

Development of Korean Academy of Medical Sciences Guideline Rating the Physical Impairment: Lower Extremities

Lower Extremities Committee of Korean Academy of Medical Sciences Guideline for Impairment Rating develops new guidelines which are based on McBride method, American Medical Association Guides, Disability evaluation by The Korean Orthopaedic Association, The Korean Neurosurgery Society, and Korean Academy of Rehabilitation Medicine. The committee analyzed and discussed to create an ideal method practical in Korea. Our committee endeavors to develop new methods which are easy to use, but are suitable for professional use and also independent from the examinee's intentions. The lower extremities are evaluated on the basis of anatomic change, functional change, and diagnosis based evaluation. Nine methods are used to assess the lower extremities. Anatomic assessment includes leg length discrepancy, ankylosis, amputation, skin loss, peripheral nerve injury, and vascular disease. In functional assessment, range of motion and muscle strength are included. Diagnosis-based assessments are used to evaluate impairment caused by specific fractures, deformities, ligament instability, meniscectomies, post-traumatic arthritis, fusion of the foot, and lower extremity joint replacements.

Key Words : Disability Evaluation; Lower Extremity; Impairment

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INTRODUCTION

Ten methods can be used to assess the lower extremities. These methods are classified by assessment methods: anatomic, functional, diagnosis-based.

The evaluator decides the diagnosis at first, then checks whether or not the individual has reached maximal medical improvement (MMI). The next step is to identify each part of the lower extremities (pelvis, hip, thigh, knee, foot, and toe). The evaluator estimates the disability using the ten items: amputation, leg length discrepancy, ankylosis, partial ankylosis (range of motion), nerve injury, muscle weakness, diagnosis-based estimation, joint replacement, vascular disease, skin loss, and then calculate the impairment rating. Assessment by muscle weakness is chosen when the other estimations are inappropriate. If lower extremity impairment is due to an underlying spine disorder, the evaluation of the impairment would be conducted with the spine impairment rating.

There are some methods to calculate the impairment rating scales that can be combined, but other methods can not

be combined. If the evaluator cannot determine which methods are correct, then the evaluator uses all methods that are related to the condition, and chooses the highest impairment rating.

MATERIALS AND METHODS

The Korean Academy of Medical Sciences comprises the Lower Extremities Committee of Korean Guideline for Impairment Rating in which orthopedic surgeons, neurosurgeons, physiatrists, and occupational and environmental medicine doctors participated. This committee analyzed the American Medical Association (AMA) Guides (1), McBride method (2), the guide of Korean Orthopaedic Association (3), the guide of Korean Neurosurgical Society (4), the Korean Academy of Rehabilitation Medicine (5) and created a new guide based on the AMA Guides.

RESULTS

Methods of assessment

There are three methods to assess the disability of the lower extremities. These methods are based on anatomical, functional, and diagnosis-based estimations (Table 1).

Combination of evaluation methods

The amputation cannot be combined with leg length discrepancy, ankylosis, nerve injury, partial ankylosis, or muscle weakness. The leg length discrepancy cannot be combined with amputation. Ankylosis and partial ankylosis cannot be combined muscle weakness and diagnosis-based estimates. Nerve injury and muscle weakness cannot be combined each other. If there is arthritis without ankylosis, it can be estimated by muscle weakness. When we use the muscle weakness, it should be Grade III or IV by the manual muscle test. If the muscle power is less than Grade III, it should be assessed by the nerve injury. Diagnosis-based estimates cannot be combined with ankylosis, partial ankylosis, or muscle weakness.

Amputation

The impairment rate depends on the site of amputation and length of the stump. The impairment rate of lower extremity is presented in Table 2. The maximal impairment rate is less than 100% of the leg except hemipelvectomy. The hemipelvectomy is 110% of lower extremity function. In case of metatarsal amputation, if the remnant of the metatarsal bone is less than 25%, it is categorized as a Lisfran amputation. Tarsometatarsal amputation includes the proximal one-fourth transmetatarsal amputation. The length of stump is estimated by the radiography.

