Original Article

JER

https://doi.org/10.12965/jer.2442254.127

Journal of Exercise Rehabilitation 2024;20(4):131-136

The effect of kinesio taping on joint range of motion and balance in total knee replacement patients

Seung-heon Song[1], Su-Kyoung Lee[2,*], Su-Hong Ahn[3]

[1]Department of Physical Therapy, Dong-Eui Hospital, Busan, Korea
[2]Department of Physical Therapy, College of Nursing and Healthcare Science, Dong-Eui University, Busan, Korea
[3]Inmotion Rehabilitation Training Center, Busan, Korea

We adopted a within-subjects quasi-experimental approach to assess the impact of kinesio taping (KT) on joint range of motion (ROM), static balance, and dynamic balance. The research subjects were 15 patients who had, within the previous 3 weeks, undergone total knee replacement (TKR) by an orthopedic surgeon in 2022. We measured the ROM, static balance, and dynamic balance of the knee joint before and after applying KT. We then compared the pre- and post-tape measurements to assess the effects of KT on joint function and balance. The ROM of the knee joint was measured using a goniometer in the supine position before the KT application. The static and dynamic balance were assessed using a balance assessment device by measuring the sway area and length of the center of gravity during the measurement period. The effects of KT on the ROM and static and dynamic balance of the knee joint were investigated. The differences in joint ROM and static and dynamic balance between pre- and post-KT applications were analyzed using a paired-sample *t*-test. This study found that the ROM of the knee joint was significantly increased after applying KT. For static and dynamic balance, both the sway area and length of the center of gravity decreased after applying KT, indicating a significant improvement in static and dynamic balance. KT, when combined with standard physiotherapy, can be a useful therapeutic approach for TKR patients, effectively enhancing joint ROM and balance function.

Keywords: Total knee replacement, Kinesio taping, Range of motion, Static and dynamic balance

INTRODUCTION

Osteoarthritis, which is a degenerative joint condition, is the most prevalent chronic disease globally, affecting 18% of women and 10% of men aged 60 years or older (Wang et al., 2021). It primarily affects weight-bearing joints, such as the knees, leading to muscle weakness and instability (Luc-Harkey et al., 2018). If these symptoms persist, they can lead to misalignment and deformity of the kneecap (Han et al., 2020). This can also cause painful cracking sounds and impaired joint movement (Semiz et al., 2018). As a result, individuals may experience difficulties in daily living and an increased risk of falling (Vennu and Bindawas, 2014). While various approaches, such as physical therapy and exercise therapy, are employed to manage degenerative knee osteoarthritis, total knee replacement (TKR) becomes an option when joint deterioration and pain escalate, causing substantial impairment in daily living (Lygre et al., 2010).

TKR is a procedure that involves replacing the damaged surfaces of the knee joint with an artificial joint that mimics the natural knee (Zarychta, 2018). TKR relieves severe pain and deformity of the knee joint (Flierl et al., 2019). However, failure to properly manage post-surgery care can lead to knee joint stiffness, restricted range of motion (ROM), increased muscle tension, and hindered efficient muscle contraction. This, in turn, can impair proprioception and lead to balance problems (Capin et al., 2022). Since balance is an essential component of all functional movements in daily life, such as sitting, standing, and walking (Wolfson et al., 1994), it is crucial to enhance balance ability through increased knee joint ROM and muscle strengthening following TKR (Casana et al., 2021; Zvetkova et al., 2023). For patients who have undergone

*Corresponding author: Su-Kyoung Lee https://orcid.org/0000-0002-4916-2188
Department of Physical Therapy, College of Nursing and Healthcare Science, Dong-Eui University, 176 Eomgwang-ro, Busanjin-gu, Busan 47340, Korea
Email: ptlsk@deu.ac.kr
Received: May 15, 2024 / Revised: June 15, 2024 / Accepted: June 22, 2024

TKR, there are two methods of increasing ROM using continuous passive motion devices (Beaupre et al., 2001) and taping.

Kinesio taping (KT), in particular, is popular for protecting joints and muscles during daily activities and sports (Gulcana and Gula, 2011; Mostafavifar et al., 2012), and it is one of the most commonly used rehabilitation tools in hospitals. Attaching elastic adhesive tape to the muscles of the body enhances proprioceptive sensation through stimulation of skin mechanoreceptors (Murray and Husk, 2001) and promotes blood and lymph circulation, thereby increasing joint ROM and improving joint stability and muscle strength (Wu et al., 2015). KT has been shown to increase knee ROM in osteoarthritis patients during daily activities, as supported by studies such as Melese et al. (2020). Additionally, Mao et al. (2021) found that KT not only improves knee joint ROM but also alleviates knee pain and enhances functional movement.

