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Do rheumatoid arthritis patients have more major complications and length of stay after lower extremities fracture surgery?

A nationwide data with propensity score matching

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Abstract

Patients with rheumatoid arthritis (RA) have a high risk of cardiovascular diseases and fractures. This retrospective cohort study explored whether patients with RA face higher complication risks or longer hospital stays than other patients when they had a lower limb fracture that required the surgery. Patients aged >45 years who received lower limb fracture surgeries between 2005 and 2012 were selected from the National Health Insurance Research Database, and 10 related variables including sex and age were used in propensity score matching to pair RA patients with non-RA patients in a 1:4 ratio. The final study sample comprised 1109 patients with RA and 4436 non-RA patients. The results indicated that 5.57% of the study sample had postoperative complications, accounting for 5.05% of patients with RA and 5.70% of the control group. After conditional logistic regression analysis was performed, the risk of major complications has no significant differences between patients with RA and the control group (odds ratio [OR] = 0.87; 95% confidence interval [CI]: 0.61–1.24; *P* > .05). However, the comorbidity severity score exerted a significant effect on complications; patients with scores ≥3 were 2.78 times more likely to experience complications (OR = 2.78; 95% CI 1.52–5.07). When considering different types of complications, patients with RA were less likely to be exposed to the risk of stroke (OR = 0.48). After controlling all related factors, no significant differences were observed in the complication risks or deaths between the 2 groups (*P* > .05). Regarding hospitalization length, the average stay for all patients was 8.12 days; after controlling related factors, the hospitalization length for patients with RA was 0.97 times that of the control group, which was nonsignificant (*P* > .05). These results may provide some information to healthcare professionals when providing treatments.

Abbreviations: CCI = Charlson Comorbidity Index, CI = confidence interval, CMU = China Medical University, DRGs = Diagnosis related groups, *ICD-9-CM = International classification of diseases, 9th revision, clinical modification*, ln = natural logarithm, NHIRD = National Health Insurance Research Database, OR = odds ratio, PSM = propensity score matching, RA = rheumatoid arthritis, REC = Research Ethic Committee, SD = standard deviation, SE = standard error.

Keywords: hospitalization length, lower extremities fracture surgery, major complication, rheumatoid arthritis

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1. Introduction

Rheumatoid arthritis (RA) is a chronic disease with a prevalence of approximately 0.5% to 1% in developed countries and an annual incidence of 20 to 50 cases per 100,000 people.[1] In Taiwan, the annual incidence of RA is approximately 15.8 per 100,000 people and most patients with RA are women (the male to female ratio for patients with RA is approximately 1: 4).[2] RA onset generally occurs between the ages of 50 and 60, and patients with RA normally experience synovitis and joint destruction as well as systemic inflammation.[3] Compared with general population, patients with RA are at least 50% more likely to experience myocardial infarctions, strokes, and heart failure, and their lifespans are reduced by 3 to 10 years on average.[1,4,5]

Because of joint damage, approximately 46.2% of RA patients are required to undergo orthopedic surgeries.[6] In addition to joint damage, osteoporosis caused by RA itself or RA medications also increase the risk of bone fractures, whether caused by external force or not, requiring patients to undergo surgery.[7,8] Furthermore, RA patients have higher rate of fracture in vertebral, hip, or other part of the body when comparing to osteoporotic patients.[7,9,10] Lower limb fracture surgeries account for approximately 40% of all fracture surgeries, among which hip fractures (ie, femoral neck fractures), foot fracture (ie, tarsal/metatarsal/phalangeal fractures), and ankle fractures rank top 3.[11] In general, postoperative complications are more likely to occur in patients who undergo lower limb surgeries, especially those who receive hip fracture surgeries;[12] the incidence of the various complications in patients who receive hip fracture surgeries is approximately 19%, including cardiac and pulmonary complications, myocardial infarctions, strokes, and renal failure.[13] For high-risk patients who fail to take perioperative anticoagulation prevention, their pulmonary embolism and mortality rate increase by up to 1.9% and 15.9%, respectively.[14] For older patients who sustain hip fractures, their postoperative hospitalization mortality rate and first-year postoperative mortality rate can be as high as 4.8% and 24%, respectively.[15]

Because of RA patients' long-term use of immunosuppressive drugs, they are generally at higher risk (2%–15%) of postoperative infection.[16] However, as medical treatments become increasingly advanced with proper preoperative drug withdrawal, healthcare professionals can better control disease deterioration and avoid further complications. Some studies have indicated no significant differences in the risk of postoperative infections between patients with RA and the general population.[17,18] In addition, scholars have not reached a consensus on whether differences exist in postoperative cardiovascular system complications between patients with RA and the general population. A study showed that patients with RA have higher risks of postoperative myocardial infarctions or cardiovascular diseases, which may lead to increased mortality.[19] However, other studies have indicated that compared with patients with degenerative arthritis or diabetes, patients with RA are not more likely to have postoperative cardiovascular complications.[17,20] Existing studies on RA have remained inadequate because they either examined relatively few cases,[16,18] did not use propensity score matching before performing analyses in large-scale database studies,[17,19–22] or only investigated patients who had received joint replacements.[17,18,21,22] Few studies have performed a comprehensive assessment of major complications in patients who underwent lower limb fracture surgery.[23]

In this study, the risk of patients with RA sustaining major complications after receiving lower limb fracture surgeries was explored, and the effect of RA on the number of days that patients were hospitalized after lower limb fracture surgeries were examined.