Table 1. Methods used in evaluating impairments of the lower extremities

Assessment method	Tools
Anatomic	Leg length discrepancy
	Ankylosis
	Amputation
	Skin loss
	Peripheral nerve injury
Functional	Vascular
	Range of motion
Diagnosis based	Muscle strength (manual muscle testing)
	Fractures
	Ligament injuries
	Menisectomies
	Post-traumatic arthritis and fusion of the foot
	Joint replacements

Leg length discrepancy

The minimum disability is more than 1.5 cm difference. The measurement for leg length is done in supine position. Measurement is done for the distance between the anterior superior iliac spine and the medial malleollus on the involved side, and compare it with the opposite side. This method has at least 0.5 to 1.0 cm variance (6). In case of pelvic angulation, knee contracture, and severe leg edema, scanogram is recommended (Table 3).

Total ankylosis

Hip joint

Impairment due to ankylosis of hip estimate flexion, adduction, abduction, internal rotation, and external rotation. The optimal position of ankylosis is 25° to 40° flexion and neutral rotation, adduction, and abduction. This position represents a 50% lower extremity impairment. Impairment estimates for rotation, abduction and adduction deformities are added (Table 4).

Table 2. Impairment estimates for amputations

Amputation	Lower extremity (foot) impairment (%)
Hemipelvectomy	110
Hip disarticulation	100
Above knee	
Proximal	100
Mid-thigh	90
Distal	80
Knee disarticulation	80
Below knee	
Less than 8 cm	80
8 cm or more	70
Syme (hind foot)	62 (100)
Midtarsal joint	52 (74)
Tarsometatarsal	45 (64)
Transmetatarsal	40 (57)
First metatarsal	20 (28)
Other metatarsal	5 (7)
All toes at metatarsophalangeal joint	22 (31)
Great toe at MTP joint	12 (17)
Great toe at interphalangeal joint	5 (7)
Lesser toes at MTP joint	2 (3) each

MTP, metatarsophalangeal.

Table 3. Impairment due to leg length discrepancy

Discrepancy (cm)	Lower extremity impairment (%)
0-1.4	0
1.5-2.9	5
3-4.9	10
5-9.9	20
10+	35

Knee joint

Impairment for flexion, valgus, varus, internal rotation, and external rotation. The optimal ankylosis position is 10° to 15° of flexion with neutral alignment. Ankylosis in the optimal position is a 67% lower extremity impairment (Table 5).

Table 4. Impairment due to hip ankylosis

Ankylosis (°)	Lower extremity (foot) impairment (%)
Flexion	
0-15	85
15-24	70
25-39	50
40-59	70
60-75	85
75+	100
Adduction	
5-9	25
10-14	37
15+	50
Abduction	
5-14	25
15-24	37
25+	50
Internal rotation	
5-9	12
10-19	25
20-29	37
30+	50
External rotation	
10-19	12
20-29	25
30-39	37
40+	50

Table 5. Impairment due to knee ankylosis

Ankylosis (°)	Lower extremity impairment (%)
Flexion	
0-20	67
20-29	73
30-39	92
40+	100
Valgus	
0-9	12
20-29	25
30+	33
Varus	
10-19	12
20-29	25
30+	33
Internal/external malrotation	
10-19	12
20-29	25
30+	33

Ankle joint

Impairment due to ankylosis of ankle estimate dorsiflexion, plantar flexion, valgus, varus, internal rotation, and external rotation. The optimal position of ankylosis is neutral position. Ankylosis in the optimal position is a 25% lower extremity impairment. Impairment of foot deformities are added (Table 6).

Toes

Impairment due to ankylosis of toe estimate dorsiflexion and plantar flexion in the great toe (Table 7).

