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Effects of social isolation associated with the COVID-19 pandemic on hip muscle strength, hip joint pain, and walking ability in patients with osteoarthritis of the hip joint



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ABSTRACT

To reduce the spread of the Sars-CoV-2 virus, governments in many countries adopted a social isolation strategy. However, social isolation may adversely affect people's health, e.g., by decreasing the muscle function of lower limbs. We recruited 118 patients who had undergone total hip arthroplasty (THA) and 87 patients with moderate to severe hip joint osteoarthritis (OA) and measured hip muscle strength, hip joint pain, and walking ability from before to one year after the start of the COVID-19 pandemic. During the pandemic, hip flexion (straight leg raise, SLR) strength decreased in 13.1% of patients in the post-THA group and 25.6% in the severe-OA group; in the severe-OA group, the decrease in SLR strength was mainly in patients aged 65 years and older. In addition, pain increased to mild or moderate and walkable distance decreased in more patients in the severe-OA group.

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Introduction

The COVID-19 pandemic has caused millions of deaths and represents a global health crisis. To reduce the spread of the Sars-CoV-2 virus, governments in many countries adopted a social isolation and lockdown strategy. In Japan, the COVID-19 epidemic began in March 2020, and the Japanese government soon recommended that people avoid others and stay at home. Social isolation may adversely affect people's health, e.g., by decreasing the muscle function of lower limbs and physical activity levels in general¹ and increasing mental stress, vascular events, and body weight.¹⁻³ Furthermore, social isolation may have a greater impact on patients with impaired lower extremity function, such as osteoarthritis of the hip joint, and the COVID-19 lockdown was reported to have a significant impact on pain, joint function, and physical function and activity in patients with end-stage hip and knee osteoarthritis (OA).⁴ Evidence that social isolation associated with the COVID-19 pandemic worsened the condition of patients with severe hip OA would indicate that patients with impaired lower limb function require interventional

measures if their outdoor activities are restricted, e.g., because of epidemics or other issues.

Generally, total hip arthroplasty (THA) is performed to relieve symptoms in patients with severe hip OA, and after THA, patients are able to regain mobility similar to that of a healthy person of equivalent age.⁵ However, no studies have examined the effects of the COVID-19 pandemic on walking ability and lower extremity muscle strength in patients after THA. In older adults and other people with OA of the hip joint, knee extension muscle strength is important for maintaining physical activity.⁵⁻⁹ Although past studies investigated the effects of social isolation, such as lock down, on lower limb muscle strength by interviewing participants, none measured the actual changes in lower limb muscle strength.

On the background of the above findings, we hypothesized that social isolation due to the COVID-19 pandemic had a greater impact on patients with severe hip OA than on those already receiving THA, resulting in decreased lower extremity function and increased hip joint pain in those with severe hip OA. Therefore, we evaluated the longitudinal changes of measured hip muscle strength, walking ability, and hip joint pain from before to one year after the start of the COVID-19 pandemic in patients with OA of the hip joint and patients who underwent THA.

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Materials and methods

Study design

The study protocol was approved by the institutional ethics review board at our institution. And oral informed consent was obtained from all individual participants included in the study.

Among the patients with osteoarthritis of the hip joint who regularly visit our clinic, we recruited 210 patients who visited all 3 of the following 3 time points. Those 3 time points were between January 2019 and March 2019 (1 year before the COVID-19 pandemic, Pre 1Y), January 2020 and March 2020 (just before the start of the COVID-19 pandemic in Japan, Pre), and between January 2021 and July 2021 (during the COVID-19 pandemic, During). At the annual routine medical examination, we took and evaluated radiographs of the hip joints, interviewed the patients regarding their walking ability and hip joint pain, and measured hip muscle strength.

Sample

Data were obtained from all patients with hip OA seen during the study period (including those who had already undergone THA), except for the following excluded patients. The following patients were excluded from this study: patients with a past or current COVID-19 infection who required hospitalization or home treatment; patients with collagen diseases; patients whose hip joint pain worsened during the study period; patients who underwent total hip arthroplasty (THA) after April 2020; and patients whose prosthesis loosened or who had revision THA during the study period.