2. Material and methods

2.1. Study subjects

The study sample comprised patients who received lower limb fracture surgeries that involved general or regional anesthesia and were hospitalized for at least 1 day between 2005 and 2012 in Taiwan. RA is considered a major disorder in Taiwan (*International classification of diseases, 9th revision, clinical modification* [*ICD-9-CM*] 714.0, 714.1, 714.2) and the diagnosis is based on the standards and stipulations revised by the American College of Rheumatology in 1987.[3] Patients have to undertake blood samples and imaging examinations to confirm the diagnosis of RA by specialist doctors, and were further reviewed and approved by the National Health Insurance Administration to receive the catastrophic illness/injury card. The process of receiving catastrophic illness/injury cards would be taken very seriously and carefully. When patients have the catastrophic illness/injury card, the patients are exempted from all copayment for medical treatments. The catastrophic illness/injury certificate will be registered in the National Health Insurance Database, and the diagnosis of RA can be strictly ensured and identified.

Patients with juvenile RA (*ICD-9-CM* 714.3) as well as other catastrophic illness/injury categories (a total of 30 categories including systemic autoimmune diseases that required life-long therapy, malignant tumor, regular dialysis for renal failure, and congenital coagulation factor abnormalities, among others) were excluded from the study subjects. The category of systemic autoimmune diseases includes systemic lupus erythematous, systemic sclerosis, polymyositis, dermatopolymyositis, vasculitis, pemphigus, sicca syndrome, Crohn disease, and ulcerative colitis.

Lower limb fracture surgeries are performed to repair hip fractures, fractures of other parts of the femur, patella fractures, tibial/fibula fractures, ankle fractures, and foot fractures (ie, tarsal/metatarsal/phalanges fractures). The included patients had primary or secondary diagnoses of lower limb fractures (*ICD-9-CM* codes ranging from 820.XX to 826.XX) requiring operations that entailed internal fixation (open or closed reduction with internal fixation; *ICD-9-CM* procedure codes 79.15–18, 79.35–38, 81.52). During these procedures, general or regional anesthesia was necessary.

To prevent interferences caused by >1 operation (performed at different times), patients who received lower limb fracture surgeries between 2003 and 2005 or >1 fracture surgery between 2005 and 2012 were excluded. Additionally, patients who underwent more severe or complex operations were excluded, including >1 surgical site of fracture, >1 fracture site in the lower limbs, fracture of skull, spine, ribs, pelvis, or upper limbs including clavicle and multiple fractures (ie, a primary or secondary diagnosis of *ICD-9-CM* codes 803, 805, 807, 808, 810–819, 828), open fractures (ie, a primary or secondary diagnosis of ICD-9-CM codes 82X.1/3/5/7/9); or pathologic fractures (ie, a primary or secondary diagnosis of ICD-9- CM code 733.1) (Fig. 1).

The study sample was divided into 2 groups according to whether patients had RA before receiving lower limb fracture surgery. To lower selection bias from characteristic differences, the study sample was paired off using propensity score matching (PSM). The pairs subsequently underwent a logistic regression analysis, where having or not having RA was set as the dependent variable, and patients' demographic information (ie, sex and age), health status (ie, comorbidity severity score), financial status, living environment, medical institution type, surgical site, type of anesthesia received, and year of surgery were set as the independent variables to calculate the patients' propensity scores (ie, a probability of 0–1). The propensity scores were used to divide the data into different pairs at a 1:4 ratio, with which the patients were grouped into the RA group and the control group for subsequent analyses.

2.2. Data sources

The data were retrieved from the nationwide cohort study datasets of fractures from the National Health Research Institutes. Since the introduction of the National Health Insurance in Taiwan in March 1995, 99.68% of Taiwan's population has been enrolled in it.[24] In this study, fracture data files were obtained from the annual National Health Insurance Research Database (NHIRD) prepared by the National Health

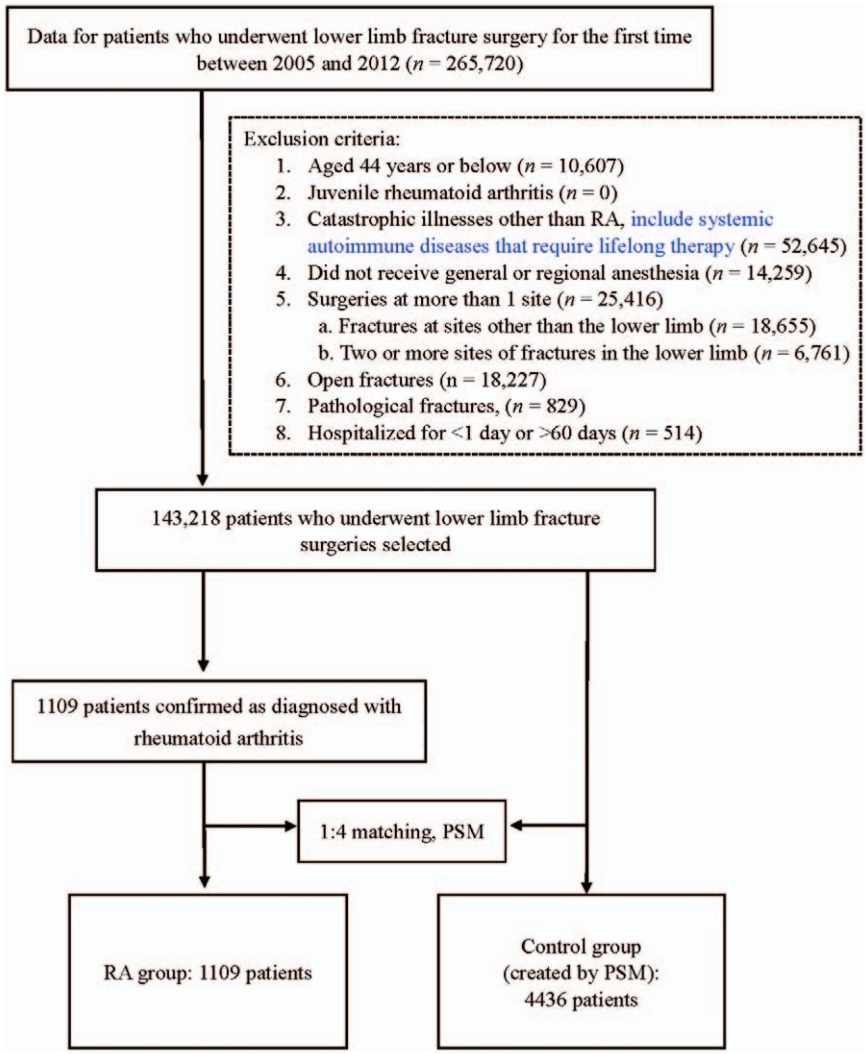

Figure 1. Flow chart for selecting the study sample.

