Establishment of Qualified Integrated Care System after Total Knee Arthroplasty as a Role of Regional Rheumatoid and Degenerative Arthritis Center

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Abstract

Elderly population and advanced knee osteoarthritis are rapidly increasing in Korea and the socioeconomic burden of total knee arthroplasty (TKA). This study aimed to analyze the demographic, clinical and socioeconomic characteristics in patients who underwent TKA and to differentiate the factors affecting participation in inpatient- intensive rehabilitation program after TKA in oo regional rheumatoid and degenerative arthritis center established by government. This retrospective cohort study included 845 patients (735 females; 72.0 ± 5.8 years) diagnosed with primary osteoarthritis (OA) of the knee and who performed an elective unilateral primary TKA between January 2013 and June 2016. Demographic, clinical and socioeconomic characteristics including age, body mass index, obesity, length of stay, OA severity, underlying disease, education level, occupation, location of residence) were reviewed and Patients were allocated to TKA only group (home discharge) and to TKA + rehab group (participation in post-TKA rehabilitation). The variables were analyzed and compared before and after establishment of center and according to participation in intensive rehabilitation. They showed predominance of female and elderly and high prevalence of comorbidities and obesity. Also, the only factor differentiating participation in intensive rehabilitation was the location of residence. Therefore, the regional rheumatoid & degenerative arthritis center was appropriate to meet the high need for participating in intensive rehabilitation after TKA and for the qualified integrated post-TKA care system. The policy support should ensure early rehabilitation and qualified integrated care system and prepare for the increased burden of revision and the future longitudinal study should be conducted for long-term effect of the integrated post-TKA rehabilitation program on functional outcome and patients' survivorship free from revision.

Introduction

Elderly population is rapidly growing in South Korea and osteoarthritis (OA) is one of the most common degenerative bone and joint disease in elderly and knee is most commonly involved. Patients with knee OA complain of severe pain that causes gait disturbance and frailty.¹ Total knee arthroplasty (TKA) is an effective method for treating advanced knee arthritis² and primary and revision TKAs have tremendously increased from 2001 to 2010 by 407% and 267%, respectively.³ The socioeconomic burden of TKA is also increased in Korea and TKA is the 6th most common surgical procedure in Korea, and, in terms of overall cost, it is the forth highest and the days of hospitalization per surgery case is longest in 2018.⁴ Despite the National Health Insurance (NHI) system and Health Insurance Review and Assessment Service (HIRA) provide universal coverage in Korea, most patients should pay out-of-pocket (OOP) for health care that accounted for approximately 32 – 26% of annual total household health care spending⁵ and it may cause an inequality of access to medical services among socioeconomic groups and geographic and overconcentration of medical resources and health care utilization of patients in the metropolitan areas. Thus, the Ministry of Health and Welfare established and has been operating five regional rheumatoid and degenerative arthritis centers to promote decentralization of medical resource utilization, as well as to improve the quality of medical services via multidisciplinary care approach among orthopaedic

surgeons, rheumatologists and physiatrists. Three centers (Chungnam, Chonnam and Jeju) opened in 2013, one (Dae gu Catholic) in 2014 and finally one (Gyeongsang) in 2016.

OO regional rheumatoid and degenerative arthritis center opened on 25th, September in 2013 and applied critical pathway incorporating intensive rehabilitation therapy after TKA. As the coverage of NHI and HIRA focused on TKA only in Korea, the studies are very limited for post-TKA rehabilitation therapy

Therefore, the objectives of this study were to analyze the demographic, clinical and socioeconomic characteristics in patients who underwent TKA and to differentiate the factors affecting participation in inpatient- intensive rehabilitation program after TKA as prerequisite to establish qualified integrated care system after TKA as a Role of Regional Rheumatoid and Degenerative Arthritis Center

Materials And Methods

Participants

This retrospective cohort study included 845 patients (735 females and 70 males; average age, 72.0 ± 5.8 years) diagnosed with primary OA of the knee and who performed an elective unilateral primary TKA at the Department of Orthopedic Surgery in oo National University Hospital between January 2013 and June 2016.

