



Evaluation of Appropriateness of the Reimbursement Criteria of Korean Health Insurance Review and Assessment Service for Total Knee Arthroplasty

Dong-Hong Kim, MD, Soo-Young Jeong, MD, Jae-Hyuk Yang, MD*, Choong Hyeok Choi, MD

Department of Orthopedic Surgery, Hanyang University Seoul Hospital, Seoul,
**Department of Orthopedic Surgery, Hanyang University Guri Hospital, Guri, Korea*

Background: We evaluated and compared South Korea's total knee arthroplasty (TKA) reimbursement criteria set by Health Insurance Review and Assessment Service (HIRA) with other TKA appropriateness criteria to find additional criterion to improve its appropriateness by reviewing TKA inappropriate cases.

Methods: Two TKA appropriateness criteria and HIRA's reimbursement criteria for TKA were adapted for use on patients undergoing TKA in one institute from December 2017 to April 2020. Preoperative data including 9 validated questionnaires on knee joint-specific parameters, age, and radiography were used. We categorized cases into appropriate, inconclusive, inappropriate groups and analyzed each group.

Results: Data on 448 cases that underwent TKA were examined. According to the HIRA's reimbursement criteria, 434 cases (96.9%) were appropriate and 14 cases (3.1%) were inappropriate; superior to other TKA appropriateness criteria. The inappropriate group had Knee Injury and Osteoarthritis Outcome score (KOOS) pain, KOOS symptoms, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) total score, and Korean Knee score total score with worse symptoms compared to the appropriate group classified by HIRA's reimbursement criteria.

Conclusions: In terms of insurance coverage, HIRA's reimbursement criteria was more effective in providing healthcare access to patients who had the most pressing need for TKA compared to other TKA appropriateness criteria. However, we found the lower age limit and patient-reported outcome measures of other criteria as useful tools in improving appropriateness of the current reimbursement criteria.

Keywords: Health insurance reimbursement, Appropriateness review, Total knee arthroplasty

Total knee arthroplasty (TKA) is a successful surgical intervention for pain relief and improvement of function and quality of life. The indications for the procedure should

be ideally selected to determine the patients who are most likely to benefit from it, while limiting it for those who are not, thereby providing healthcare access to those with the most urgent need. The determination of the extent to which TKA is appropriate or inappropriate requires the use of valid appropriateness criteria and they should diminish variability observed in the indications of the procedure, especially in the indications of inappropriate interventions. There are numerous criteria used to select optimal patients for TKA,¹⁻⁶⁾ with the most common being improvement in pain and function for appropriate patients⁷⁾, but it is often

Received November 19, 2021; Revised March 2, 2022;

Accepted March 14, 2022

Correspondence to: Choong Hyeok Choi, MD

Department of Orthopedic Surgery, Hanyang University College of Medicine,
222-1 Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea

Tel: +82-2-2290-8483, Fax: +82-2-2299-3774

E-mail: chhchoi@hanyang.ac.kr

difficult to find objectivity. Riddle et al.¹⁾ and Hawker et al.⁵⁾ used objective clinical scores as the key criteria in their system. The Hawker et al.'s criteria⁵⁾ developed in Canada use the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) total score of 39 and above (range, 0–100) as the cutoff point for surgery, and Riddle et al.'s criteria¹⁾ developed in the United States is a modified version of a validated appropriateness algorithm developed by Escobar et al.,²⁾ which weigh patient symptoms and radiologic

knee osteoarthritis grading as the two strongest predictors of appropriateness judgements.