Table 6. Impairment due to ankle ankylosis

Ankylosis (°)	Lower extremity (foot) impairment (%)
Plantar flexion or dorsiflexion	
20+ dorsiflexion	42 (60)
10-19 dorsiflexion	33 (47)
0-9 dorsiflexion	25 (35)
0-9 plantar flexion	25 (35)
10-19 plantar flexion	30 (43)
20-29 plantar flexion	37 (53)
30+ plantar flexion	47 (67)
Valgus position	
5-9	3 (4)
10-19	8 (11)
20-29	12 (47)
30+	25 (53)
Varus position	
5-9	8 (11)
10-19	12 (17)
20-29	25 (35)
30+	37 (53)
Internal malrotation	
0-9	8 (11)
10-19	12 (17)
20-29	25 (35)
30+	37 (53)
External malrotation	
10-19	8 (11)
20-29	12 (17)
30-39	25 (35)
40+	37 (53)

Table 7. Impairment due to toe ankylosis

Position	Lower extremity (foot) impairment (%)
Great toe	
Metatarsophalangeal Joint	
Neutral	5 (7)
20 dorsiflexion	8 (12)
20 plantar flexion	11 (15)
Interphalangeal joint	
Neutral	2 (3)
20 plantar flexion	2 (3)
Other toes	
Ankylosis	1 (2)

Partial ankylosis (range of motion)

Lower extremity impairment can be evaluated by assessing the range of motion of its joints. If the restricted range of motion is based on organic abnormality, measurement is done for the range three times and use the greatest range as an evaluation (7).

Table 8. Hip motion impairment

Hip motion (°)	Lower extremity impairment (%)
Flexion	
80-100	5
50-79	10
25-49	20
<25	35
Extension	
10-19 flexion contracture	5
20-29 flexion contracture	10
>30 flexion contracture	20
Internal rotation	
10-20	5
0-9	10
External rotation	
20-30	5
0-19	10
Abduction	
15-25	5
5-14	10
<5	20
Adduction	
0-15	5
Abduction contracture	
0-4	5
5-9	10
10-19	20
20+	35

Table 9. Knee impairment

Knee motion (°)	Lower extremity impairment (%)
Flexion	
80-110	10
60-79	20
<60	35
Flexion contracture	
5-10	10
10-19	20
20+	35
Varus	
2° valgus-0° (neutral)	10
1-7 varus	20
8-12; add 1% per 2° over 12°	35
Valgus	
10-12	10
13-15	20
16-20; add 1% per 2° over	35

Hip

Flexion, extension, internal rotation, external rotation, abduction, and adduction are estimated. The impairment rate due to partial ankylosis of the hip is presented in Table 8.

Knee

Flexion, flexion contracture, varus, and valgus position are

Table 10. Ankle motion impairment

Ankle motion (°)	Lower extremity (foot) impairment (%)
Plantar flexion (from neutral)	
20-29	2 (3)
10-19	11 (15)
5-9	19 (27)
0-5	25 (35)
Flexion contracture	
10-19	15 (21)
20+	29 (41)
Dorsiflexion (from neutral)	
0-5	25 (35)
6-10	15 (21)

Table 11. Hindfoot impairment

Hindfoot motion (°)	Lower extremity (foot) impairment (%)
Inversion	
10-20	2 (3)
0-9	5 (7)
Eversion	
0-10	2 (3)

Table 12. Forefoot impairment

Forefoot motion (°)	Lower extremity (foot) impairment (%)
External rotation (from neutral)	
0-5	2 (3)
Internal rotation (from neutral)	
5-9	7 (10)
11-20	5 (10)

Table 13. Toe impairment

Toe motion (°)	Lower extremity (foot) impairment (%)
Great toe	
Metatarsophalangeal, extension	
15-30	2 (3)
<15	5 (7)
Interphalangeal, flexion	
<20	2 (3)
Lesser toes	
Metatarsophalangeal, extension	
<10	1 (2)

estimated. The impairment rate due to partial ankylosis of the knee is presented in Table 9.