The inclusion criteria consisted of the ability to walk independently with or without an ambulatory aid. The exclusion criteria were as follow: 1) previous neurological or orthopedic disease disturbing ambulation, such as orthopedic injury or previous joint surgery in lower extremities and unstable cardio-respiratory disease 2) bilateral TKA 3) revision TKA 4) TKA surgery at another hospital 5) combined severe medical complications.

Demographic and clinical data

Demographic characteristics included age, gender, weight, height and body mass index (BMI) were calculated as the weight (kg) divided by the height (m^2). The individuals aged 65 years or older and 75 years or older were classified as elderly and very elderly respectively and the obesity was defined by the modified Asia-Pacific criteria ($BMI \geq 25.0 \text{ kg}/m^2$).⁶ The presence of comorbidities such as hypertension (HTN) and diabetes mellitus (DM) was reviewed.

Patients were asked to mark the level of knee pain using a Visual analogue scale (VAS) preoperatively. The scale consisted of a 10 cm-long horizontal line ranging from 0 (worst, totally unsatisfied) to 10 (best, completely satisfied) points with facial expressions above the line.⁷ The severity of knee osteoarthritis was classified in anterior posterior (AP) radiographs using Kellgren-Lawrence (K-L) grade which was described as follows:⁸ 1) grade 1, doubtful narrowing of the joint space with possible osteophyte formation 2) grade 2, possible narrowing of the joint space with definite osteophyte formation. 3) grade 3, definite narrowing of joint space, moderate osteophyte formation, some sclerosis, and possible deformity

of bony ends 4) grade 4, large osteophyte formation, severe narrowing of the joint space with marked sclerosis, and definite deformity of bone ends. Comorbidities including hypertension and diabetes that was diagnosed by a physician were also collected. Patients discharged to home were allocated to TKA only group and patients discharged or transferred to department of rehabilitation for intensive rehabilitation program were assigned to TKA + rehab group.

Intensive rehabilitation program consisted of progressive resistance exercises (incline leg press, leg press, leg extension, leg curl, hip abduction, and hip adduction) using air resistance machines (HUR Co., Kokkola, Finland) and progressive gait training using a lower-body positive pressure treadmill (Alter-G Inc., Fremont, CA, USA), and aerobic exercise using a stationary ergometer.⁹ The parameters were also compared before and after the establishment of the center (BEC vs AEC).

Socioeconomic characteristics

The locations of residence were classified using address according to current (Jeju, and Seogwipo) and previous administrative districts (Jeju City, Seogwipo City, North Jeju county, South Jeju county), respectively. We also investigated whether they lived in urban area such as Jeju City and Seogwipo City and whether they lived in Jeju City that had the oo regional rheumatoid and degenerative arthritis center.

The date of admission, date of discharge and length of hospital stay (LOS) and in-hospital complications, medical insurance status (National health insurance; NHI, Medicaid) and education level were also retrieved.

Education level was categorized depending on the highest diploma that the patient acquired as below: no formal education, primary education (elementary diploma), secondary education (middle or high school or 2-year college diploma) and finally higher education (university or graduate school diploma).¹⁰

The classification of occupation

We also evaluated the job that the patient had for the longest period according to the Korean

Standard Classification of Occupations.¹¹ These occupations were categorized as three groups depending on their degree of physical work: non-manual workers (managers, professionals

and related workers, and clerks), service or sales workers, and manual workers (skilled agricultural, forestry, fishery, craft, and related trades workers, equipment, machine operating and assembling workers, and elementary workers).¹²

Statistical analysis

For statistical analysis, standard statistical software (SPSS version 20.0 for Windows, SPSS, Inc., Chicago, IL, USA) was used. All descriptive statistics were used, and the data was as mean $\pm$ standard deviation (SD). Nominal and categorical variables were analyzed by χ^2 tests. Baseline demographic and clinical characteristics were compared between TKA only and TKA + rehabilitation groups and also

between BEC and AEC groups (before and after the establishment of center) using independent sample t-tests for continuous data. A p-value < 0.05 was considered significant.

Ethics approval and waived consent

Given the retrospective study design, the informed consent from patients in this research was waived by the institutional review board of Jeju National University Hospital and the study protocol was reviewed and approved by the Institutional Review Board of Jeju National University hospital (ethical approval number: JNUH-IRB 2019-10-004). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments.