However, existing studies have primarily focused on the general effects of KT, and there is a lack of research on the effects of KT applied at specific time points after TKR, particularly in elderly patients. Therefore, this study aims to address this research gap by investigating the effects of KT in patients in their 70s. By applying KT at a specific time point after surgery and analyzing its effects, we seek to evaluate the potential benefits of KT in the recovery of elderly patients following TKR. To this end, the ROM was measured by assessing the knee joint flexion angle using a goniometer, and static and dynamic balance were evaluated by comparing the sway area and length of the center of pressure using the balance platform of BioRescue.

MATERIALS AND METHODS

Participants

This study was conducted at the Dong-Eui Medical Center in Busan, South Korea, with 15 patients who had been medically diagnosed with degenerative knee osteoarthritis. After outlining the objectives and procedures of the study, we selected participants from those who consented to take part. The study was approved by the Dong-Eui University Institutional Review Board (DIRB-202201-HR-E-25) to ensure compliance with ethical principles and to protect participants' rights and well-being.

The subject selection criteria were as follows: (1) patients had been diagnosed with osteoarthritis and had undergone TKR within the past 2 weeks, and (2) patients did not have any impairment in their ability to perform exercise.

Fig. 1. Attaching kinesio taping to the knee joint.

Application procedure of KT

Kinesio tape (BB Kinesiology Tape, Pyeongtaek, Korea) was applied to the patient's fully extended knee with 30%–40% tension (Guner et al., 2015; Yeung et al., 2015). The taping method involved stabilizing the patient's femur and internally rotating the tibia. The first tape was applied to the distal anterior–inferior one-third of the subject's femur, extending over the knee joint and attaching to the proximal one-third of the tibia. The second tape was overlapped by about 50% on the same spot that the first tape was attached. The application attaching of KT on the knee joint is illustrated in Fig. 1.

Knee joint range of motion

To measure the ROM of the knee joints of the subjects, a goniometer (Jamar, New Jersey, NJ, USA) was used. Fig. 2 shows the procedure for measuring the ROM of the knee joint. The research subjects were placed in a supine position, with their legs fully extended and flat against the floor for measurement. The axis of the goniometer was placed over the lateral femoral condyle of the knee joint. The stationary arm was aligned with the lateral midline of the femur using the greater trochanter for reference. The movable arm was aligned with the lateral midline of the fibula using the lateral malleolus for reference. The subjects performed three repetitions of a slow knee flexion exercise until just before the onset of pain, and the average value was used.