Research Institutes, which includes cohort study data concerning patients older than 45 years who had skull, spine, rib, pelvis, upper limb, or lower limb fractures. The data files contain the patients' basic hospitalization/outpatient visit information, primary and secondary diagnoses, surgical sites, prescriptions, and medical expenses. All of the patients' personal data was masked to protect their privacy, rights, and interests. This study was approved by the institutional review board of researcher's affiliated organization (IRB number: CMU-REC-101–012).

2.3. Descriptions of variables

In this study, the independent variable was having or not having RA, whereas the dependent variables were the number of days hospitalized and whether complications were observed within 30 days after surgery.[20,21] The last variable, "complications observed within 30 days after surgery," recorded whether the patient sustained any of the following: acute myocardial infarction (*ICD-9-CM* 410), stroke (*ICD-9-CM* 430–438), acute renal failure (*ICD-9-CM* 584), deep wound infection (*ICD-9-CM* 958.3), septicemia (*ICD-9-CM* 038 and 998.5), pulmonary embolism (*ICD-9-CM* 415.1), pneumonia (*ICD-9-CM* 480–486), or postoperative bleeding (*ICD-9-CM* 998.0, 998.1 and 998.2).

The control variables included patients' demographic characteristics (ie, sex and age), financial status, living environment, health status (ie, comorbidity severity score), medical institution type, surgical site, type of anesthesia received, and year of surgery. Financial status was assessed using the patients' monthly salary, whereas their living environment was evaluated using an urbanization rating for their cities of residence (Level 1 indicating most urbanized and Level 7 least urbanized).[25] Patients' comorbidity severity score was obtained using Deyo revised Charlson comorbidity index, for which scores were derived by converting the *ICD-9-CM* codes of patients' primary and secondary diagnoses into weighted scores and tallying them.[26] The Charlson Comorbidity Index (CCI) of RA was removed from the RA group. Preoperative steroid use was defined as whether the patients used steroids within 30 days before surgeries.[27] "Primary medical institutions" denotes the medical institutions where the study sample received their surgeries; the institutions were classified into medical centers, regional hospitals, and district hospitals, and further classified into public hospitals and nonpublic hospitals. Surgical sites specified the type of lower limb fracture, namely hip fractures, fractures of other parts of the femur, patella fractures, tibial/fibula fractures, ankle fractures, and foot fractures. The types of anesthesia received were general anesthesia and regional anesthesia (ie, spinal anesthesia and epidural anesthesia). The year of surgery refers to the year in which the surgery was performed (in the range 2005–2012).

2.4. Statistical analysis

Descriptive statistics were used to illustrate the demographic characteristic distribution of the RA and control groups. Subsequently, a χ^2 test was conducted to compare the 2 groups before and after PSM. The use of PSM entails that the 2 groups were not completely independent from each other; thus, conditional logistic regression analysis was performed to determine whether RA and other related factors caused any major complications within 30 days after surgeries. Different types of major postoperative complications that were affected by the presence or absence of RA were then analyzed.

For "number of days in hospital," a *t* test or analysis of variance was performed to compare the differences between the 2 groups, followed by a multiple regression analysis to examine the effect of RA or other related factors. Because this variable was not normally distributed, it was converted using natural logarithm. SAS 9.4 (SAS institute, Cary, NC) was used for the statistical analyses and 2-tailed tests, all of which exhibited a confidence level of $\alpha = 0.05$.

3. Results

Table 1 displays the pre- and post-matching basic characteristics of patients who underwent lower limb fracture surgeries between 2005 and 2012 and were older than 45 years at that time. The initial number of patients was 143,218, in which patients with RA accounted for 1109 (0.77%) and female patients 84935 (59.3%). Before propensity score matching, patients with RA differed significantly from the general population in sex, age, CCI, hospital level, surgical site, and the type of anesthesia received ($P < .05$). The analysis results indicated that patients with RA were more likely to be women, aging 65 to 74 years, had poor health status (ie, a CCI of ≥1), chose medical centers over other institution types, had fractures over hip area, and received general anesthesia. To reduce the differences in basic characteristics between patients with RA and the control group, PSM was performed using 10 related variables including sex and age. Data for 1109 patients with RA and 4436 other patients were collected, creating a final study sample of 5,545 people. By performing PSM, differences in basic characteristics between patients with RA and the control group became nonsignificant (Table 1) ($P > .05$).

Table 2 shows the results of bivariate analysis and conditional logistic regression analysis on whether patients with RA and the control group experienced any complications within 30 days after receiving lower limb fracture surgeries. The number of patients who experienced complications totaled 309 (5.57%), accounting for 5.05% of patients with RA and 5.70% of the control group. The bivariate analysis results showed significant differences in demographic variables such as sex, age, CCI, and surgical site for the risks of postoperative complications ($P < .05$). After controlling other related variables and conducting a conditional logistic regression analysis, the risk of major complications has no significant differences between patients with RA and the control group (odds ratio [OR] = 0.87; 95% confidence interval [CI]: 0.61–1.24; $P > .05$). The CCI was significantly correlated with postoperative complications ($P < .05$). With the reference score set to 0, a score of 1 carried a risk of complications 2.01 times higher (95% CI: 1.05–3.85), and for a score ≥3, it was 2.78 times higher (95% CI: 1.52–5.07).

