed, and over

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1 million people have died of this disease,2 seriously impacting the global economy.

The first imported case in Taiwan was announced on January 21, 2020.3 The trend of total cumulative cases increased significantly from March 17, 2020 to April 6, 2020 and then became stable. To date (August 19, 2020), a cumulative total of 618 cases has been confirmed, and seven of these have resulted in mortality.4 Among these cases, 527 were imported, 55 were local, and 36 were Navy personnel aboard the Panshi fast combat support ship.5 As a result of Taiwan’s experience with SARS in 2003, the Taiwan Central Epidemic Command Center (CECC) reacted quickly and effectively to avoid a COVID-19 outbreak of epidemic proportions.6,7

Although Taiwan has achieved successful results in limiting the spread of COVID-19, the comprehensive epidemic prevention strategy has seriously affected its economy.8 To keep the public appraised about the current situation, the CECC established an open and transparent epidemic information platform on January 23, 2020. Taiwan’s government asked people to avoid going to public places and to monitor self-health, and mandated wearing a mask in the public and in hospitals. Moreover, before entering hospitals, everyone had to visit outdoor quarantine stations, and have their overseas travel history checked and updated on the National Health Insurance card. Additionally, everyone had to undergo infrared thermal camera scanning and have their body temperature checked with a forehead thermometer. Therefore, a reduced rate of hospital visits for orthopedic diseases was expected. Similarly, a study conducted in Northern Italy reported a reduced rate of hospital admissions for acute coronary syndrome during the COVID-19 pandemic.9 Although orthopedic surgeons may not be considered as frontline medical staff in the fight against this pandemic, several patients with orthopedic diseases continue to require surgery.

Taiwan has implemented some effective strategies to prevent the COVID-19 outbreak,10 but the actual impact of the pandemic on orthopedic surgery practice in Taiwan’s hospitals is still unclear. It would also be interesting to know whether the current triage and preventive strategies implemented in hospitals for scheduling orthopedic surgeries could avoid the suspension of orthopedic surgeries during the COVID-19 pandemic. Since the epidemic situation in Taiwan is not serious, there has been almost no change in medical administrative control. Contrary to several other countries that had a partial or complete disruption of clinical practice,11-17 no policy has attempted to limit the number of outpatients and the scheduling of routine surgeries in Taiwan. Therefore, any changes to related medical practice could be attributed to the psychological effects of general epidemic prevention measures, such as patients’ fear of COVID-19, rather than the hospital itself.

Accordingly, the present study aimed to assess the impact of the COVID-19 pandemic on orthopedic surgery practice at a university hospital (medical center) and a community teaching hospital in Taiwan.

Patients and methods

Data collection

This study was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (IRB number: KMUHIRB-EXEMPT(II)-2020). A retrospective analysis was performed using data from March 1, 2020 to April 31, 2020, and the corresponding period from the previous year as a control. Monthly data on patients with orthopedic diseases were collected from the departments of orthopedics at two hospitals (Kaohsiung Medical University Hospital and Kaohsiung Municipal Ta-Tung Hospital) in southern Taiwan, including information about hospital admissions, outpatients, and surgical records. Additionally, daily data on patients who underwent surgery were collected from the community teaching hospital. Surgical procedures were categorized as all types of surgery, emergency surgery, elective surgery, fracture surgery, and total knee arthroplasty. Each of these categories has its own unique characteristics for analysis but they do have some overlaps. For example, total knee arthroplasty is also a kind of elective surgery. We compared the data between the study period and a control period that comprised the corresponding period during the previous year (March 1, 2019 to April 30, 2019).

Statistical analysis

Descriptive statistics were used to examine the major characteristics of the data. Continuous variables were presented as mean ± standard deviation (SD) and categorical variables as frequencies. Continuous data from the two periods were compared using a two-sample t-test, while categorical data were compared using the χ² test. A p-value <0.05 was considered to indicate a significant difference. All analyses were conducted using the statistical package IBM SPSS version 19 (IBM Corp., Armonk, New York, USA).

Results

University hospital

Data from 22,800 outpatients were analyzed, which comprised 9872 visits during the study period (March and April 2020) (43%) and 12,928 during the control period in 2019 (57%). The number of outpatients reduced by 22% and 26% in March and April 2020, respectively, as compared with that in 2019 (Figure 1(a)). Further, among the 5780 hospital admissions analyzed, 2417 occurred during the study period (42%) and 3363 during the control period in 2019 (58%). The number of patients reduced by 22% and 35% in March and April 2020, respectively, as compared with that in 2019 (Figure 1(b)). Among the analyzed 1432 patients who underwent all types of surgery, 591 did so during the study period (41%) and 841 during the control period in 2019 (59%). The number of patients by 26% and
Figure 1. Distribution of monthly number of outpatients, hospital admissions, and surgeries, conducted during the study period (March and April 2020) and the control period (2019) at the Department of Orthopedics of the (a) to (c) university and (d) to (f) community teaching hospitals.
34% in March and April 2020, respectively, compared with that in 2019 (Figure 1(c)).