South Korea's health insurance system uses the TKA reimbursement criteria set by the Korean Health Insurance Review and Assessment Service (HIRA), which is an overarching guideline but may not be clinically related with patient symptoms (Table 1). The existing criteria are an insurance-based policy that has a broad spectrum of indications to provide healthcare access to as many patients

Table 1. Comparison of TKA Appropriateness Criteria

HIRA's reimbursement criteria*	Riddle et al. ^{1),†}	Hawker et al. ^{5),‡}
60–64 Years old with KL grade 4 [§]	Age	WOMAC summary score of 39 or greater (0–100)
	< 55 yr	
	55 to 65 yr	
	> 65 yr	
65 Years old and above with KL grade 3 or higher [§]	Radiology	No absolute contraindications to surgery
	Slight (KL grade 3 or lower)	
	Moderate (KL grade 4)	
	Severe (KL grade 4)	
Severe knee flexion contracture with cartilage degeneration	Localization	Clinical evidence of arthritis
	Unicompartmental tibiofemoral	
	Unicompartmental plus patellofemoral	
	Tricompartmental	
Polyarthritis (including RA) with severe functional deterioration	Knee Joint Mobility and Stability	Radiologic evidence of arthritis
	Preserved mobility and stable joint	
	Limited mobility and/or unstable joint	
Avascular necrosis with subchondral depression	Symptomatology (WOMAC pain and function scores)	
	Slight: 0 to 11	
	Moderate: 12 to 22	
	Intense: 23 to 33	
	Severe: 34 and higher	
Multiple ligament injury with severe knee instability after previous surgery failure		
Depending on the patient status and need for TKA, other factors can be accepted as appropriate		

TKA: total knee arthroplasty, HIRA: Health Insurance Review and Assessment Service, KL: Kellgren-Lawrence, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, RA: rheumatoid arthritis.

*Any of the below must be met to satisfy the criteria. [†]Each criteria is surveyed and categorized in the algorithm to classify appropriate, inconclusive, and inappropriate groups. [‡]All criteria must be met to satisfy the criteria. [§]Pain and functional loss persist with 3 months of conservative treatment.

^{||}Major mental illness, stroke with paralysis, and another major neurologic disorder.

who require TKA as possible. This study aimed to evaluate and improve the reimbursement criteria by comparing with other TKA appropriateness criteria and review the inappropriate cases that should have access to TKA in order to resolve the potential unmet need for TKA.⁸⁾ Thus, TKAs performed in a single institute were judged on its appropriateness according to HIRA, Riddle et al.'s criteria,¹⁾ and Hawker et al.'s criteria⁵⁾ and those categorized as inappropriate were analyzed to explore ways to expand the insurance coverage for patients in need of surgery and improve overall completeness of the reimbursement criteria as an insurance policy. We hypothesized that HIRA's reimbursement criteria would have the highest prevalence rate of appropriate cases because they are detailed and insurance-based, but have a limitation of less flexibility compared to other criteria. Our study aimed to find potential criteria that could be added for improvement of the current reimbursement criteria.

METHODS

The study was approved by the Institutional Review Board of Hanyang University Medical Center (No. HYUH 2020-12-004) and patient informed consent was waived.

We used prospective, longitudinally maintained database obtained from our institution to retrospectively identify patients who underwent primary TKA according to one surgeon's (CHC) consistent decision from December 2017 to April 2020. Inclusion criteria were patients who had (1) primary TKA, (2) completed preoperative patient-reported outcome surveys, and (3) had knee radiographic imaging preoperatively. Revision TKA cases were excluded from the study. The patients were classified as an appropriate or an inappropriate group by the reimbursement criteria set by HIRA and compared with the classification results based on Riddle et al.'s¹⁾ and Hawker et al.'s⁵⁾ criteria. We did detailed analysis on the inappropriate group patients and re-evaluated them using other appropriateness criteria suggested by Riddle et al.¹⁾ and Hawker et al.⁵⁾ to reveal issues of the reimbursement criteria for primary TKA used in South Korea.