Table 3 reveals the risks of the various complications in patients with RA and the control group within 30 days after receiving lower limb fracture surgeries. Compared with the control group, patients with RA were less likely to experience postoperative myocardial infarctions and strokes but more likely to experience postoperative deep wound infections, septicemia, and pneumonia. Before data adjustments, the risk of postoperative stroke in patients with RA was significantly lower (0.48 times) than that of the control group ($P < .05$). However, after controlling other related variables and performing a logistic regression analysis, the results indicated that no significant differences existed between patients with RA and the control group in the risks of various complications (OR = 0.87, 95% CI: 0.61–1.24) or death (OR = 1.12, 95% CI: 0.42–3.03) within 30 days after receiving lower limb fracture surgeries.

Table 4 demonstrates the analysis results concerning the length of hospitalization for patients with RA and the control group after receiving lower limb fracture surgeries. The overall average was 8.12 days. Patients with RA and the control group were hospitalized for 8.12 and 8.13 days on average, respectively. Patients who did not experience any complications during hospitalization were hospitalized for an average of 7.81 days, compared with 13.4 days for those who experienced major complications. Bivariate analysis results indicate that variables such as age, living environment, CCI, preoperative steroid use, hospital level and classification, surgical site, type of anesthesia received, and year of surgery have a significant impact on the length of hospitalization ($P < .05$). After controlling related variables and performing a multiple regression analysis, this study revealed that patients with RA were hospitalized 0.97 times as long as the control group; this difference is nonsignificant ($P > .05$). The length of hospitalization was significantly lower for all patients at urbanization level 3 or when the year of surgery was 2007 or later ($P < .05$). By contrast, the hospitalization was significantly longer for patients aged 65 to 100 years, had a CCI of ≥1, used steroids before surgery, chose a regional hospital, sustained fractures other than foot fracture, or received general anesthesia ($P < .05$).

For the year of surgery, the length of hospitalization for both groups exhibited a downward trend and could be divided into 2 intervals (2007–2009 and 2010–2012); the average hospitalization length in 2007 to 2009 was 8.21 to 8.31 days and in 2010 to 2012 was 7.23 to 7.58 days. This length increased with age; compared with the reference group (45–64 years old), the 85- to 100-year-old group was hospitalized 2.27 days longer. The length of hospitalization also increased with the CCI; patients with CCI scores ≥3 had hospital stays 2.13 days longer than those with a CCI score of 0. Furthermore, patients who used steroids before surgery were hospitalized 0.67 days longer than those who did not.

Regarding the surgical site, patients with foot fractures were set as the reference group. Fracture site over hip, femur, and tibial/fibula was considered as long bone fracture, whereas fractures over ankle and patella were non-long-bone fractures. The results indicate that patients with long and non-long-bone fractures were hospitalized 4 and 2 more days than the reference group,

Table 1

Patients with or without RA who underwent lower limb fracture surgery (before and after PSM).