Hip joint condition was used to classify the participants into 3 groups: a post-THA group, i.e., patients who had already undergone THA; a severe OA group, i.e., patients with moderate to severe hip joint OA (\geq grade 3 assessed according to the Kellgren and Lawrence classification); and a mild OA group, i.e., patients with mild hip joint OA (\leq grade 2 assessed according to the Kellgren and Lawrence classification). Among the patients treated by unilateral THA, those whose contralateral hip joint showed moderate to severe OA were assigned to the severe OA group, but those whose contralateral hip joint showed normal to mild OA were assigned to the post-THA group. The groups consisted of the following patients: post-THA group, 19 men and 99 women; severe OA group, 13 men and 74 women; and mild OA group, no men and 5 women. Because the mild-OA group was small, the group was excluded from the study, and only patients in the post-THA group and severe OA group were included. In addition, patients in the post-THA and severe OA groups were subdivided into 3 age groups ($<$ 65 years, 65 to 75 years, and $>$ 75 years), and changes in muscle strength over time were compared between the 3 groups.

Data collection and procedure

Muscle strength testing

The maximum voluntary bilateral hip flexion strength (SLR strength) and hip abduction strength were measured with a hand-held dynamometer (μ Tas F-1, Anima, Co. Ltd, Japan) during isometric contraction for 3 seconds against manual resistance, as reported previously.¹⁰ During the measurement, the patient rested in the supine position with the hip and knee in the neutral position for flexion/extension and with the hip in the neutral position for abduction/adduction. When assessing hip flexion, the dynamometer sensor was placed at the proximal border of the patella, so the lever arm for calculating hip flexion (SLR) torque corresponded to the distance from the proximal border of the patella to the anterior superior iliac spine. Similarly, when assessing hip abduction the sensor was placed 5 cm proximal to the proximal border of the lateral malleolus, and the

lever arm for calculating hip abduction torque corresponded to the distance from this point to the anterior superior iliac. Muscle strength was defined as the mean strength of the left and right legs.

Walking ability and hip pain

We examined the longitudinal changes of the distance that can be walked continuously and degree of hip pain just before the COVID-19 pandemic (Pre) and one year after the start of the pandemic (During). The walking distance was evaluated by referring to the "Distance able to walk" in the Function-Gait section of the modified Harris Hip Score and classified as follows: Level 4, unlimited walking; level 3, 6 blocks (30 minutes); level 2, 2 to 3 blocks (10–15 minutes); level 1, about 5 minutes; and level 0, indoor walking only. The patients were not asked whether or not they needed to use a cane while walking. Pain intensity was similarly classified according to the pain section of the modified Harris Hip Score, as follows: none, slight (occasional, not interfering with activity), mild (not affecting normal activity, pain after activity), moderate (interfering with daily living), and marked (severely limiting).

Data analysis

To investigate whether staying at home during the COVID-19 pandemic had an impact on SLR and hip abduction strength, we evaluated changes in muscle strength by comparing the ratio of Pre to Pre 1Y strength (Pre 1Y referred to 1 year before the COVID-19 pandemic, and Pre, to just before the COVID-19 pandemic) and During to Pre strength (During referred to during the COVID-19 pandemic). When the Pre to Pre 1Y ratio was 0.9 or less, muscle strength was considered to have decreased in the period from 1 year before the COVID-19 pandemic (Pre 1Y) to just before the COVID-19 pandemic (Pre). Similarly, when the During to Pre ratio was 0.9 or less, muscle strength was considered to have decreased in the period from just before the COVID-19 pandemic (Pre) to during the COVID-19 pandemic (During). Overall, a pandemic-related decrease in muscle strength was considered to have occurred in patients with a Pre 1Y to Pre ratio of 0.9 or more but a During to Pre ratio of 0.9 or less.