Ankle and foot

In ankle motion, plantar flexion, flexion contracture and dorsiflexion are estimated. In foot motion, inversion, eversion, valgus, and varus position are estimated. The impairment rate due to partial ankylosis of the ankle and foot is presented in Table 10-13.

Muscle weakness

Muscle weakness is measured by manual muscle testing. When we use muscle weakness method, it should be Grade

Table 14. Impairment due to lower extremity muscle weakness

Muscle group	Grade of lower extremity (foot) impairment (%)				
	0	1	2	3	4
Hip	Flexion			7	5
	Extension			26	12
	Aduction			19	17
Knee	Flexion			12	8
	Extension	Estimate in the nerve injury part		12	8
Ankle	Plantar flexion			17 (24)	12 (17)
	Dorsiflexion			17 (24)	8 (11)
	Inversion			8 (11)	4 (6)
	Eversion			8 (11)	4 (6)
Great toe	Extension			5 (7)	1 (2)
	Flexion			8 (7)	3 (4)

Table 16. Impairment estimate for the knee lesion

Region and condition	Lower extremity impairment (%)
Patella subluxation or dislocation with instability	7
Patellectomy	
Partial	7
Total	22
Meniscectomy, medial or lateral	
Partial	2
Total	7
Meniscectomy, medial and lateral	
Partial	10
Total	22
Cruciate ligament laxity	
Mild (<5 mm)	7
Moderate (5-10 mm)	17
Severe (>10 mm)	25
Collateral ligament laxity	
Moderate (5-10°)	2
Severe (>10)	7
Tibial shaft fracture, malalignment	
10-14	20
15-19	30
>20	+2 per degree up to 20

III or IV by manual muscle test. If the muscle power is less than Grade III, it should be assessed according to peripheral nerve injury (Table 14).

Diagnosis-based estimation

Sometimes the diagnosis-based estimation is more precise

Table 15. Impairment estimate for the hip lesion

Region and condition	Lower extremity impairment (%)
Femur neck fracture	
Malunion	30+ROM assessment
Non-union	37+ROM assessment
Femur shaft fracture	
Angulation or malrotation	
10-14	25
15-19	45
20+	+2/degree up to 62

ROM, range of motion.

Table 17. Impairment estimate for the ankle and foot lesion

Region and condition	Lower extremity (foot) impairment (%)
Pilon fracture	
Post traumatic arthritis (loss of joint space >1/2)	25 (35)
Distal tibia intra-articular comminuted fracture	7 (10)
Distal tibial intra-articular fracture	Partial ankylosis
Fracture of the calcaneus	
Subtalar arthritis with non-union	15 (21)
Comminuted fracture with good improvement	10 (14)
Simple fracture	7 (10)
Malunion without articular surface involvement	5 (7)
Fracture of the talus	
Post-traumatic arthritis with nonunion	15 (21)
Avascular necrosis <1/2 (MRI)	5 (7)
Avascular necrosis >1/2 (MRI)	12 (7)
Fracture of navicular or cuboid	
Malunion with arthritis	10 (14)
Lisfranc fracture	
First tarso-metatarsal joint	5 (7)
2, 3, 4, 5 tarso-metatarsal joint	2 (3)
Metatarsal fracture (malunion: 20° angulation)	
First metatarsal	5 (7)
Other metatarsal	2 (3)
Arthrodesis	
Ankle fusion	25 (35)
Triple arthrodesis	22 (31)
Subtalar or talonavicular fusion	15 (21)
Calcaneocuboid fusion	7 (10)
Lisfranc joint arthrodesis	
First joint	5 (7)
Other joint	2 (3)
Hammer toe	
Great toe	7 (10)
Other toes	2 (3)

MRI, magnetic resonance imaging.