**Community teaching hospital**

Among the 17,039 outpatients analyzed, 7308 visited during the study period (43% and 20% in March and April 2020, respectively, compared with that in the control period (Figure 1(d)). Among the 2541 hospital admissions analyzed, 1032 occurred during the study period (41% and 60% during the control period (41%) and 1509 during the control period (60%). The number of patients reduced by 27% and 37% in March and April 2020, respectively, compared with that in the control period (Figure 1(e)). Among the analyzed 619 patients who underwent all types of surgery, 261 did so during the study period (42%) and 358 during the control period (58%). The number of patients reduced by 35% and 18% in March and April 2020, respectively, compared with that in the control period (Figure 1(f)).

**Comparison of surgeries conducted during the two periods**

Patients who underwent surgery in the same month of the two periods were compared. At the university hospital, those who underwent surgery in March 2020 were significantly younger than those who did so during the control period for all types of surgery, emergency surgeries, and fracture surgeries (Figure 2). However, no significant differences were observed in the age of patients who underwent surgery in April 2019 and 2020. Similarly, there were no sex-based differences between the two periods for both months (Table 1). The mean number of patients who underwent surgery in March 2020 was significantly smaller than that during the corresponding control period for all types of surgery and elective surgeries (Table 2). However, this difference was not observed in the month of April in the two periods.

At the community hospital, the age of patients who underwent surgery in March did not differ significantly among the two periods. However, among those who underwent surgery in April, those who did so during the study period were significantly younger than those during the control period for all types of surgery, elective surgeries, and total knee arthroplasties (Figure 2). There was no significant difference in the sex ratio between the two periods for both months (Table 1). The mean number of patients who underwent surgery in March 2020 was significantly smaller than that during the corresponding month of the control period for all types of surgery, elective surgeries, and total knee arthroplasties (Table 2). However, with
reference to surgeries conducted in April 2019 and 2020, this difference was only observed for total knee arthroplasties.

Comparison of surgeries conducted in the two types of hospitals

The reduction in the number of patients who underwent surgery was compared between the two hospitals (Table 2). The results showed that reduction in all types of surgery was significantly smaller for the university hospital as compared to that for the community hospital in March 2020. However, there were no significant differences in reduction between the two hospitals with reference to emergency surgeries, elective surgeries, fracture surgeries, and total knee arthroplasties conducted in March and April 2020.

Discussion

This study examined the impact of the COVID-19 pandemic on orthopedic surgery practice at two types of hospitals (a university and community hospital) in Taiwan. Findings revealed that, in both hospitals, the total number of outpatients, hospital admissions, and surgeries conducted during the pandemic (March and April 2020) were significantly smaller than those in the corresponding months of the previous year. Patients who underwent surgery during the COVID-19 pandemic were significantly younger than those who did so in the control period. Both hospitals exhibited a significant reduction in the weekly mean number of patients undergoing all types of surgery and elective surgeries during the pandemic in March 2020. However, the reduction in all types of surgery at the university hospital was significantly smaller than that at the community hospital in March 2020. The mean number of patients undergoing total knee arthroplasty in March and April 2020 were significantly smaller than those during the corresponding control period only at the community hospital. Our results demonstrated that the COVID-19 pandemic had a serious impact on orthopedic surgery practice at the studied hospitals in Taiwan.

The Chinese Lunar New Year as an important holiday in Taiwan, when hospitals are closed (for elective surgery) for about 5 days. Patients are likely to make travel plans with their families during these holidays, and they do not prefer to visit a hospital unless their disease is acute. This holiday fell in January during the COVID-19 pandemic and in February during the control period. To avoid the effect of

Table 1. Sex ratio (males/females) of patients who underwent surgery at the university and community hospitals during the two periods.