A range of objective validated questionnaires are available for assessing joint-specific parameters and general health outcome before TKA, including Knee Society Knee score (KSKS), Knee Society Function score, Knee Injury and Osteoarthritis Outcome score (KOOS), and WOMAC, all of which were surveyed and calculated one day before surgery by an attending orthopedic surgeon (CHC). In addition, Korean Knee score (KKS), High-Flexion Knee Scoring system, Feller patella score, Kujala score, and Samsung Medical Cen-

ter patellofemoral (SMC PF) scoring system were surveyed to consider the floor-sitting culture where high-knee flexion position is common⁹⁾ and to assess PF-specific symptoms.¹⁰⁾ Excluding the WOMAC score, SMC PF score, and pain and function scores, higher scores indicate less severe symptoms. Preoperative radiographs were rated by an orthopedic surgeon (CHC) according to the Kellgren-Lawrence (KL) classification system of osteoarthritis.¹¹⁾

These scores were evaluated in each appropriate, inappropriate, and inconclusive group classified by the three appropriateness criteria compared in this study, and the inappropriate group classified by HIRA's reimbursement criteria was re-evaluated. For statistical analysis, the analysis of variance was used to compare scores between groups and the threshold for statistical significance was set at $p < 0.05$.

RESULTS

HIRA's Reimbursement Criteria

In total, 448 cases of primary TKA were examined and on the basis of the reimbursement criteria set by HIRA, 434 cases (96.9%) were classified as appropriate and 14 cases (3.1%) inappropriate. All 14 inappropriate cases were not classified as inappropriate by Riddle et al.'s criteria¹⁾ but 2 cases were inappropriate based on Hawker et al.'s TKA appropriateness criteria.⁵⁾ Regarding the 14 cases judged inappropriate by HIRA, all of the cases had bi-compartmental or tri-compartmental osteoarthritis involvement, of which 8 cases were between 60 and 64 years old with KL grade 3 on radiographic examination and 6 cases were below 60 years old with KL grade 4. Compared to the group classified as appropriate based on the reimbursement criteria, the inappropriate group had worse KOOS pain ($p = 0.15$) and symptoms ($p = 0.08$) scores, WOMAC score ($p = 0.20$), and KKS total score ($p = 0.36$) (Table 2).

Riddle et al.'s TKA Appropriateness Criteria

When using Riddle et al.'s TKA appropriateness criteria,¹⁾ a total of 333 cases out of 448 cases (74.3%) were classified as appropriate, 20 cases (4.5%) as inappropriate, and 95 cases (21.2%) as inconclusive. Of the 20 inappropriate cases, 5 cases were those with secondary osteoarthritis, rheumatoid arthritis, or avascular necrosis, 14 cases were above 65 years old with KL grade 3 or 4, and 1 case was between 60 and 64 years old with KL grade 4, all of which met the requirements of HIRA's reimbursement criteria.

Hawker et al.'s TKA Appropriateness Criteria

When using Hawker et al.'s TKA appropriateness criteria,⁵⁾ a total of 310 out of 448 cases (69.2%) were classified as

Table 2. Clinical Scores of Appropriate and Inappropriate Groups Classified by HIRA's Reimbursement Criteria