than other methods. This method includes fractures, ligament injury, meniscal injury, fractures with deformity. In fracture category, malunion, nonunion, angulation and malrotation are estimated. Joint instability due to ligament injury in the

Table 18. Impairment estimate for the hip and knee joint replacement

Joint replacement	Lower extremity impairment (%)
Good results, 85-100 points	35
Fair results, 50-84 points	50
Poor results, less than 50 points	75

Table 19. Rating hip replacement results*

	Score		Score
a. Pain		High chair	2
None	44	Unable to sit comfortable	0
Slight	40	Public transportation	
Moderate, occasional	30	Able to use	1
Moderate	20	Unable to use	0
Marked	10	d. Deformity	
b. Function		Fixed adduction	
Limp		<10°	1
None	11	=10°	0
Slight	8	Fixed internal rotation	
Moderate	5	<10°	1
Severe	0	=10°	0
Supportive device		Fixed external rotation	
None	11	<10°	1
Cane for long walks	7	=10°	0
Cane	5	Flexion contracture	
One crutch	3	<15°	1
Two cane	2	=15°	0
Two crutch	0	Leg length discrepancy	
Distance walked		<1.5 cm	1
Unlimited	11	=1.5 cm	0
200 m	8	e. Range of motion	
100 m	5	Flexion	
Indoor	2	>90°	1
In bed or chair	0	=90°	0
c. Activities		Abduction	
Stairs climbing		>15°	1
Normal	4	=15°	0
Using railing	2	Adduction	
Cannot climb readily	1	>15°	1
Unable to climb	0	=15°	0
Putting on shoes and socks		External rotation	
With ease	4	>30°	1
With difficulty	2	=30°	0
Unable to sit comfortably	0	Internal rotation	
Sitting		>15°	1
Any chair, 1 hr	4	=15°	0

*Add the points from categories a, b, c, d, and e to determine the total scores which represent the result of replacement. Modified from Gross AE, Lavoie MV, McDermott P, Marks P. The use of allograft bone in revision of total hip arthroplasty. Clin Orthop Relat Res 1985; 115-22.

knee and ankle is evaluated by stress radiography (8).

Hip

The impairment rate of hip based on diagnosis-based estimation method is presented in Table 15.

Knee

The impairment rate of knee based on diagnosis-based estimation method is presented in Table 16.

Ankle and foot

The impairment rate of ankle and foot based on diagnosis-based estimation method is presented in Table 17.

Table 20. Rating knee replacement results*

	Score
a. Pain	
None	50
Mild or occasional	45
Stairs only	40
Walking and stairs	
Moderate	30
Occasional	20
Continual	10
Severe	0
b. Range of motion	
Add 1 point per 5°	25
c. Stability	
Anteriorposterior	
<5 mm	10
5-9 mm	5
>9 mm	0
Mediolateral	
5°	15
6-9°	10
10-14°	5
≥ 15°	0
Deduction (minus) d, e, f	
d. Flexion contracture	
5-9°	2
10-15°	5
16-20°	10
>20°	20
e. Extension lag	
<10°	5
10-20°	10
>20°	15
f. Alignment	
0-4°	0
5-10°	3 points per degree
11-15°	3 points per degree
>15°	20
Deduction subtotal	-

*The point total for estimating knee replacement results is the sum of the points in categories a, b, and c minus the sum of the points in categories d, e, and f. Modified from Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. Clin Orthop Relat Res 1989; 13-4.

Joint replacement

The evaluation of joint replacement is based on the functional score in the hip (9) and knee joint (10) and the range of motion in the ankle joint (Table 18).

Hip joint replacement

Pain, function, activities, deformity, range of motion are evaluated. Each category has points and add the points to determine the total scores. Rating hip replacement results are presented in Table 19.

Knee joint replacement

Pain, range of motion, stability, flexion contracture, extension lag, and alignment are evaluated. Rating knee replacement results are presented in Table 20.