|                      | University hospital | Community hospital | p-Value 2019 | p-Value 2020 | p-Value 2019 | p-Value 2020 | p-Value 2019 | p-Value 2020 |
|----------------------|---------------------|--------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| All types of surgery | 243/185             | 162/154            | 0.227        | 125/73       | 0.936        | 82/47        | 0.784        | 103/57       | 0.874        |
| Emergency surgery    | 59/52               | 44/46              | 0.557        | 17/9         | 0.333        | 18/16        | 0.594        | 18/13        | 0.579        |
| Elective surgery     | 184/133             | 118/108            | 0.178        | 108/64       | 0.454        | 64/31        | 0.979        | 85/44        | 0.727        |
| Fracture surgery     | 77/53               | 61/66              | 0.122        | 32/17        | 0.123        | 25/25        | 0.209        | 27/24        | 0.178        |
| Total knee arthroplasty | 32/10              | 13/3               | 0.68         | 32/8         | 0.915        | 13/3         | 0.768        | 26/6         | 0.768        |

Table 2. Weekly mean number of patients who underwent surgery at the university and community hospitals during the two periods.

|                      | University hospital | Community hospital | p-Value 2019 | p-Value 2020 | p-Value 2019 | p-Value 2020 | p-Value 2019 | p-Value 2020 |
|----------------------|---------------------|--------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| All types of surgery | 100.0 ± 10.3        | 73.3 ± 11.6        | **0.014**    | 47.0 ± 8.4   | **0.018**    | 30.8 ± 5.4   | **0.002**    | 26.6 ± 10.0  | 33.6 ± 13.8  | **0.018**    |
| Emergency surgery    | 83.8 ± 13.1         | 61.8 ± 13.9        | 0.061        | 36.3 ± 5.1   | **0.002**    | 24.0 ± 10.3  | 0.077        | 25.2 ± 18.7  | 34.5 ± 26.8  | **0.880**    |
| Elective surgery     | 26.5 ± 4.5          | 20.3 ± 2.8         | 0.056        | 5.8 ± 1.5    | 0.138        | 8.0 ± 2.2    | **0.018**    | 22.9 ± 9.3   | -42.0 ± 39.2 | 0.141        |
| Fracture surgery     | 21.5 ± 3.1          | 19.0 ± 8.2         | 0.591        | 6.8 ± 3.0    | 0.429        | 5.3 ± 1.9    | **0.005**    | 8.5 ± 43.4   | 2.5 ± 62.3   | **0.228**    |
| Total knee arthroplasty | 73.5 ± 7.9         | 53.0 ± 9.4         | **0.016**    | 41.3 ± 8.1   | **0.002**    | 22.8 ± 3.3   | **0.005**    | 27.5 ± 12.9  | 43.5 ± 13.3  | **0.746**    |
| Fracture surgery     | 62.3 ± 13.1         | 42.8 ± 12.3        | 0.074        | 29.5 ± 5.1   | **0.005**    | 24.3 ± 4.2   | **0.005**    | 31.5 ± 14.6  | 16.9 ± 15.7  | **0.977**    |
| Total knee arthroplasty | 30.3 ± 4.8          | 28.3 ± 6.1         | 0.625        | 11.3 ± 2.2   | 1.000        | 11.3 ± 4.0   | 1.000        | 6.4 ± 15.6   | 1.5 ± 21.4   | 0.758        |
| Total knee arthroplasty | 27.3 ± 6.9          | 27.5 ± 6.2         | 0.959        | 11.5 ± 4.0   | 1.000        | 11.5 ± 2.5   | 1.000        | -10.3 ± 51.2 | -8.9 ± 43.2  | 0.514        |
| Total knee arthroplasty | 9.0 ± 3.4           | 4.0 ± 2.9          | 0.067        | 10.0 ± 1.8   | 0.002        | 4.0 ± 1.4    | **0.437**    | 54.2 ± 37.2  | 60.3 ± 10.1  | 0.437        |
| Total knee arthroplasty | 4.3 ± 2.6           | 2.5 ± 1.9          | 0.323        | 7.8 ± 1.5    | **0.019**    | 3.0 ± 2.6    | **0.593**    | 25.0 ± 86.6  | 58.3 ± 42.9  | **0.593**    |

Bold font indicates significant difference. Note that these categories of surgeries were not mutually exclusive.
the holiday closure on findings, we only utilized data from March and April.

Findings revealed a significant reduction in the total number of outpatients in March and April 2020 for both types of hospitals due to the COVID-19 pandemic. In March 2020, hospitals in Taiwan began monitoring and recording visitors’ travel history before admittance. Indeed, such screening measures require substantial amounts of time. The government also asked people to avoid going to public places, including hospitals. As people were afraid of being infected with COVID-19 in hospitals, these factors reduced their willingness to visit hospitals for non-acute diseases. This could explain why the number of outpatients reduced significantly in March and April 2020 in both hospitals.