Results

166 patients were enrolled between January and September in 2013 and 679 patients from October, 2013 to June, 2016. Annual numbers of primary TKA were 227, 225 and 258 in 2013, 2014 and 2015 respectively and total numbers of primary TKA were 135 during 6 months in 2016. There were significant annual differences in the proportions of manual worker and male gender and prevalence of obesity, especially in 2015 (Table 1).

Table 1
Comparison of General, Clinical and Socioeconomic characteristics between 2013 and 2015

Variables	2013	2014	2015	p value
Numbers	227	225	258	
Age	71.7 ± 5.9	71.3 ± 6.2	72.7 ± 5.4	0.24
≤59	5 (2.2)	6 (2.7)	4 (1.6)	0.094
60–69	76 (33.5)	79 (35.1)	61 (23.3)	
70–79	126 (55.5)	125 (55.6)	170 (65.9)	
≥80	20 (8.8)	15 (6.7)	23 (8.9)	
Elderly (≥ 65)	204 (89.9)	200 (88.9)	239 (92.6)	0.339
Very elderly (≥ 80)	20 (8.8)	15 (6.7)	23 (8.9)	0.609
Sex (female: male)	206 (90.7): 21 (9.3)	201 (89.3): 24 (10.7)	212 (82.2): 46 (17.8)	0.009**
Op site (Right)	93 (41.0)	92 (40.9)	119 (46.1)	
BMI	26.8 ± 3.2	26.1 ± 3.5	26.3 ± 3.6	0.076
Weight	62.2 ± 9.3	61.7 ± 9.4	62.7 ± 10.5	0.546
Obesity	165 (72.7)	130 (57.8)	154 (59.7)	0.002**
LOS	16.7 ± 2.2	16.8 ± 3.5	16.3 ± 1.5	0.08
VAS	5.7 ± 0.7	5.8 ± 0.4	5.8 ± 0.5	0.052
K-L grade				
3/4	75 (33.0)/152 (67.0)	59 (26.2)/166 (73.8)	63 (24.4)/195 (75.6)	0.088
Education				
No formal education	31 (13.7)	28 (12.4)	12 (12.4)	0.001**
Occupation				
Manual work	16 (7.0)	34 (15.1)	133 (51.6)	< 0.001**
Urban residence				

Values are mean ± standard deviation or numbers (%)

Op, operation; BMI, body mass index; LOS, length of stay; VAS, visual analogue scale; K-L, Kellgrene-Lawrence; NHI, national health insurance

Variables	2013	2014	2015	p value
Urban: Country	137 (60.4): 90 (39.6)	132 (58.7): 93 (41.3)	152 (58.9): 106 (41.1)	0.924
Location of residence (Current administrative districts)				
Jeju: Seogwipo	149 (65.6): 78 (34.4)	148 (65.8): 77 (34.2)	174 (67.4): 84 (32.6)	0.895
Formal administrative districts				
Jeju city	111 (48.9)	104 (46.2)	122 (47.3)	0.848
Medical insurance				
NHI: Medicaid	209 (92.1): 18 (7.9)	215 (95.6): 10 (4.4)	249 (96.5): 9 (3.5)	0.074
Values are mean $\pm$ standard deviation or numbers (%)				
Op, operation; BMI, body mass index; LOS, length of stay; VAS, visual analogue scale; K-L, Kellgrene-Lawrence; NHI, national health insurance				

Only 3% of the patients were transferred or admitted to Department of rehabilitation in BEC group, whereas 59.2% agreed with intensive post-TKA rehabilitation in AEC group. The BEC group showed higher mean BMI and prevalence of obesity but fewer proportion of patients with K-L grade 4 ($27.1 \pm 3.2 \text{ kg/m}^2$, 65.7%) than the AEC group ($26.2 \pm 3.5 \text{ kg/m}^2$, 75.7%) (Table 2). The distributions of education level were significantly different between BEC and AEC groups and the proportion of the patients who did not have any formal education was higher and the proportion of the manual workers were fewer in BEC group (14.5%, 7.2%) than in AEC group (7.1% 33.3%), but there were no significant differences between BEC and AEC groups in the residence-related factors (Table 3). After EC, 59.2 % participated in the intensive post-TKA rehabilitation. BEC group had significantly higher proportions of the patients who lived in Jeju of both former and current administrative districts than AEC group (Tables 4 and 5).