	Before PSM							After PSM (4:1)						
	Total		Other patients		Patients with RA			Total		Control group (other patients)		Patients with RA		
Variables	Number	%	Number	%	Number	%	P*	Number	%	Number	%	Number	%	P*
Total	143,218	100.00	142,109	99.23	1109	0.77		5545	100.00	4436	80.00	1109	20.00	
Sex							<.001							1.000
Female	84,935	59.30	84,014	98.92	921	1.08		4606	83.07	3685	80.00	921	20.00	
Male	58,283	40.70	58,095	99.68	188	0.32		939	16.93	751	79.98	188	20.02	
Age, y							<.001							.254
45–64	52,169	36.43	51,820	99.33	349	0.67		1634	29.47	1285	78.64	349	21.36	
65–74	26,348	18.40	25,991	98.65	357	1.35		1856	33.47	1499	80.77	357	19.23	
75–84	40,020	27.94	39,691	99.18	329	0.82		1635	29.49	1306	79.88	329	20.12	
85–100	24,681	17.23	24,607	99.70	74	0.30		420	7.57	346	82.38	74	17.62	
Financial status (insured salary)							.600							.582
≤NT$22,800	68,087	47.54	67,537	99.19	550	0.81		2834	51.11	2284	80.59	550	19.41	
NT$22,801– NT$28,800	36,841	25.72	36,576	99.28	265	0.72		1316	23.73	1051	79.86	265	20.14	
NT$28,801– NT$36,300	16,574	11.57	16,451	99.26	123	0.74		622	11.22	499	80.23	123	19.77	
NT$36,301–$45,800	10,130	7.07	10,049	99.20	81	0.80		370	6.67	289	78.11	81	21.89	
≥NT$45,801	11,586	8.09	11,496	99.22	90	0.78		403	7.27	313	77.67	90	22.33	
Urbanization level of city of residence							.760							.993
Level 1	34,879	24.35	34,605	99.21	274	0.79		1362	24.56	1088	79.88	274	20.12	
Level 2	41,614	29.06	41,288	99.22	326	0.78		1615	29.13	1289	79.81	326	20.19	
Level 3	22,040	15.39	21,884	99.29	156	0.71		793	14.30	637	80.33	156	19.67	
Level 4	24,634	17.20	24,447	99.24	187	0.76		932	16.81	745	79.94	187	20.06	
Level 5	4632	3.23	4599	99.29	33	0.71		175	3.16	142	81.14	33	18.86	
Level 6	8122	5.67	8054	99.16	68	0.84		360	6.49	292	81.11	68	18.89	
Level 7	7297	5.10	7232	99.11	65	0.89		308	5.55	243	78.90	65	21.10	
CCI							<.001							.740
0	71,819	50.15	71,351	99.35	468	0.65		2369	42.72	1901	80.24	468	19.76	
1	35,911	25.07	35,567	99.04	344	0.96		1748	31.52	1404	80.32	344	19.68	
2	19,620	13.70	19,460	99.18	160	0.82		744	13.42	584	78.49	160	21.51	
≥3	15,868	11.08	15,731	99.14	137	0.86		684	12.34	547	79.97	137	20.03	
Hospital level							<.001							.529
Medical center	39,887	27.85	39,454	98.91	433	1.09		2087	37.64	1654	79.25	433	20.75	
Regional hospital	65,630	45.83	65,160	99.28	470	0.72		2422	43.68	1952	80.59	470	19.41	
District hospital	37,701	26.32	37,495	99.45	206	0.55		1036	18.68	830	80.12	206	19.88	
Hospital classification							.525							.509
Public hospital	41,063	28.67	40,735	99.20	328	0.80		1593	28.73	1265	79.41	328	20.59	
Nonpublic hospital	102,155	71.33	101,374	99.24	781	0.76		3952	71.27	3171	80.24	781	19.76	
Surgical site							<.001							.654
Hip fracture	80,729	56.37	79,983	99.08	746	0.92		3847	69.38	3101	80.61	746	19.39	
Fracture of other parts of femur	9040	6.31	8891	98.35	149	1.65		710	12.80	561	79.01	149	20.99	
Patella fracture	10,384	7.25	10,340	99.58	44	0.42		200	3.61	156	78.00	44	22.00	
Tibial/fibula fracture	16,955	11.84	16,876	99.53	79	0.47		359	6.47	280	77.99	79	22.01	
Ankle fracture	15,893	11.10	15,840	99.67	53	0.33		258	4.65	205	79.46	53	20.54	
Foot fracture	10,217	7.13	10,179	99.63	38	0.37		171	3.08	133	77.78	38	22.22	
Type of anesthesia received							<.001							1.000
Regional anesthesia	101,149	70.63	100,441	99.30	708	0.70		3538	63.81	2830	79.99	708	20.01	
General anesthesia	42,069	29.37	41,668	99.05	401	0.95		2007	36.19	1606	80.02	401	19.98	
Year of surgery							.284							.917
2005	17,717	12.37	17,596	99.32	121	0.68		606	10.93	485	80.03	121	19.97	
2006	17,142	11.97	17,020	99.29	122	0.71		594	10.71	472	79.46	122	20.54	
2007	17,206	12.01	17,080	99.27	126	0.73		604	10.89	478	79.14	126	20.86	
2008	17,599	12.29	17,448	99.14	151	0.86		742	13.38	591	79.65	151	20.35	
2009	17,574	12.27	17,436	99.21	138	0.79		695	12.53	557	80.14	138	19.86	
2010	17,115	11.95	16,971	99.16	144	0.84		774	13.96	630	81.40	144	18.60	
2011	19,499	13.61	19,359	99.28	140	0.72		741	13.36	601	81.11	140	18.89	
2012	19,366	13.52	19,199	99.14	167	0.86		789	14.23	622	78.83	167	21.17	

CCI = Charlson Comorbidity Index, PSM = propensity score matching, RA = rheumatoid arthritis.

* χ^2 test.

respectively. Patients who received general anesthesia were hospitalized 0.46 days longer than those who received regional anesthesia.

4. Discussion

In this retrospective cohort study, NHIRD records for patients aged >45 years who underwent surgery for lower limb fractures between 2005 and 2012 were selected (n=143,218). After applying exclusion criteria and performing PSM, a sample of 5545 patients was obtained. The results showed that no significant differences existed between patients with RA and the control group in postoperative complications, deaths, or the number of days in hospital.

Compared with the control group, patients with RA contained a higher proportion of women (83.1%) and were more likely to

Table 2

Bivariate analysis and conditional logistic regression analysis of whether patients with or without RA experienced any complications within 30 days after receiving lower limb fracture surgeries.