Clinical score	HIRA's reimbursement criteria			p-value
	Total (n = 448)	Appropriate (n = 434, 96.9%)	Inappropriate (n = 14, 3.1%)	
KSKS	29.6 ± 13.6 (0–93)	29.6 ± 13.7 (0–93)	29.9 ± 7.7 (17–45)	0.94
KSFS	46.8 ± 17.6 (0–90)	46.7 ± 17.7 (0–90)	50 ± 15.6 (25–80)	0.49
KOOS pain	46.6 ± 18.4 (0–88.8)	46.8 ± 18.44 (0–88.8)	39.6 ± 15.6 (8.3–61.6)	0.15
KOOS symptom	53.9 ± 19.3 (7–100)	54.2 ± 19.4 (7–100)	45.1 ± 9.8 (21.4–60.7)	0.08
KOOS ADL	50.8 ± 18 (8.8–91.1)	50.9 ± 18 (8.8–91.1)	45.6 ± 15.9 (20.6–75)	0.28
KOOS sport/recreation	17.8 ± 21.4 (0–100)	17.9 ± 21.1 (0–100)	17.5 ± 28.4 (0–90)	0.95
KOOS QOL	36. ± 23.4 (0–95)	36.1 ± 23.3 (0–95)	41.6 ± 25.8 (6.3–83)	0.39
WOMAC total	49.2 ± 17.5 (9.4–100)	49 ± 17.6 (9.4–100)	55.2 ± 15.4 (28.1–81.3)	0.20
KKS pain & symptoms	23.8 ± 8.6 (0–43)	23.8 ± 8.7 (0–43)	23.8 ± 6.1 (10–32)	0.17
KKS function	34.5 ± 12.2 (6–62)	34.6 ± 12.3 (6–62)	34.6 ± 10.9 (14–51)	0.28
KKS floor life	7.2 ± 5 (0–24)	7.2 ± 5 (0–24)	7.2 ± 4.4 (2–20)	0.86
KKS socio-emotional function	7.6 ± 4.1 (0–22)	7.6 ± 4 (0–22)	7.6 ± 5.2 (1–17)	0.93
KKS total	44.5 ± 15.7 (9.1–85.4)	44.6 ± 15.8 (9.1–85.4)	40.7 ± 11.3 (17.7–59.2)	0.36
HFKS pain	4.7 ± 1.6 (2–9)	4.71 ± 1.6 (2–9)	4.9 ± 1.8 (3–8)	0.62
HFKS function	16.5 ± 5.2 (7–32)	16.4 ± 5.2 (7–32)	16.7 ± 4 (11–26)	0.85
Feller patella	15.8 ± 5.4 (5–34)	15.9 ± 5.5 (5–34)	13.9 ± 4.2 (7–22)	0.17
Kujala	41.2 ± 12.2 (17–88)	41.3 ± 12.4 (17–88)	36.7 ± 6.3 (27–48)	0.17
SMC PF pain	58.3 ± 14.3 (13–80)	58.3 ± 14.4 (13–80)	59.7 ± 11.8 (38–76)	0.71
SMC PF function	54.6 ± 14.1 (12.5–85)	54.6 ± 14.2 (12.5–85)	53.6 ± 9.2 (35–65)	0.79

Values are presented as mean ± standard deviation (range). WOMAC total score ranges from 0–100, with higher scores equating to worse symptoms. Excluding the WOMAC score and SMC PF pain and function score, higher scores equate to less symptoms.

HIRA: Health Insurance Review and Assessment Service, KSKS: Knee Society Knee score, KSFS: Knee Society Function score, KOOS: Knee Injury and Osteoarthritis Outcome score, ADL: activities of daily living, QOL: quality of life, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, KKS: Korean Knee score, HFKS: High Flexion Knee Scoring system, SMC: Samsung Medical Center, PF: patellofemoral.

appropriate and 138 cases (30.8%) were classified as inappropriate. Of the 138 inappropriate cases, 134 cases (97.8%) were classified as appropriate and 3 cases (2.2%) were classified as inappropriate according to HIRA's reimbursement criteria. Of the 3 inappropriate cases, 2 cases were between 60 and 64 years old with KL grade 3 and 1 case was below 60 years old with KL grade 4. Regarding the total 138 inappropriate cases, the average age was 70 ± 6.9 years (range, 36–85 years), all had KL grade 3 and above, 53 cases (38.4%) had tri-compartmental involvement, and 11 cases (8.0%) were those with secondary osteoarthritis, rheumatoid arthritis, or avascular necrosis.

Demographics of Appropriate Cases by All Three Criteria

Of the total 448 cases that underwent TKA, 213 cases (47.5%) met the HIRA's reimbursement criteria and Riddle et al.'s¹⁾ and Hawker et al.'s⁵⁾ TKA appropriateness criteria. They were on average 68.8 ± 8.7 years of age (range, 34–85 years) with KL grade 4 (100%), and 132 cases (62%) had tri-compartmental involvement, representing radiologically severe osteoarthritis. The average sum of WOMAC pain and function score was 51.7 ± 11.1 (range, 34–76), classified as severe symptoms by Riddle et al.,¹⁾ and the total average was 58.6 ± 12.5 (range, 39.6–86.5), which was well above the cutoff point of 39, set by Hawker et al.⁵⁾ A majority of knee joints showed limited mobility or unstable joint (n = 126, 59.2%) as defined by Riddle et al.,¹⁾ and 46 cases (71.9%)

out of the total 64 cases that underwent TKA surgery had secondary osteoarthritis, rheumatoid arthritis, or avascular necrosis. These cases showed both clinical and radiologic evidence of severe arthritis and could be defined as the most appropriate group for TKA for the purpose of this study.