https://doi.org/10.12965/jer.2442254.127

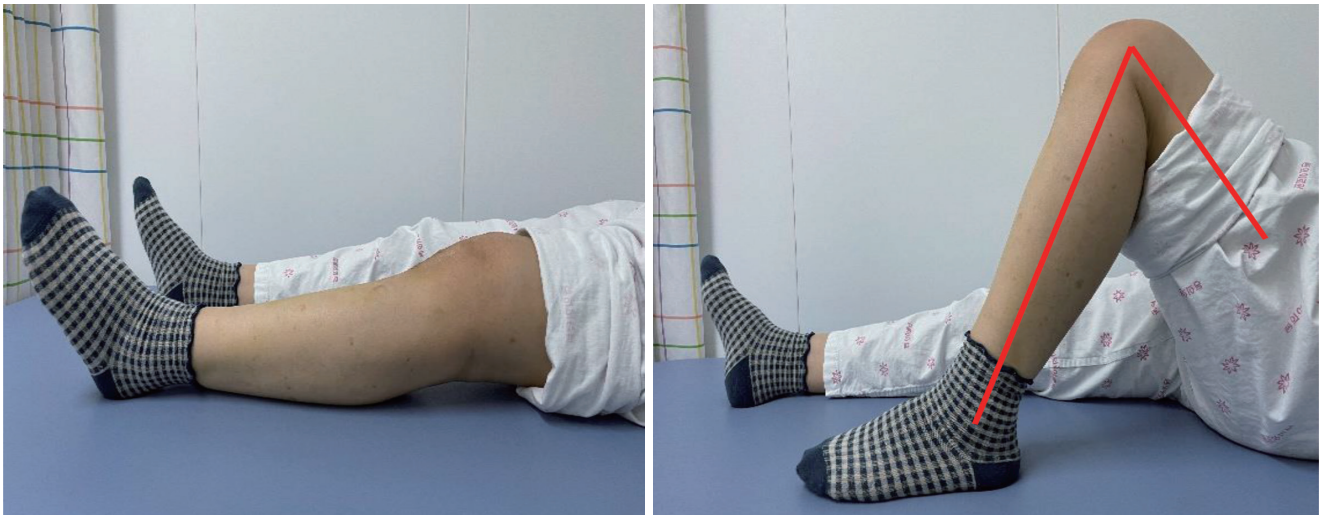

Fig. 2. Measurement of range of motion.

Static and dynamic balance

Static and dynamic balance measurements were performed using BioRescue (RM Ingenierie, Rodez, France), a motion analysis system equipped with a pressure-sensitive platform. BioRescue is a system that comprises a platform (610×580×10 mm), software, and a monitor. The platform is equipped with 1,600 sensors, with one sensor per cm^2. Before measuring balance, the researchers directly demonstrated the procedure and methods to the research subjects and provided them with pre-training. They then measured the subjects' static and dynamic balance by assessing the total sway area (surface area ellipse) and the length of the center of gravity. The assessment of static balance was conducted while the research subjects stood upright with their feet shoulder-width apart, with their eyes open. They maintained this position, facing forward, for 10 sec after the researcher's "start" signal. The method of measuring static balance is illustrated in Fig. 3.

Dynamic balance was evaluated using a modified version of the method described by Row and Cavanagh (2007), Objero et al. (2019). The subjects stood upright with their hands clasped together. Upon receiving a "start" signal from the researcher, they performed three repetitions of arm lifting using shoulder joint flexion to 90° and then three repetitions of arm lifting after trunk rotation in a 45° diagonal direction to the left and right, respectively. Measurements were taken 3 times before the tape application and 3 times after the application. A 3-min rest was given between each measurement to prevent muscle fatigue. The average value of all measurements within the "Total" range was used. The method of measuring dynamic balance is depicted in Fig. 4.

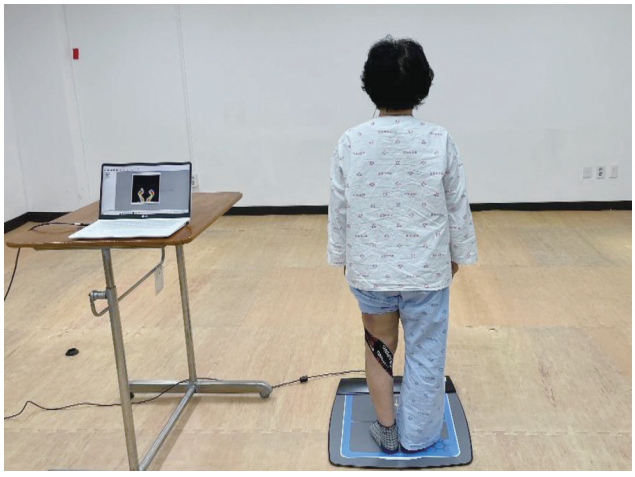

Fig. 3. Measurement of static balance.

Measurement method

To investigate the effects of KT on joint ROM and static and dynamic balance, a quasi-experimental study was conducted on 15 patients who had undergone TKR. The study involved comparing the same group of patients in two conditions: with and without KT. We measured the ROM, static balance, and dynamic balance of the knee joint before and after applying KT. We then compared the results to assess the effects of KT on joint function and balance. Before applying the KT, the ROM of the knee joint was measured using a goniometer in the supine position. The static and dynamic balance were assessed using BioRescue. To prevent substitution movements, a three-minute rest period was taken after each sequence of three repeated measurements.