Variables	Total		Postoperative complications not observed		Postoperative complications observed			Adjusted†			
	Number	%	Number	%	Number	%	P*	OR	95%	CI	P
Total number of people	5545	100.00	5236	94.43	309	5.57					
RA							.438				
Control group (Ref.)	4436	80.00	4183	94.30	253	5.70					
RA group	1109	20.00	1053	94.95	56	5.05		0.87	0.61	1.24	.434
Sex							<.001				
Female (Ref.)	4606	83.07	4374	94.96	232	5.04					
Male	939	16.93	862	91.80	77	8.20		1.25	0.25	6.19	.781
Age, y							<.001				
45–64 (Ref.)	1634	29.47	1583	96.88	51	3.12					
65–74	1856	33.47	1766	95.15	90	4.85		1.40	0.85	2.29	.185
75–84	1635	29.49	1514	92.60	121	7.40		1.35	0.50	3.65	.550
85–100	420	7.57	373	88.81	47	11.19		2.80	0.26	30.27	.396
Financial status (insured salary)							.684				
≤NT$22,800 (Ref.)	2834	51.11	2665	94.04	169	5.96					
NT$22,801– NT$28,800	1316	23.73	1250	94.98	66	5.02		0.80	0.47	1.35	.399
NT$28,801– NT$36,300	622	11.22	590	94.86	32	5.14		0.70	0.35	1.41	.314
NT$36,301– NT$45,800	370	6.67	352	95.14	18	4.86		0.95	0.45	1.98	.882
≥NT$45,801	403	7.27	379	94.04	24	5.96		1.07	0.55	2.06	.852
Urbanization level of the city of residence							.153				
Level 1 (Ref.)	1362	24.56	1293	94.93	69	5.07					
Level 2	1615	29.13	1533	94.92	82	5.08		1.01	0.58	1.76	.981
Level 3	793	14.30	756	95.33	37	4.67		0.75	0.39	1.44	.381
Level 4	932	16.81	869	93.24	63	6.76		1.29	0.70	2.36	.418
Level 5	175	3.16	166	94.86	9	5.14		2.17	0.56	8.42	.262
Level 6	360	6.49	335	93.06	25	6.94		1.15	0.50	2.62	.747
Level 7	308	5.55	284	92.21	24	7.79		1.01	0.42	2.44	.987
CCI							<.001				
0 (Ref.)	2369	42.72	2288	96.58	81	3.42					
1	1748	31.52	1644	94.05	104	5.95		2.01	1.05	3.85	.036
2	744	13.42	696	93.55	48	6.45		1.90	1.02	3.56	.045
≥3	684	12.34	608	88.89	76	11.11		2.78	1.52	5.07	.001
Preoperative steroid use							.452				
No (Ref.)	4669	84.20	4414	94.54	255	5.46					
Yes	876	15.80	822	93.84	54	6.16		1.04	0.70	1.54	.857
Hospital level							.931				
Medical center (Ref.)	2087	37.64	1973	94.54	114	5.46					
Regional hospital	2422	43.68	2287	94.43	135	5.57		0.74	0.37	1.49	.402
District hospital	1036	18.68	976	94.21	60	5.79		1.02	0.38	2.73	.970
Hospital classification							.347				
Public hospital (Ref.)	1593	28.73	1512	94.92	81	5.08					
Nonpublic hospital	3952	71.27	3724	94.23	228	5.77		0.99	0.66	1.49	.963
Surgical site							<.001				
Foot fracture (Ref.)	171	3.08	169	98.83	2	1.17					
Hip fracture	3847	69.38	3590	93.32	257	6.68		2.10	0.28	16.02	.473
Fracture of other parts of femur	710	12.80	686	96.62	24	3.38		1.40	0.14	14.15	.777
Patella fracture	200	3.61	193	96.50	7	3.50		1.66	0.27	10.08	.580
Tibial/fibula fracture	359	6.47	349	97.21	10	2.79		1.07	0.20	5.71	.940
Ankle fracture	258	4.65	249	96.51	9	3.49		1.68	0.27	10.61	.581
Type of anesthesia received							.967				
Regional anesthesia (Ref.)	3538	63.81	3340	94.40	198	5.60					
General anesthesia	2007	36.19	1896	94.47	111	5.53		1.10	0.74	1.64	.629
Year of surgery							.407				
2005 (Ref.)	606	10.93	568	93.73	38	6.27					
2006	594	10.71	558	93.94	36	6.06		1.16	0.54	2.52	.705
2007	604	10.89	577	95.53	27	4.47		0.70	0.31	1.54	.369
2008	742	13.38	706	95.15	36	4.85		0.75	0.33	1.72	.500
2009	695	12.53	664	95.54	31	4.46		0.83	0.35	1.98	.678
2010	774	13.96	728	94.06	46	5.94		1.55	0.68	3.53	.298
2011	741	13.36	690	93.12	51	6.88		1.18	0.56	2.49	.672
2012	789	14.23	745	94.42	44	5.58		1.12	0.48	2.62	.793

CCI = Charlson Comorbidity Index, CI = confidence interval, OR = odds ratio, RA = rheumatoid arthritis.

* χ^2 test.

† Conditional logistic regression analysis; variables including sex, age, incomes, urbanization, CCI score, hospital level, hospital type, surgery type, anesthesia type and year of surgery were controlled in the models.

Table 3

Risks of the various complications in patients with RA and the control group within 30 days after receiving lower limb fracture surgeries.

			Unadjusted		Adjusted*			
Outcomes (post-op complications)	Control group (%)	Patients with RA (%)	OR	P	OR	95%	CI	P
Myocardial infarction	0.32	0.09	0.29	.226	0.46	0.05	4.13	.489
Stroke	2.03	0.99	0.48	.023	0.87	0.39	1.91	.720
Acute renal failure	0.47	0.27	0.57	.365	0.40	0.11	1.50	.172
Deep wound infection	0.07	0.09	1.33	.803	0.22	0.01	4.47	.327
Septicemia	1.38	2.07	1.52	.090	1.21	0.62	2.38	.573
Pulmonary embolism	0.20	0.18	0.89	.880	1.81	0.16	20.08	.628
Pneumonia	2.05	2.07	1.01	.962	0.79	0.43	1.48	.465
Postoperative bleeding	0.20	0.09	0.44	.442	0.86	0.07	10.16	.904
Any of the above complications	5.70	5.05	0.88	.394	0.87	0.61	1.24	.434
Death within 30 days after receiving surgery	0.70	0.63	0.90	.807	1.12	0.42	3.03	.819

CI = confidence interval, OR = odds ratio, RA = rheumatoid arthritis.
* Indicates the presence of complication(s) or death; data obtained using conditional logistic regression analysis.

require lower limb fracture surgeries at a younger age. These findings are supported by Lin et al,[23] who found that female patients with RA accounted for a substantially high percentage (81.6%) of patients who sustained hip fractures, and that on average, they sustained fractures 5.5 years earlier than the control group did. Female patients with RA generally have lower bone density, which may be caused by disease-led immobilization and glucocorticoid-induced osteoporosis resulting from frequent steroid use.[28] Additionally, partial female patients in our study may reach menopause, and it could lead to higher risk of fracture owing to osteoporosis. When a patient has the disease of RA and also is postmenopausal, the prevalence of osteoporosis could be higher and reaching 50%.[29] However, the characteristics of osteoporosis in postmenopausal female were different from those of RA patients. It showed marked loss of bone over axial bone for postmenopausal female, whereas that of RA patients was over hip and radius area.[28] In addition, RA patients typically experienced more comorbidities and restricted mobility when performing daily activities.[18,22] And relatively higher percentage of these patients choose hospitals or medical centers with more hospital beds and undergo general anesthesia.[21] These findings are consistent with those of the present study.