Comparison of All Three Criteria Appropriate Cases and HIRA Inappropriate Cases

The 213 cases that met all three appropriateness criteria were compared with the inappropriate group of HIRA's reimbursement criteria. Compared to the HIRA inappropriate cases, all three criteria appropriate cases had worse symptoms except for KOOS symptoms ($p = 0.68$) (Table 3). Individual comparisons of the 14 HIRA inappropriate cases were made for those between 60 and 64 years of age (8 cases) and below 60 years of age (6 cases). There were 3 cases

between 60 and 64 years of age (37.5%), in which 11 of the 19 clinical scores indicated worse symptoms than those in the all three criteria appropriate cases (Table 4). In addition, in 3 cases below 60 years of age (50%), 14 of the 19 clinical scores indicated worse symptoms (Table 4).

DISCUSSION

The most important finding of this study is that we confirmed the inappropriate cases classified by HIRA's reimbursement criteria had radiologically severe arthritis (all with more than bi-compartmental osteoarthritis involvement and KL grade 3 or 4) and several clinical scores with worse symptoms compared to the appropriate cases. So, objective clinical scores could better represent patient symptoms and lowering the age limit could enable those judged inappropriate by the

Table 3. Clinical Scores of the Most Suitable Candidates for TKA and Inappropriate Group Classified by HIRA's Reimbursement Criteria

Clinical score	All Appropriate (n = 213, 47.5%)	HIRA Inappropriate, (n = 14, 3.1%)	p-value
KSKS	26.1 ± 10.6 (0–66)	29.9 ± 7.7 (17–45)	0.19
KSFS	40.3 ± 15.7 (0–80)	50 ± 15.6 (25–80)	0.03
KOOS pain	38.6 ± 15.2 (2–75)	39.6 ± 15.6 (8.3–61.6)	0.83
KOOS symptom	47.2 ± 18.5 (7–85.7)	45.1 ± 9.8 (21.4–60.7)	0.68
KOOS ADL	41.3 ± 12.5 (16.2–64.7)	45.6 ± 15.9 (20.6–75)	0.22
KOOS sport/recreation	9.3 ± 15 (0–100)	17.5 ± 28.4 (0–90)	0.07
KOOS QOL	33 ± 23.9 (0–91.3)	41.6 ± 25.8 (6.3–83)	0.20
WOMAC total	58.5 ± 12.4 (39.6–100)	55.2 ± 15.4 (28.1–81.3)	0.34
KKS pain & symptoms	20 ± 7.3 (0–37)	23.8 ± 6.1 (10–32)	0.74
KKS function	28.1 ± 8.6 (11–44)	34.6 ± 10.9 (14–51)	0.22
KKS floor life	5.4 ± 3.8 (0–21)	7.2 ± 4.4 (2–20)	0.06
KKS socio-emotional function	6.2 ± 3.3 (0–18)	7.6 ± 5.2 (1–17)	0.12
KKS total	36.4 ± 10.8 (9.2–61)	40.7 ± 11.3 (17.7–59.2)	0.15
HFKS pain	4 ± 1.2 (2–7)	4.9 ± 1.8 (3–8)	0.005
HFKS function	14.2 ± 3.6 (7–27)	16.7 ± 4 (11–26)	0.01
Feller patella	13.6 ± 4.6 (5–34)	13.9 ± 4.2 (7–22)	0.83
Kujala	36 ± 8.9 (17–68)	36.7 ± 6.3 (27–48)	0.76
SMC PF pain	64.1 ± 10.2 (29–80)	59.7 ± 11.8 (38–76)	0.13
SMC PF function	60 ± 11.5 (22.5–85)	53.6 ± 9.2 (35–65)	0.04

Values are presented as mean ± standard deviation (range). WOMAC total score ranges from 0–100, with higher scores equating to worse symptoms. Excluding the WOMAC score and SMC PF pain and function score, higher scores equate to less symptoms.