On the other hand, to determine whether staying at home during the COVID-19 pandemic affected the walking ability and hip joint pain of patients in the severe-OA and THA groups, we compared which category the patients' walking ability and hip joint pain belonged to Pre and During.

The mean age of the groups was compared with the unpaired *t* test for normally distributed data. Statistical analysis was performed with StatView Ver. 5.0 software for Macintosh (SAS Institute Inc., North Carolina), and a *p* value less 0.05 was considered to indicate statistical significance.

Results

Table 1 shows the numbers and age of patients in each group. The mean ages of the post-THA and severe OA groups were significantly different (72.4 vs 65.2 years, respectively; $p < 0.01$). According to the definitions described in the Methods section above, SLR strength decreased in 13.1% of patients in the post-THA group and 25.6% in the severe-OA group. On the other hand, hip abduction strength decreased in 3.8% of patients in the post-THA group and 8.5% in the severe-OA group. In the comparisons between the 3 age groups, no changes were seen in SLR strength in the post-THA group, but SLR strength decreased in patients aged 65 and older in the severe-OA group (Table 2).

The changes in hip pain and walkable distance in the post-THA and severe-OA groups are shown in Tables 3 and 4, respectively. In the severe OA group, more patients had mild or moderate pain during the pandemic than immediately before the pandemic, and pain

Table 1
Patients demographics

Group	Patients number (M / F)				Mean age (yr.)
	Total	< 65	65 - 75	75 <	
Post-THA	118 (19 / 99)	18 (5 / 13)	49 (7 / 42)	51 (7 / 44)	72.4 *
Severe-OA	87 (13 / 74)	39 (8 / 31)	30 (4 / 26)	18 (1 / 17)	65.2 *
Total	205 (32 / 173)	57 (13 / 44)	79 (11 / 68)	69 (8 / 61)	69.4

* The mean ages of the post-THA and severe OA groups were significantly different (72.4 vs 65.2 years, respectively; $p < 0.01$).

tended to worsen more often in patients aged 65 years and older. Regarding walkable distance, the percentage of patients in the severe OA group classified as level 1 increased from 17.9% (15 of 84) before the pandemic to 29.8% (25 of 84) during it. On the other hand, the patients in the post-THA group did not experience significant changes in pain or walkable distance from Pre to During. During the pandemic, we found no difference in pain or change in walkable distance ability between patients whose SLR strength did or did not decrease.

Discussion

Our longitudinal study of the changes of hip muscle strength from before to one year after the start of the COVID-19 pandemic in Japan revealed that SLR strength decreased in 13.1% of patients in the post-THA group and 25.6% in the severe-OA group during the pandemic and that in the severe-OA group the decrease in SLR strength occurred mainly in patients aged 65 years and older. On the other hand, hip abduction muscle strength decreased during the COVID-19 pandemic in few patients in both the post-THA and the severe-OA group. As knee extension muscle strength are important for maintaining physical activity in older adults and other people with osteoarthritis of the hip joint,⁵⁻⁹ staying at home during the COVID-19 pandemic may have adversely affected patients with severe hip OA. Moreover, in the severe-OA group, pain worsened to mild or moderate from before to during the pandemic in more patients and the percentage of patients who could walk continuously for only about 5 minutes increased from 17.9% to 29.8% during the pandemic.

In the past, many studies have assessed the effects on physical activity in older adults of lockdown due to the COVID-19 pandemic. A study in Japan by Yamada et al.¹¹ assessed the physical activity of 1,600 community-dwelling older adults by performing an online survey with the Short Version of the International Physical Activity Questionnaire and reported that the total physical activity time was significantly lower during the COVID-19 epidemic in Japan than before. In addition, they stated the necessity of promoting indoor exercise and walking habits around the house to reduce physical disability in older adults. These behavioral changes in older adults have been reported from other countries. For example, Salaiva et al.¹² reported that the opportunity for Brazilian older adults to leave the

Table 2

Percentage of patients in the post-THA and severe-OA groups who decreased or not decreased SLR and hip abductor strength in the three age groups (<65 years, 65 to 75 years, and >75 years).