Table 2
General and clinical characteristics in all patients and comparison between before and after the establishment of regional rheumatoid and degenerative arthritis center

Variables	All	BEC	AEC	p value
Numbers	845	166 (19.6)	679 (80.4)	
Age	72.0 ± 5.8	71.1 ± 5.8	72.2 ± 5.7	0.03*
≤59	16 (1.9)	4 (2.4)	12 (1.8)	0.108
60–69	258 (30.5)	63 (38.0)	195 (28.7)	
70–79	501 (69.3)	88 (53.0)	413 (60.8)	
≥80	70 (8.3)	11 (6.6)	59 (8.7)	
Elderly (≥ 65)	769 (91.0)	147 (88.6)	622 (91.6)	0.227
Very elderly (≥ 80)	70 (8.3)	59 (8.7)	11 (6.6)	0.436
Sex (female)	735 (87.0)	151 (91.0)	584 (86.0)	0.095
Op site (Right)	361 (42.7)	73 (44.0)	288 (42.4)	0.727
BMI	26.4 ± 3.4	27.1 ± 3.2	26.2 ± 3.5	0.003**
Weight	62.1 ± 9.7	62.8 ± 8.9	62.0 ± 9.9	0.323
Obesity	528 (62.5)	124 (74.7)	404 (59.5)	< 0.001**
LOS	16.6 ± 2.4	16.7 ± 2.3	16.5 ± 2.5	0.371
Rehabilitation	407 (48.2)	5 (3.0)	402 (59.2)	< 0.001**
VAS	5.8 ± 0.5	5.7 ± 0.8	5.8 ± 0.4	0.094
K-L grade				
3/4	222 (26.3)/623 (73.7)	57 (34.3)/109 (65.7)	165 (24.3)/514 (75.7)	0.01*
Underlying diseases				
HTN	564 (66.7)	121(72.9)	443 (65.2)	0.066
DM	174 (20.6)	34 (20.5)	140 (20.6)	1
Values are mean ± standard deviation or numbers (%), *p < 0.05, **p < 0.01				
EC, the establishment of regional rheumatoid and degenerative arthritis center; BEC, before EC; AEC, after EC; Op, operation; BMI, body mass index; LOS, length of stay; VAS, visual analogue scale; K-L, Kellgrene-Lawrence; HTN, hypertension; DM, diabetes mellitus				

Table 3
Socioeconomic Characteristics in all patients and comparison between before and after the establishment of regional rheumatoid and degenerative arthritis center

Variables	All	BEC	AEC	p value
Education				0.001**
No formal education	72 (8.5)	24 (14.5)	48 (7.1)	0.005**
Primary education	260 (30.8)	62 (37.3)	198 (29.2)	
Secondary education	490 (58.0)	76 (45.8)	414 (61.0)	
Higher education	23 (2.7)	4 (2.4)	19 (2.8)	
Occupation				
Manual work	238 (28.2)	12 (7.2)	226 (33.3)	< 0.001**
Urban residence				
Urban: Country	509 (60.2): 336 (39.8)	103(62.0): 63 (38.0)	406 (59.8): 273 (40.2)	0.658
Location of residence (Current administrative districts)				
Jeju: Seoqwipo	557 (65.9): 288 (34.1)	105 (63.3): 61 (36.7)	251 (57.3): 187 (42.7)	0.465
Formal administrative districts				
Jeju city	402 (47.6)	80 (48.2)	322 (47.4)	0.863
Medical insurance				
NHI: Medicaid	799 (94.6): 46 (5.4)	152 (91.6): 14 (8.4)	647 (95.3): 32 (4.7)	0.083
Values are mean ± standard deviation or numbers (%), *p < 0.05, **p < 0.01				
EC, the establishment of regional rheumatoid and degenerative arthritis center; BEC, before EC; AEC, after EC; NHI, national health insurance				

Table 4

General and Clinical characteristics in patients after the establishment of regional rheumatoid and degenerative arthritis center and comparisons between the home discharge and rehabilitation groups