Ankle joint replacement

Only range of motion is evaluated. The impairment rate due to ankle joint replacement is presented in Table 21.

Peripheral vascular disease

Impairment due to peripheral vascular disease is based on clinical symptoms. Table 22 shows the lower extremity impairment rate due to peripheral vascular disease. This table provide impairment due to arterial disease, vascular disease, and lymphedema of lower extremity. These diseases should be confirmed by radiologic study, sonography or lymphoscintigraphy.

Table 21. Impairment estimate for ankle joint replacement

Range of motion (°)	Lower extremity (foot) impairment (%)
≥20	20 (28)
<20	25 (35)

Table 22. Lower extremity impairment due to peripheral vascular disease

Class 1 (5%) impairment	Class 2 (15%) impairment	Class 3 (30%) impairment	Class4 (60%) impairment	Class 5 (90%) impairment
No claudication No pain at rest and Transient edema and In physical examination - loss of pulses - minimal loss of subcutaneous tissue - calcification of arteries (by radiography) - asymptomatic dilation of arteries or vein	Intermittent claudication on walking <100 m, at an average pace or Persistent edema of a moderate degree, incompletely controlled by elastic supports or Vascular damage as evidenced by a sign such as a healed, painless stump of an amputated digit	Intermittent claudication onwalking 25-100 m, at an average pace or Marked edema that is partially controlled by elastic supports or Vascular damage as evidenced by a sign such as healed amputation of two or more digits of one extremity	Intermittent claudication on walking <25 m, at an average pace or Marked edema that can not be controlled by elastic supports or Vascular damage as evidenced by sign such as an amputation of two or more digits of two extremities	Severe and constant pain at rest or Vascular damage as evidenced by such sign as amputations at or above the ankles of two extremities, or amputation of all digits of two or more extremities

In the lymphedema patient, lymphatic flow decrease is detected by lymphoscintigraphy. For stage II lymphedema and more than 3 cm circumference difference which needs elastic support is class 2. For stage III lymphedema and more than 5 cm circumference difference which needs elastic support is class 3.

Skin loss

Full-thickness skin loss in the weight bearing area makes a disability. Impairment due to skin loss of the foot is presented in Table 23.

DISCUSSION

Korean Guideline for Impairment Rating of lower extremities were developed mainly based on the criteria in the 5th edition of AMA Guides. It is different from AMA Guides in that Korean Guideline omits some classification which is not realistic in Korea. In the muscle weakness category, if muscle power is less than Grade III it would be evaluated in the peripheral nervous system. It may reduce inaccuracy. In this guideline, the method which can be modified by examinee such as gait derangement is excluded. Through this process we can make it simpler and more objective guideline than AMA Guides. When we use this new guideline for the evaluation of disability, the examiner should know about comprehensive medical history and review the all records. After understanding the patient's symptoms and signs, evaluator

Table 23. Impairment for skin loss

Impairment for skin loss	Lower extremity (foot) impairment (%)
Heel covering that limits standing and walking time and needs soft tissue reconstruction	20 (28)

should do physical examination thoroughly. The physician should record lower extremity-related physical findings, such as range of motion, limb length discrepancy, deformity, reflexes, muscle strength, muscle atrophy, ligament laxity, motor and sensory deficits, and specific diagnoses such as fractures.

In summary, a stepwise approach of evaluating a lower extremity impairment is as follows;

- 1) Establish the diagnosis.
- 2) Determine whether maximal medical improvement has been reached.
- 3) Identify each lower extremity anatomic region with abnormalities that are related to injury in question.
- 4) Calculate impairment according to the text and tables for each applicable method.
- 5) Identify and calculate injury which is related to peripheral nervous system impairment.
- 6) Identify and calculate all injuries which is related to the peripheral vascular system.
- 7) The lower extremity impairment rating for each limb is then converted to whole person impairment.

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