TKA: total knee arthroplasty, HIRA: Health Insurance Review and Assessment Service, KSKS: Knee Society Knee score, KSFS: Knee Society Function score, KOOS: Knee Injury and Osteoarthritis Outcome score, ADL: activities of daily living, QOL: quality of life, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, KKS: Korean Knee score, HFKS: High Flexion Knee Scoring system, SMC: Samsung Medical Center, PF: patellofemoral.

Table 4. Clinical Scores of the Most Suitable Candidates for TKA and Inappropriate Groups Separated by Age Classified by HIRA's Reimbursement Criteria

Clinical score	All appropriate (n = 213)	HIRA inappropriate		p-value	HIRA inappropriate	
		Age 60–64 yr (n = 3, 37.5%)			Age < 60 yr (n = 3, 50%)	p-value
KSKS	26.1 ± 10.6 (0–66)	34.3 ± 6 (28–40)	0.18	26 ± 12.6 (35–60)	0.99	
KSFS	40.3 ± 15.7 (0–80)	30 ± 5 (25–35)	0.26	48.3 ± 12.6 (35–60)	0.38	
KOOS pain	38.6 ± 15.2 (2–75)	24 ± 13.7 (8.3–33.3)	0.10	29.1 ± 11.1 (16.7–37.8)	0.29	
KOOS symptoms	47.2 ± 18.5 (7–85.7)	45.1 ± 10.4 (39–57.1)	0.84	38.1 ± 14.9 (21.4–50)	0.40	
KOOS ADL	41.3 ± 12.5 (16.2–64.7)	32.8 ± 8.1 (25–41.1)	0.25	34.2 ± 15.5 (20.6–51)	0.33	
KOOS sport/recreation	9.3 ± 15 (0–100)	10 ± 13.2 (0–25)	0.94	10 ± 0 (10–10)	0.94	
KOOS QOL	33 ± 23.9 (0–91.3)	29.2 ± 14.4 (12.5–37.5)	0.78	62.7 ± 32.7 (25–83)	0.04	
WOMAC total	58.5 ± 12.4 (39.6–100)	67.7 ± 6.3 (60.4–71.9)	0.21	64 ± 15.7 (47–78)	0.27	
KKS pain & symptoms	20 ± 7.3 (0–37)	16.3 ± 4 (12–20)	0.43	15 ± 4.6 (10–19)	0.28	
KKS function	28.1 ± 8.6 (11–44)	22.3 ± 5.5 (17–28)	0.25	23.3 ± 10.7 (14–35)	0.34	
KKS floor life	5.4 ± 3.8 (0–21)	7 ± 3.5 (3–9)	0.47	6 ± 1.7 (4–7)	0.76	
KKS socio-emotional function	6.2 ± 3.3 (0–18)	7 ± 4.6 (2–11)	0.67	4.7 ± 3.2 (1–7)	0.44	
KKS total	36.4 ± 10.8 (9.2–61)	32.1 ± 6.6 (27.4–39.6)	0.52	29.9 ± 11.6 (17.7–40.9)	0.32	
HFKS pain	4 ± 1.2 (2–7)	3.3 ± (3–4)	0.33	3.3 ± 0.6 (3–4)	0.32	
HFKS function	14.2 ± 3.6 (7–27)	16 ± 3.6 (12–19)	0.39	14.3 ± 2.9 (11–16)	0.96	
Feller patella	13.6 ± 4.6 (5–34)	11.3 ± 0.6 (11–12)	0.40	10 ± 3 (7–13)	0.18	
Kujala	36 ± 8.9 (17–68)	40 ± 8 (32–48)	0.43	30 ± 4.4 (27–35)	0.25	
SMC PF pain	64.1 ± 10.2 (29–80)	62 ± 19.1 (40–73)	0.73	72 ± 5.3 (66–67)	0.18	
SMC PF function	60 ± 11.5 (22.5–85)	55.8 ± 8.8 (47.5–65)	0.54	64.2 ± 1.4 (62.5–65)	0.53	