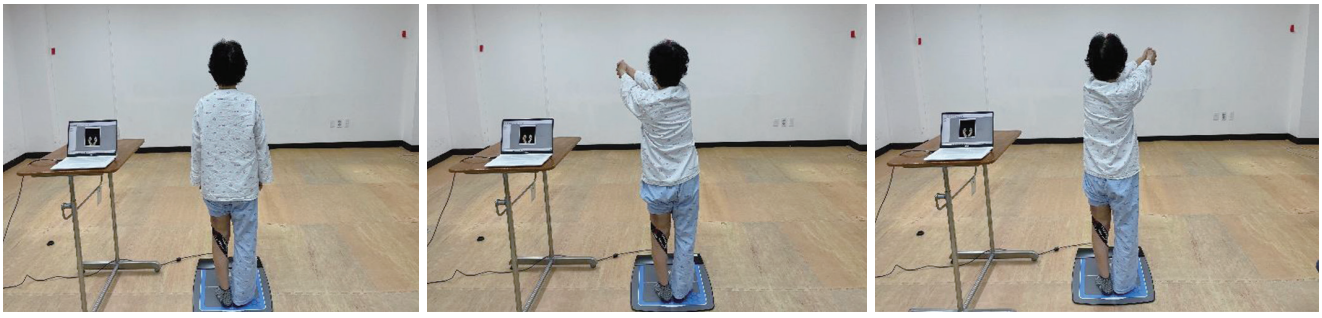

Fig. 4. Measurement of dynamic balance.

Table 1. Characteristics of study participants (n = 15)

Characteristic	Value
Sex, male:female	2:13
Age (yr)	72.12 ± 4.92
Height (cm)	158.27 ± 5.35
Weight (kg)	64.16 ± 6.92

Values are presented as number or mean ± standard deviation.

Table 2. Comparison of the range of motion differences before and after attaching kinesio tape

Variable	Mean ± SD	*t*	*P*-value
ROM		-4.19	0.01*
Pre	122.74 ± 6.58		
Post	125.14 ± 5.41		

SD, standard deviation; ROM, range of motion.
*$P < 0.05$.

Data analysis

Data analysis for this study was conducted using IBM SPSS Statistics ver. 26.0 (IBM Co., Armonk, NY, USA). A paired *t*-test was employed to investigate the impact of KT on joint ROM and static and dynamic balance outcomes in TKR patients. The significance level (α) for statistical processing was set to 0.05.

RESULTS

General characteristics of the research subjects

The research subjects consisted of 2 males and 13 females. Their mean age was 72.12 ± 4.92 years, mean height was 158.27 ± 5.35 cm, and mean weight was 64.16 ± 6.92 kg. The general characteristics of the research subjects are presented in Table 1.

Knee joint ROM before and after KT

Before KT, the ROM of the knee joint was 122.74° ± 6.58°. After KT, the ROM of the knee joint increased to 125.14° ± 5.41°, a significant increase of 2.4° ($P < 0.05$) (Table 2).

Table 3. Comparison of the static balance differences before and after attaching kinesio tape

Variable	Mean ± SD	*t*	*P*-value
SAE (mm^2)		3.89	0.02*
Pre	59.32 ± 37.60		
Post	47.78 ± 35.71		
Length (cm)		3.64	0.03*
Pre	19.08 ± 19.52		
Post	14.44 ± 17.33		

SD, standard deviation; SAE, surface area ellipse.
*$P < 0.05$.

Static balance before and after KT

Before KT, the sway area of the center of gravity was 59.32 ± 37.60 mm. After KT, the sway area of the center of gravity decreased to 47.78 ± 35.71 mm an average decrease of 11.54 mm. Before KT, the average length was 19.08 ± 19.52 cm. After KT, the average length decreased to 14.44 ± 17.33 cm a reduction of 4.64 cm. This resulted in statistically significant decreases in both the sway area and the length of the center of gravity ($P < 0.05$) (Table 3).

Dynamic balance before and after KT

Before KT, the sway area of the center of gravity was 945.13 ± 396.3 mm. After KT, the sway area of the center of gravity decreased to 621.31 ± 271.85 mm an average decrease of 548.83 mm. Before KT, the average length was 21.12 ± 6.62 cm. After KT, the average length decreased to 15.40 ± 4.94 cm a reduction of 5.72 cm. This resulted in a statistically significant decrease in both the sway area and length of the center of gravity ($P < 0.05$) (Table 4).

https://doi.org/10.12965/jer.2442254.127

Table 4. Comparison of the dynamic balance differences before and after attaching kinesio tape

Variable	Mean ± SD	*t*	*P*-value
SAE (mm^2)		5.74	0.00*
Pre	945.13 ± 396.30		
Post	621.31 ± 271.85		
Length (cm)		5.61	0.00*
Pre	21.12 ± 6.62		
Post	15.40 ± 4.94		

SD, standard deviation; SAE, surface area ellipse.
*$P<0.05$.