Group	Age	SLR strength		Abduction strength	
		Decreased	Not decreased	Decreased	Not decreased
Post-THA	< 65	12.5 %	87.5	6.3	93.7
	65 - 75	14.0	86.0	2.3	97.7
	75 <	14.6	85.4	4.2	95.8
	Total	13.1	86.9	3.8	96.2
Severe-OA	< 65	18.4	81.6	10.5	89.5
	65 - 75	33.3	66.7	7.4	92.6
	75 <	29.4	70.6	5.9	94.1
	Total	25.6	74.4	8.5	91.5

house at least once a week for external activities and to perform regular physical activity at least 3 times per week decreased from before to during the COVID-19-related quarantine from 74% to 19% and 42% to 26%, respectively. Rantanen et al.¹³ reported that life-space mobility, an active aging score, and a quality of life score were statistically lower during COVID-19 social distancing versus 2 years before. Moreover, de Rocha et al.¹ reported that the physical inactivity imposed by the lockdown increased body mass and muscle function loss in physically active older women in Brazil. Visser et al.² and Di Renzo et al.³ stated that the cause of increased body mass is an increased feeling of hunger and the consequent change in eating habits, including overfeeding and alcohol consumption. However, most studies were based on online surveys or telephone interviews with questionnaires^{2-4,11-14} and not on face-to-face interviews. Furthermore, social isolation due to the COVID-19 pandemic had a greater impact on patients with impaired lower extremity function, such as OA of the hip joint, during the first week after lockdown, in the fourth week, and again at the end of the lockdown, Endstrasser et al.⁴ evaluated patients with end-stage hip or knee OA by telephone interviews with a pain visual analog scale (VAS), and the self-administered Western Ontario and McMaster Universities Osteoarthritis Index, Short Form 12, and Tegner activity scale questionnaires. They reported that the COVID-19 lockdown had a significant impact on pain, joint function, and physical function and activity in patients with end-stage hip OA. Our study of patients with severe hip OA showed similar results, but the present study differs from previous ones in that it included patients who had already undergone THA. The results showed that patients who had undergone THA had no decrease in walking distance or hip flexor strength, indicating that THA supports the maintenance of mobility and quality of life. Moreover, a strength of this study is that it was the first to investigate the impact of staying at home during the COVID-19 pandemic on lower limb muscle strength among older adults with OA of the hip joint. In addition, it had a longitudinal design and therefore provided insights into changes in lower limb muscle strength caused by pandemic-related behavioral measures.

Physical activity is reported to have a positive impact on health and quality of life in older adults and to reduce the risk of functional and cognitive impairment, falls, fractures, depression, disability, geriatric syndromes, hospitalization, and mortality.¹⁵ Furthermore, there is a strong evidence linking physical inactivity to various hypokinetic diseases, including cardiovascular diseases and type 2 diabetes,¹⁶ so dramatic reductions in physical activity may have serious consequences for public health in the long term. Because of these concerns, home exercise has been recommended during the COVID-19 pandemic to avoid the effects of a lack of exercise and maintain or achieve good health.¹⁷ Similarly, appropriate home exercise instruction for patients with severe hip OA is necessary to protect them from the negative effects of lower extremity weakness caused by staying at home.