Values are presented as mean ± standard deviation (range). WOMAC total score ranges from 0–100, with higher scores equating to worse symptoms. Excluding the WOMAC score and SMC PF pain and function score, higher scores equate to less symptoms. Comparison of the all appropriate group to each of the two different age groups was made using the analysis of variance, with $p < 0.05$ representing statistically significant values.

TKA: total knee arthroplasty, HIRA: Health Insurance Review and Assessment Service, KSKS: Knee Society Knee score, KSFS: Knee Society Function score, KOOS: Knee Injury and Osteoarthritis Outcome score, ADL: activities of daily living, QOL: quality of life, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, KKS: Korean Knee score, HFKS: High Flexion Knee Scoring system, SMC: Samsung Medical Center, PF: patellofemoral.

current reimbursement criteria to get access to healthcare.

This is the first study on HIRA's reimbursement criteria for TKA. All citizens in South Korea are compulsorily subscribed to the National Health Insurance Service and HIRA evaluates the medical service fee, quality of healthcare, and adequacy of medical service of the healthcare provider to determine reimbursement. This ultimately causes physicians to make medical decisions according to the reimbursement criteria and be often hesitant to make exceptions, thus biased decisions are inevitable. It is ideal for the reimbursement criteria to be equivalent to clinically based treatment indications, but patients with an unmet need for surgical intervention such as TKA still exist.⁸⁾

In this regard, finding new criterion to facilitate access to TKA for those in need is critical.

The reimbursement criteria set by HIRA is a validated tool that uses age and KL grade as the two main factors, in addition to the underlying condition after 3 months of conservative treatment before deciding on TKA, which may be devastating for people with far advanced knee osteoarthritis. Therefore, clinical scores could be used as markers for timely TKA, as well as better representation of patient symptoms, in terms of knee pain, deformity, and functional deterioration.^{9,12,13)} There were 14 cases (3.1%) of the 448 cases that did not fit HIRA's reimbursement criteria, which were far fewer than the cases considered inappropriate for

TKA according to Riddle et al.'s¹⁾ or Hawker et al.'s⁵⁾ criteria.

When using Riddle et al.'s appropriateness criteria,¹⁾ of the 14 cases classified as inappropriate, 9 cases (64.3%) were classified as appropriate, 5 cases (35.7%) were classified as inconclusive, and no cases were classified as inappropriate. When using Hawker et al.'s appropriateness criteria,⁵⁾ 12 cases (85.7%) were appropriate and 2 cases (14.3%) were categorized as inappropriate. The 2 inappropriate cases had radiologic findings of KL grade 3 and above with several clinical symptoms (KOOS symptoms, $p = 0.97$; KOOS sport and recreation, $p = 0.23$; KSKS, $p = 0.50$) and worse symptoms than those in the appropriate cases categorized by HIRA's reimbursement criteria. If radiologic arthritis severity and other clinical factors not included in the WOMAC criteria (pain, function, and stiffness) are taken into account, these 2 cases would be considered suitable for TKA.

Using Riddle et al.'s TKA appropriateness criteria,¹⁾ 20 cases (4.5%) were classified as inappropriate. Patient symptoms and KL grade were the two strongest predictors of appropriateness judgement in the regression models tested by Escobar et al.²⁾ and are weight heaviest in the criteria. The inappropriate cases had on average moderate symptoms: 17 cases with KL grade 3 or below and 3 cases with KL grade 4, which do not meet the age, symptom, and disease status profile of a typical TKA patient.^{14,15)}

However, all 20 cases satisfied HIRA's reimbursement criteria for TKA, so there may be room for improvement in the Riddle et al.'s appropriateness criteria.¹⁾ These results show that Riddle et al.'s appropriateness criteria¹⁾ do not work well on cases with rheumatoid arthritis, avascular necrosis, or secondary osteoarthritis, a disadvantage over HIRA's reimbursement criteria where disease profile is taken into account regardless of age.