DISCUSSION

This study aimed to investigate the effects of KT on joint ROM and static and dynamic balance in patients who had undergone TKR. The study found that KT significantly increased the ROM in the shoulder joint compared to not applying KT. Castrogiovanni et al. (2016) reported that in patients aged 60 and older with degenerative knee osteoarthritis, the application of KT significantly increased the ROM of the knee joint compared to pre-taping measurements. Similarly, Rahlf et al. (2019) found that applying KT to elderly patients with knee osteoarthritis, with an average age of 65, facilitated joint movement and improved ROM, thereby positively impacting the functional recovery of the knee.

The improved joint ROM can likely be attributed to the tape's tension reducing knee joint tension, thereby activating muscles and sensory receptors around the knee and facilitating joint movement (Kelley et al., 2021). Additionally, the tape's traction effect, one of its mechanisms of action, is thought to contribute to increased ROM by correctly aligning the joint position, reducing knee joint compression, and enhancing joint function (Altmiş et al., 2018; Melese et al., 2020).

KT significantly improved static balance ability compared to the no-taping condition. Rahlf et al. (2019) applied KT to the knees of patients with 141 patients aged 65 years or older diagnosed with knee osteoarthritis and found that it stabilized the knee joint and improved static balance ability. This is because the application of tape to the skin stimulates sensory receptors, leading to increased neural transmission to the central nervous system (Limroongreungrat and Boonkerd, 2019). This stimulation is thought to enhance proprioception and awareness of joint position and movement, which can contribute to improved balance and coordination (Gholami et al., 2020; Winter et al., 2022).

KT also significantly improved dynamic balance ability compared to the no-taping condition. Park et al. (2019) found that KT combined with dynamic walking exercises increased gait stability in elderly patients with knee osteoarthritis. These findings suggest that taping interventions can enhance exercise performance by supporting the knee joint and increasing muscle activation (Park et al., 2019). Furthermore, Gholami et al. (2020) and Guner et al. (2015) found that stimulating proprioceptors during knee movement improves dynamic balance ability by minimizing unnecessary movements during exercise and providing more information about joint position and movement, leading to proper muscle use. This aligns with our findings.

In conclusion, most previous studies have focused on the effects of KT in the general population of knee osteoarthritis patients, with a lack of detailed analysis on the effects of KT applied at specific time points after TKR. Additionally, studies examining the efficacy of KT in elderly patients are rare. Therefore, in this study, we applied KT to elderly patients in their 70s who had undergone TKR surgery and found that KT not only improved joint movement but also enhanced stability and reduced the risk of falls. Consequently, KT is an important element of rehabilitation exercises for the elderly population and can be effectively utilized as a therapeutic intervention alongside conventional physical therapy methods to improve knee joint flexion range of motion and enhance both static and dynamic balance abilities.

CONFLICT OF INTEREST

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

ACKNOWLEDGMENTS

The authors received no financial support for this article.

REFERENCES

Altmış H, Oskay D, Elbasan B, Düzgün İ, Tuna Z. Mobilization with movement and kinesio taping in knee arthritis-evaluation and outcomes. Int Orthop 2018;42:2807-2815.

Beaupre LA, Davies DM, Jones CA, Cinats JG. Exercise combined with continuous passive motion or slider board therapy compared with exercise only: a randomized controlled trial of patients following total knee arthroplasty. Phys Ther 2001;81:1029-1037.

Capin JJ, Bade MJ, Jennings JM, Snyder-Mackler L, Stevens-Lapsley JE. Total knee arthroplasty assessments should include strength and performance-based functional tests to complement range-of-motion and