The results of present study showed no significant differences between patients with RA and the control group in postoperative complications. In the long term, although patients with RA are exposed to higher risks of death from cardiovascular diseases[4] and infections because of frequent immunosuppressive drug use, whether they face higher risks of major complications shortly after surgery remains to be determined. One study indicated that patients with RA were exposed to higher risks of cardiovascular diseases after undergoing join surgeries[19]; however, other studies have indicated the opposite or no differences between patients with RA and those without.[17,18,20,21] Most studies have suggested that because of their disease, patients with RA received more attention from healthcare professionals; sometimes, even physicians from the immune rheumatology department partake in caring for the patients before and after surgeries, producing care results similar to those produced by multidisciplinary team care. Selective bias may occur because surgeons tend to adopt a less invasive approach of surgery when treating patients with RA. Patients with RA generally receive their treatments at higher-level hospitals to ensure superior medical care. Advances in medical treatments, consensus on how long patients should discontinue their medications before surgeries, and new drugs such as biological products all may achieve more favorable outcome for RA patients.[17,18,21]

Before data adjustments, patients with RA were less likely to sustain postoperative strokes than the general population. Postoperative strokes usually occur on the second day after surgery; of these strokes, ischemic strokes accounted for a higher percentage and hemorrhagic strokes accounted for <5%.[30] Possible causes of postoperative strokes include surgery-induced systemic inflammations, platelet activations, and vascular endothelial dysfunctions, which result in a hypercoagulable state after surgery.[30] The reason for lower stroke risk in patients with RA in our study was unknown, possibly because of the long-term usage of several anti-inflammatory drugs. However, it still needs more supporting data to be presented.

This study found a correlation between the risk of major postoperative complications and the CCI; higher CCIs were associated with significantly higher risks. The CCIs were first utilized to identify the relationships between comorbidity and 1-year mortality in hospitalized patients. A correlation has been confirmed between comorbidity severity and 1-year mortality rate, various postoperative complications, and the number of days patients are hospitalized.[31,32] For lower limb surgery, a study on hip fracture surgeries indicated that surgery time delays exhibited no effect on postoperative complications, but CCI score did.[33] Another study compared 6 risk estimation models used to assess complications after hip fracture surgeries, finding that comorbidity severity could be used to predict the onset of major postoperative complications.[34]

In this study, patients with RA were hospitalized for an average of 8.12 days, which was not significantly different from that of the control group. However, for patients who sustained major postoperative complications, the average hospitalization length increased to 13.40 days, which was 5.59 days longer than those who did not encounter complications. Other factors that increased the hospitalization length included being older, higher CCIs, steroid use before surgery, selecting regional hospitals for treatment, undergoing long-bone (femur or tibial/fibular) fracture surgery, and receiving general anesthesia. Preoperative steroid use may be related to the relatively more preoperative comorbidities found in the patients. Studies on lower extremity fracture surgeries revealed that the CCI was positively correlated with the number of days that patients were hospitalized,[35,36]

Table 4

Descriptive statistics concerning the number of hospitalization days and related factors for patients receiving lower limb fracture surgeries.

Variables	Number of days in hospital				Adjusted*		
	Number of people	mean	SD	*P*†	Coefficient‡	SE	*P*†
Total	5545	8.12	5.10				
RA				.981			
Control group (Ref.)	4436	8.13	4.99				
RA group	1109	8.12	5.52		0.97	1.02	.056
Sex				.172			
Female (Ref.)	4606	8.08	4.94			.	
Male	939	8.33	5.82		1.02	1.02	.187
Age, y				<.001			
45–64 (Ref.)	1634	7.20	4.46			.	
65–74	1856	8.04	5.08		1.04	1.02	.014
75–84	1635	8.80	5.32		1.15	1.02	<.001
85–100	420	9.47	5.91		1.25	1.03	<.001
Financial status (insured salary)				.111			
≤NT$22,800 (Ref.)	2834	8.17	5.00			.	
NT$22,801– NT$28,800	1316	8.27	5.63		1.01	1.02	.563
NT$28,801– NT$36,300	622	7.64	4.40		1.00	1.02	.860
NT$36,301– NT$45,800	370	7.97	4.72		1.03	1.03	.328
≥NT$45,801	403	8.23	5.25		1.01	1.03	.576
Urbanization level of the city of residence				<.001			
Level 1 (Ref.)	1362	8.13	5.23			.	
Level 2	1615	7.94	4.76		1.00	1.02	.854
Level 3	793	7.63	4.23		0.95	1.02	.013
Level 4	932	8.69	6.34		1.03	1.02	.118
Level 5	175	8.14	4.45		1.02	1.04	.661
Level 6	360	8.23	4.74		0.99	1.03	.767
Level 7	308	8.50	4.71		1.04	1.03	.237
CCI				<.001			
0 (Ref.)	2369	7.60	4.49			.	
1	1748	8.12	4.87		1.04	1.02	.014
2	744	8.34	5.07		1.05	1.02	.026
≥3	684	9.73	7.00		1.15	1.02	<.001
Preoperative steroid use				<.001			
No (Ref.)	4669	8.02	4.84			.	
Yes	876	8.69	6.29		1.07	1.02	<.001
Hospital level				.038			
Medical center (Ref.)	2087	8.16	5.45				
Regional hospital	2422	8.25	5.16		1.05	1.01	<.001
District hospital	1036	7.77	4.12		1.01	1.02	.469
Hospital classification				.183			
Public hospital (Ref.)	1593	8.27	5.15			.	
Nonpublic hospital	3952	8.07	5.08		1.00	1.01	.798
Surgical site				<.001			
Foot fracture (Ref.)	171	4.30	3.49				
Hip fracture	3847	8.40	5.15		1.94	1.04	<.001
Fracture of other parts of femur	710	8.74	5.08		2.15	1.04	<.001
Patella fracture	200	6.24	5.58		1.48	1.05	<.001
Tibial/fibula fracture	359	8.13	4.24		2.06	1.04	<.001
Ankle fracture	258	6.31	4.30		1.51	1.05	<.001
Type of anesthesia received				.001			
Regional anesthesia (Ref.)	3538	7.96	4.82			.	
General anesthesia	2007	8.42	5.54		1.03	1.01	.014
Year of surgery				<.001			
2005 (Ref.)	606	9.15	6.11			.	
2006	594	9.26	5.73		1.01	1.03	.628
2007	604	8.21	4.51		0.93	1.03	.006
2008	742	8.31	5.07		0.93	1.03	.005
2009	695	8.21	5.43		0.91	1.03	<.001
2010	774	7.55	4.89		0.84	1.03	<.001
2011	741	7.23	4.07		0.82	1.03	<.001
2012	789	7.58	4.66		0.84	1.03	<.001
Complications within 30 days after receiving surgery				<.001	—	—	
No (Ref.)	5236	7.81	4.26		—	—	—
Yes	309	13.40	11.39		—	—	—