The small number of inappropriate cases categorized by HIRA may reflect the surgeon's personal decision to meet the requirements of the reimbursement criteria but make a few exceptions based on patient's severe knee pain and functional deterioration; the KOOS pain ($p = 0.15$) and symptoms score ($p = 0.08$), WOMAC score ($p = 0.20$), and KKS score ($p = 0.36$) showed worse symptoms in the inappropriate cases than those in the appropriate cases (Table 2). Six cases (42.9%) with KL grade 4 were also in the inappropriate group for being below 60 years of age and this age limit of 60 years is higher than 55 years of age in Escobar et al.'s²⁾ or Riddle et al.'s¹⁾ appropriateness criteria. This arbitrary age criterion¹⁶⁾ could be lowered because TKA utilization is increasing in younger patients in the United States and Europe.¹⁷⁾

There are some limitations of this study. First, our

study was done in a single institution, and thus the patient population may not fully represent the rest of the country. Second, Riddle et al.'s¹⁾ and Hawker et al.'s⁵⁾ appropriateness criteria are focused on selecting patients with the most improvement in knee symptoms through TKA and avoiding improper interventions, while HIRA's reimbursement criteria are a medical insurance-based policy that prioritizes distribution of medical fees. Thus, comparing these criteria may not be suitable since they have different goals. Third, comorbidities of patients are factors that are not taken into account in all three criteria, and recent studies have shown they have effects on complication rates and outcome of TKA.¹⁸⁻²⁰⁾

As regulations change to increase insured individuals, an impact on utilization of TKA will follow. This may represent an unmet need for TKA among newly enrolled beneficiaries,⁸⁾ revealing potential patients that do not undergo surgical procedures due to insurance-based reasons. HIRA's reimbursement criteria are an insurance-based policy, which must consider the medical fee aspect of TKA unlike other appropriateness criteria that mainly aim to relieve patient symptoms. An improvement in the criteria will benefit a large group of potential patients that require TKA.

The decision on TKA candidacy should be dependent on the clinical status^{21,22)} of the patient and the current reimbursement criteria are excellent in taking into account age, radiological findings, and disease profile. However, patients younger than the age limit with advanced knee arthritis or those with severe knee pain and functional deterioration with limited treatment options should be able to undergo TKA. The activity level and life expectancy of the patients, as well as the longevity of TKA implants, are also the factors to consider when optimizing decision-making; elderly patients without severe knee symptoms or advanced radiologic findings could benefit from an efficient procedure such as TKA. Nonetheless, the HIRA's reimbursement criteria are insurance-based and may differ from clinical indications. Although there is no universally accepted criteria for determining the appropriateness of arthroplasty, efforts in lowering the age limit and using clinical evaluation results such as KOOS pain and symptoms, WOMAC scores, and KKS score should be considered to optimize patient selection for primary TKA.

In terms of healthcare provision, HIRA's reimbursement criteria are more effective than other TKA appropriateness criteria in providing access to patients who have the most pressing need for TKA. However, we found that the lower age limit and patient-reported outcome measures according to Riddle et al.'s¹⁾ or Hawker et al.'s⁵⁾ criteria are useful in improving appropriateness of the current reimbursement criteria.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ORCID

Dong-Hong Kim <https://orcid.org/0000-0002-9088-7551>
 Soo-Young Jeong <https://orcid.org/0000-0002-4513-0461>
 Jae-Hyuk Yang <https://orcid.org/0000-0001-8853-1997>
 Choong Hyeok Choi
<https://orcid.org/0000-0001-7401-9116>

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