As discussed above, social isolation because of the COVID-19 pandemic had a detrimental effect on walking function, pain, and hip muscle strength in patients with severe hip OA. Therefore, in case of future events that restrict free movement, such as pandemics, natural disasters, and extreme weather events, interventional measures will

Table 3

The changes in hip pain and walkable distance for patients in the severe-OA group (numbers shown in parentheses indicate the number of patients aged 65 years and older)

			Pain intensity					
			None	Slight	Mild	Moderate	Severe	Total
Walkable distance	4	Pre	17 (6)	3 (1)	-	-	-	20 (7)
		During	13 (6)	4 (2)	-	-	-	17 (8)
	3	Pre	16 (10)	12 (4)	2 (1)	-	-	30 (15)
		During	15 (7)	5 (1)	6 (1)	-	-	26 (9)
	2	Pre	9 (6)	6 (4)	5 (4)	2 (0)	-	22 (14)
		During	6 (6)	5 (4)	5 (0)	3 (3)	-	19 (13)
	1	Pre	6 (5)	1 (1)	7 (5)	1 (1)	-	15 (12)
		During	8 (7)	5 (4)	9 (5)	3 (2)	-	25 (18)
	0	Pre	-	-	-	-	-	-
		During	-	-	-	-	-	-
Total		Pre	48 (27)	22 (10)	14 (10)	3 (1)	-	87 (48)
		During	42 (26)	19 (11)	20 (6)	6 (5)	-	-

More patients had mild or moderate pain during the pandemic than immediately before the pandemic, and pain tended to worsen more often in patients aged 65 years and older. Regarding walkable distance, the percentage of patients in the severe OA group classified as level 1 increased from 17.9% (15 of 84) before the pandemic to 29.8% (25 of 84) during it.

Table 4

The changes in hip pain and walkable distance for patients in the THA groups (numbers shown in parentheses indicate the number of patients aged 65 years and older)

			Pain intensity					
			None	Slight	Mild	Moderate	Severe	Total
Walkable distance	4	Pre	45 (35)	-	-	-	-	45 (35)
		During	52 (42)	-	-	-	-	52 (42)
	3	Pre	32 (27)	2 (1)	-	-	-	34 (28)
		During	25 (25)	2 (1)	-	-	-	27 (26)
	2	Pre	23 (21)	-	-	-	-	23 (21)
		During	22 (18)	-	1 (0)	-	-	23 (18)
	1	Pre	15 (14)	1 (1)	-	-	-	16 (15)
		During	16 (14)	-	-	-	-	16 (14)
	0	Pre	-	-	-	-	-	-
		During	-	-	-	-	-	-
Total		Pre	115 (98)	3 (2)	-	-	-	118 (100)
		During	115 (99)	2 (1)	1 (0)	-	-	-

Patients in the post-THA group did not experience significant changes in pain or walkable distance from Pre to During.

be required to maintain motor function in patients with impaired lower limb function. Such measures include promoting do-it-yourself home exercises, having patients with end-stage OA consider undergoing THA, and performing THA if necessary, even during a pandemic.

As limitations, our study had a small sample size and did not assess the change in body weight, walking distance per day, or physical activity from before to during the COVID-19 pandemic. Therefore, we cannot assess the relationship between these factors and changes in muscle strength, hip joint pain, and walking ability. However, in this regard, Yamada et al.¹⁸ investigated the changes of physical activity in older Japanese older adults before and after the pandemic and reported that total physical activity time decreased by 33.3%, 28.3%, and 40.0% at 3 months, 7 months, and 1 year after the start of the pandemic, respectively. Probably, the same tendency can be found many older adults in Japan, including the patients in this study, which is concerning considering that the pandemic has been ongoing for two years. Second, the infection control policy implemented by the Japanese government was a voluntary stay-at-home policy that was not as strict as the measures in other countries. Therefore, the effects of lockdown on patients in Japan may be slightly different from those on patients in other countries with a stricter approach to lockdown.

Conclusion

We found that SLR strength decreased in about 25% of patients with severe hip OA, especially those aged 65 years and older, during the COVID-19 pandemic. In addition, we also found an increase in the number of patients with severe hip OA who had more hip pain and

shorter continuous walking distances during the pandemic. Social isolation may have adversely affected patients with severe hip OA.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

The study protocol was approved by the institutional ethics review board at our institution.

Informed consent

Oral informed consent was obtained from all individual participants included in the study.

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