In Taiwan, the two types of hospitals differ in that university hospitals provide standard negative pressure rooms for COVID-19 patients while community hospitals do not. The public was aware that several patients with COVID-19 had been admitted to the university hospital included in our study. This may have had a stronger effect on orthopedic surgery admissions at the university hospital than that at the community teaching hospital. Moreover, the reduction in the number of patients who underwent all types of surgery at the university hospital was significantly larger than that at the community hospital. However, the reduction in the total number of hospital admissions at the university hospital was not greater than that at the community hospital. These findings suggest that the pandemic may have had a more serious impact on scheduled surgeries at the university hospital than it did at the community hospital.

To reduce the risk of patient exposure to the virus, and the resultant impact on the entire hospital, an epidemic prevention strategy has been developed for scheduling patients at admission.\textsuperscript{18,19} The two hospitals included in the present study had also developed an algorithm for scheduling patients at admission to mitigate COVID-19 transmission (Figure 3). Considering Taiwan’s success in controlling local or community transmission, these strategies may have facilitated the normal operation of medical services.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{algorithm.png}
\caption{Triage and preventive strategies for scheduling surgery for patients with orthopedic diseases during the COVID-19 pandemic implemented at university and community hospitals in Taiwan. Considering Taiwan’s success in controlling local or community transmission, it is evident that these strategies reduce patients’ fear and facilitate the normal operation of medical services. In the presence of community infection or local transmission, hospitals remain on high alert and do not ignore asymptomatic cases/mildly symptomatic cases in the community.}
\end{figure}
facilities, thus reducing patients’ fear of contagion. In the presence of community or local transmission, medical facilities are often on high alert and asymptomatic cases/mildly symptomatic cases are not ignored. Although there is a lack of a control group to prove the effectiveness of these preventive strategies or algorithms, the present findings suggest that these measures may actually help us maintain normal operation of medical services and prevent the suspension of orthopedic surgeries. Taiwan’s has controlled the epidemic successfully, with few cases of local transmission. With hospital checks and traffic control bundling, most patients can feel safe while visiting hospitals. However, the present study revealed that the weekly mean number of patients during the COVID-19 pandemic was significantly smaller than that in the control period for all types of surgery, elective surgeries, and total knee arthroplasties at the community hospital, and for all types of surgery and elective surgeries at the university hospital. Additionally, patients who underwent elective surgeries or total knee arthroplasties during the COVID-19 pandemic were significantly younger than those who did so during the control period. Elderly patients are more vulnerable to the COVID-19 infection and they carry a higher mortality risk after being infected. Elective surgery and total knee arthroplasty are not emergency surgeries. Therefore, it is possible that elderly patients may have postponed their surgeries until the pandemic situation is mitigated.

There were some possible factors related to the public’s panic. First, the mass panic may be originated from the exaggeration of the mass media, false news or rumors, including hot topics. For example, elderly patients are more susceptible to COVID-19 and with more severe illness. Second, some panic came from the fear of lack of medical resources, such as masks or personal protective equipment. Third, the hospital had admitted some confirmed COVID-19 patients and people feared that they will be infected after admission.

There are some limitations to this study. First, daily number of outpatients and hospital admissions was not recorded. We observed that the total number of outpatients in March and April 2020 was substantially lower than that in the corresponding months of the previous year; however, this difference was not statistically significant. Second, we could not retrospectively investigate the reason for patients’ unwillingness to visit the hospital during the pandemic. Consequently, other influencing factors could not be identified. These factors could help us develop an optimal strategy to reduce the impact of disease pandemics on hospitals. Accordingly, factors affecting patients’ willingness to seek medical services during a pandemic should be investigated in future studies.

**Conclusion**

Taiwan is one of the very few countries in the world that did not restrict hospital visits, admissions, and surgery amid the COVID-19 pandemic. The reduction in the frequency of orthopedic surgeries during this period could be solely attributed to patients’ fear of COVID-19. We investigated the impact of this fear on orthopedic practice at two styles of hospitals in southern Taiwan. Findings revealed that the number of outpatients, hospital admissions, and surgeries reduced during the pandemic at the university and community hospitals. The COVID-19 pandemic seemed to significantly reduce the number of patients who underwent surgery; furthermore, it had a more serious impact on the frequency of orthopedic surgeries conducted at the university hospital as compared to those conducted at the community hospital. The COVID-19-related fear seemed to reduce elderly individuals’ willingness to undergo elective surgery or total knee arthroplasty. Taiwan’s experience has shown that the implementation of appropriate triage and preventive strategies may aid the scheduling of surgeries during the pandemic, which may in turn reassure patients and prevent the suspension of normal orthopedic surgery practice.

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