Variables	TKA + Rehab	TKA only	p value
Numbers	402 (59.2)	277 (40.8)	
Age	72.1 ± 5.9	72.2 ± 5.6	0.33
≤59	7 (1.7)	4 (2.5)	0.436
60–69	121 (30.1)	62 (38.5)	
70–79	235 (58.5)	85 (52.8)	
≥80	39 (9.7)	10 (6.2)	
Elderly (≥ 65)	366 (91.0)	256 (92.4)	0.575
Very elderly (≥ 80)	39 (9.7)	20 (7.2)	0.271
Sex	343 (85.3)	241 (87.0)	0.575
Op site (Right)	173 (43.0)	115 (41.5)	0.752
BMI	26.0 ± 3.4	26.4 ± 3.5	0.204
Weight	61.9 ± 9.7	62.4 ± 9.8	0.441
Obesity	227 (56.5)	177 (63.9)	0.601
LOS	16.5 ± 2.7	16.5 ± 2.1	0.908
VAS	5.8 ± 0.4	5.8 ± 0.5	0.294
K-L grade			
3/4	110 (27.0)/297 (73.0)	112 (25.6)/326 (74.4)	0.64
Underlying diseases			
HTN	266 (66.2)	177 (63.9)	0.566
DM	82 (20.4)	28 (20.9)	1
Values are mean ± standard deviation or numbers (%), *p < 0.05, **p < 0.01			
Op, operation; BMI, body mass index; LOS, length of stay; VAS, visual analogue scale; K-L, Kellgren-Lawrence; HTN, hypertension; DM, diabetes mellitus			

Table 5
Socioeconomic Characteristics in patients after the establishment of regional
rheumatoid and degenerative arthritis center and comparisons between the home
discharge and rehabilitation groups

Variables	TKA + Rehab	TKA only	p value
Education level			0.034*
No formal education	26 (6.5)	22 (7.9)	1
Primary education	133 (33.1)	65 (23.5)	
Secondary education	230 (57.2)	184 (66.4)	
Higher education	13 (3.2)	6 (2.2)	
Occupation			
Manual work	140 (34.8)	86 (31.0)	0.321
Urban residence (Jeju city and Seogwipo city)			
Urban: Country	242 (60.2): 160 (39.8)	164 (59.2): 113 (40.8)	1
Location of residence (Current administrative districts)			
Jeju: Seogwipo	303 (75.4): 99 (24.6)	149 (53.8): 128 (46.2)	< 0.001**
Formal administrative districts			
Jeju city	213 (53.0)	109 (39.4)	0.001**
Medical insurance			
NHI: Medicaid	385 (94.6): 22 (5.4)	414 (94.5): 24 (5.5)	1
Values are mean $\pm$ standard deviation or numbers (%), *p < 0.05, **p < 0.01			
NHI, national health insurance			

Discussion

This study confirmed the demographic, clinical and socioeconomic characteristics in patients who underwent TKA and after the establishment of center, the need for the inpatient- intensive rehabilitation program after TKA increased from 3–59.2% in OO regional rheumatoid and degenerative arthritis center. These trends of increasing male gender and older patients (age $\geq$ 70) were similar with study using HIRA Korean database which reported procedure rate as 155.5 (2013), 155.8 (2014) and 173.3 (2015) per 100,000 person.³ It also reported that the proportion of patients more than 70 years old increased markedly from 48.1% (2010) to 61% (2018)³. In this study, the mean age of all participants (72.0 $\pm$ 5.8) was in the early 70s which was recommended as an optimal age for TKA that could achieve the maximal

passive range of motion (PROM) without increasing the revision or mortality rates¹³. 60.2% lived in urban area and 65.9% lived in Jeju city of current administrative districts and 47.6% lived in Jeju city of formal administrative districts. Manual workers accounted for 28.2% of all participants, approximately 20% of Jeju and 33% of Seogwipo.