CCI = Charlson Comorbidity Index, RA = rheumatoid arthritis, SD = standard deviation, SE = standard error.

* A multivariate regression analysis was performed; number of days in hospital was converted using natural logarithm (ln).

† *t* test or analysis of variance.

‡ The coefficient represents the value after e^x conversion.

and that on average, patients with a CCI of 2 spent 1.92 more days in hospitals than those with a CCI of 0. [35] For type of anesthesia received, the effects of general and regional anesthesia on overall postoperative complications and the length of stay were inconclusive. Our result was similar to the report of Neuman et al, in which postoperative complications did not differ between the 2 groups, but the length of stay was 0.6 days longer in the general anesthesia group; this may indicate that regional anesthesia exhibits more favorable postoperative rehabilitation and pain control effects.[37]

A decreasing trend was found regarding the year of surgery. Since 2007, the hospitalization length has decreased significantly. The downward trend could be divided into 2 intervals (2007–2009 and 2010–2012); the average hospitalization length was 8.21 to 8.31 days in 2007 to 2009 and 7.23 to 7.58 days in 2010 to 2012, respectively (not shown). Taiwan has implemented the diagnosis-related groups (DRGs) policy since 2010, and the implementation of this policy had been set to start in 2007, originally. However, the DRG policy was opposed by the healthcare practitioners and was suspended. Until 2010, Taiwan began the first stage of DRG payments, which included 164 diseases or conditions such as fractures, childbirths, and coronary artery bypass surgeries. A study indicated that by implementing DRG in coronary artery bypass surgeries or percutaneous coronary angioplasty, the overall number of days that patients were hospitalized decreased by an average of 10% and medical care intensity and frequency decreased. However, no significant differences were observed in medical care indicators such as the number of emergency department visits, the percentage of readmission, and deaths after hospital discharge.[38] These results were similar to our study, in which a decreasing trend in the hospitalization length was observed, but no significant differences in the percentage of major overall complications was determined. It seems that DRGs implementation can effectively lower the health care utilization without affecting the outcomes or complications. Many hospitals would change their policy inside the hospitals or use more efficient clinical pathways to adapt to the DRGs implementation. Overall, it reveals that the announcement and implementation of DRGs indeed changes medical care behaviors.

This study has the following limitations. First, only the *ICD-9* primary and secondary diagnoses were used, and no related biochemical blood sampling data were provided. Second, the study only considered cases with one surgical site; therefore, the results may not apply to surgeries with >1 surgical site. Third, factors such as disease-related conditions (whether patients had extra-articular RA manifestation, disease duration, and detailed medication or biological products usage) and lifestyle (whether patients smoked or consumed alcohol) were not considered. Finally, despite we have excluded patients with multiple fractures and pathologic fractures, we did not evaluate or control the other causes of fracture, such as previous stroke subtypes, vitiligo, bone-grafting infection, chronic nonsteroidal anti-inflammatory drugs usage, schizophrenia, compliance with bisphosphonate usage.[39–44] Our patient's characteristics may differ from other countries. For example, repeated osteoporotic fracture risk was higher in elderly Taiwanese, and high Chinese herbal medicine was used in patients with Parkinson disease.[45,46] Whether the different causes of fracture or patient's characteristics would affect the complications after fracture surgery remained unknown. However, we have controlled the patient's comorbidity severity score (CCI score), preoperative steroid usage, and baseline patients' demographic data to improve the validity of our study.

5. Conclusion

When patients with RA underwent lower limb fracture surgeries, higher percentage of them were women, happened at younger age, had poor health status, selected mostly medical centers for treatment, were prone to hip fractures and preferred receiving general anesthesia for their surgery. Subsequent regression analyses indicated that comorbidity severity affected whether patients sustained major postoperative complications. The number of days that patients were hospitalized decreased depending on the year of surgery, perhaps because of the announcement and implementation of DRG policies.

No significant differences were observed between patients with RA and the control group in major complications shortly after the surgeries, the number of days that patients were hospitalized after undergoing lower limb fracture surgeries, or deaths. This finding is crucial because as population aging becomes increasingly severe, the percentage of patients with RA sustaining fractures and required to undergo surgeries will increase. The results of this study may provide some information to surgeons and healthcare professionals when providing treatments before and after such surgeries.

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