Interestingly, the mean duration of LOS was 16.7 ± 2.2 days and it might be prolonged, compared with the western countries such as United States (3.6 ± 1.7 days)¹⁴ and Denmark (3 ± 3 days in elective case, 5 ± 6 days in non-elective cases).¹⁵ But notably, our data was shorter than the average LOS of HIRA (21.2 days in 2018)

However, the national medical insurance systems worldwide that guarantee universal coverage to treatment usually allowed longer LOS if there were reasonable reasons such as bilateral arthroplasty, intractable pain, gait instability, and other perioperative complications¹⁶ and especially, the national medical insurance systems of Japan supported coverage during much longer LOS (35.1 ± 1.7 days)¹⁷ and also provided comprehensive rehabilitation therapy in long-term care wards for community-based integrated care systems.¹⁸

Recent large-scaled study based on HIRA registries reported the gradual increase of TKA growth in Korea from 2010 to 2018, contrary to the dramatic increase of growth rate before 2010³ which might be caused by improved accessibility to the medical system as well as increase of elderly population.¹⁹ They concluded that the demographic characteristics of Korea are quite different and the revision rates were very low, although primary TKA use was popular and similar to the most developed Western countries. And they also insisted that further studies on various demographic variables would be necessary and Korean policymakers and healthcare providers should prepare for the revision burdens and the comorbidities care for elderly and very elderly based on comprehensive analysis of various patients' demographical and clinical information.¹⁹

Our data also indicated that total numbers of TKA had been steady or had increased gradually after EC by 114% between 2014 and 2015 and they showed the higher proportions of female and elderly and the substantial prevalence of comorbidity such as HTN and DM. Interestingly, male, elderly and manual workers had increased and it might be affected by the westernization of life style and manual work that prevent rapid osteoarthritis progression. The regional rheumatoid and degenerative arthritis center is an emerging experimental model for managing arthritis, comorbidities and perioperative side effects which integrated medical and surgical treatment with rehabilitation in Korea.

This result was the first study with a detailed review of various characteristics on the patients undergoing TKA in the regional rheumatoid and degenerative arthritis center and it was comparable to represent general population of Korea TKA use. Notably, the needs for post-TKA rehabilitation were very high, but the main factor differentiating participation in rehabilitation was the location of residence despite of slightly different distributions of education level between two groups. Thus, to establish regional

rheumatoid and degenerative arthritis center in their residence is appropriate for the integrated care of arthritis in elderly.

On the other hand, the mean duration of LOS in this study was relatively constant regardless of EC and rehabilitation. It might be explained by that the hospital prefer readmission after discharge rather than transfer to inpatient rehabilitation ward, because Korean HIRA cut or reduced the medicare payment if the LOS was more than 15 days. Considering the average LOS (21days) and no long-term care wards for TKA in Korea, the policy support would be necessary to ensure sufficient days of hospitalization after TKA and to build incentive programs for early rehabilitation and qualified integrated care system.

This study had some limitations. First, it was a retrospective cohort study and the available demographical and clinical data were very limited, especially in TKA only group. Second, it was a cross-sectional analysis without follow-up. Thus, we could not analyze the effect of pre-operative status or monitor functional changes between admission and discharge. Third, we excluded revision procedures and could compare primary TKA with revision. Third, the practice patterns might differ according to the facilities and region and it might affect LOS and participation in rehabilitation differ according to the facilities. Finally, this study has a limitation to explore the causative and longitudinal relationship of rehabilitation therapy with functional outcome.

In conclusion, this study revealed that the demographical and clinical characteristics of patients who underwent primary TKA in OO regional rheumatoid and degenerative arthritis center showed the predominance of female and elderly and high prevalence of comorbidities and obesity. Also, the only factor differentiating participation in intensive rehabilitation was the location of residence. Thus, the regional rheumatoid & degenerative arthritis center was appropriate to meet the high need for participating in intensive rehabilitation after TKA and for the qualified integrated post-TKA care system. Furthermore, the policy support should ensure adequate hospital stay after TKA and build incentive programs for early rehabilitation and qualified integrated care system and prepare for the increased burden of revision and the future longitudinal study should be conducted for long-term effect of the integrated post-TKA rehabilitation program on functional outcome and patients' survivorship free from revision.

Declarations

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Author contributions

E.Y.H. and S.H.I. had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis ant contributed to the study design, data analysis and interpretation, and the writing of the manuscript

S.R.K. contributed substantially to patients' enrollment, data analysis and interpretation, and the writing of the manuscript.

Competing interests

The authors declare no competing interests.

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