patient-reported outcome measures. Phys Ther 2022;102:pzac033.
Casana J, Calatayud J, Silvestre A, Sanchez FJ, Andersen LL, Jakobsen MD, Ezzatvar Y, Alakhdar Y. Knee extensor muscle strength is more important than postural balance for stair-climbing ability in elderly patients with severe knee osteoarthritis. Int J Environ Res Public Health 2021;18:3637-3646.
Castrogiovanni P, Giunta AD, Guglielmino C, Roggio F, Romeo D, Fidone F, Imbesi R, Loreto C, Castorina S, Musumeci G. The effects of exercise and kinesio tape on physical limitations in patients with knee osteoarthritis. J Funct Morphol Kinesiol 2016;1:355-368.
Flierl MA, Sobh AH, Culp BM, Baker EA, Sporer SM. Evaluation of the painful total knee arthroplasty. J Am Acad Orthop Surg 2019;27:743-751.
Gholami M, Kamali F, Mirzeai M, Motealleh A, Shamsi M. Effects of kinesio tape on kinesiophobia, balance and functional performance of athletes with post anterior cruciate ligament reconstruction: a pilot clinical trial. BMC Sports Sci Med Rehabil 2020;12:57.
Gulcana A, Gula B. Does kinesiotaping increase knee muscles strength and functional performance. Isokinet Exerc Sci 2011;19;149-155.
Guner S, Alsancak S, Koz M. Effect of two different kinesio taping techniques on knee kinematics and kinetics in young females. J Phys Ther Sci 2015;27:3093-3096.
Han X, Cui J, Xie K, Jiang X, He Z, Du J, Chu L, Qu X, Ai S, Sun Q, Wang L, Wu H, Zhang W, Yu Z, Yan M. Association between knee alignment, osteoarthritis disease severity, and subchondral trabecular bone microarchitecture in patients with knee osteoarthritis: a cross-sectional study. Arthritis Res Ther 2020;22:203.
Kelley D, Kelsberg G, Safranek S. Kinesiology taping for knee osteoarthritis pain. Am Fam Physician 2021;103:434-436.
Limroongreungrat W, Boonkerd C. Immediate effect of ACL kinesio taping technique on knee joint biomechanics during a drop vertical jump: a randomized crossover controlled trial. BMC Sports Sci Med Rehabil 2019;11:32.
Luc-Harkey BA, Safran-Norton CE, Mandl LA, Katz JN, Losina E. Associations among knee muscle strength, structural damage, and pain and mobility in individuals with osteoarthritis and symptomatic meniscal tear. BMC Musculoskelet Disord 2018;19:258.
Lygre SHL, Espehaug B, Havelin LI, Furnes O, Vollset SE. Pain and function in patients after primary unicompartmental and total knee arthroplasty. J Bone Joint Surg Am 2010;92:2890-2897.
Mao HY, Hu MT, Yen YY, Lan SJ, Lee SD. Kinesio taping relieves pain and improves isokinetic not isometric muscle strength in patients with knee osteoarthritis—a systematic review and meta-analysis. Int J Environ Res Public Health 2021;18:10440.
Melese H, Alamer A, Temesgen MH, Nigussie F. Effectiveness of kinesio taping on the management of knee osteoarthritis: a systematic review of randomized controlled trials. J Pain Res 2020;13:1267-1276.
Mostafavifar M, Wertz J, Borchers J. A systematic review of the effectiveness of kinesio taping for musculoskeletal injury. Phys Sportsmed 2012;40:33-40.
Murray H, Husk L. Effect of kinesio taping on proprioception in the ankle. J Orthop Sports Phys Ther 2001;31:30-37.
Objero CN, Wdowski MM, Hill MW. Can arm movements improve postural stability during challenging standing balance tasks? Gait Posture 2019;74:71-75.
Park JS, Yoon T, Lee SH, Hwang NK, Lee JH, Jung YJ, Lee G. Immediate effects of kinesiology tape on the pain and gait function in older adults with knee osteoarthritis. Medicine (Baltimore) 2019;98:e17880.
Rahlf AL, Braumann KM, Zech A. Kinesio taping improves perceptions of pain and function of patients with knee osteoarthritis: a randomized, controlled trial. J Sport Rehabil 2019;28:481-487.
Row BS, Cavanagh PR. Reaching upward is more challenging to dynamic balance than reaching forward. Clin Biomech 2007;22:155-164.
Semiz B, Hersek S, Whittingslow DC, Ponder L, Prahalad S, Inan OT. Using knee acoustical emissions for sensing joint health in patients with juvenile idiopathic arthritis: a pilot study. IEEE Sens J 2018;18:9128-9136.
Vennu V, Bindawas SM. Relationship between falls, knee osteoarthritis, and health-related quality of life: data from the Osteoarthritis Initiative study. Clin Interv Aging 2014;9:793-800.
Wang Y, Nguyen USD, Lane NE, Lu N, Wei J, Lei G, Zhang Y. Knee osteoarthritis, potential mediators, and risk of all cause mortality: data from the osteoarthritis initiative. Arthritis Care Res 2021;73:566-573.
Winter L, Huang Q, Sertic J, Konczak J. The effectiveness of proprioceptive training for improving motor performance and motor dysfunction: a systematic review. Front Rehabil Sci 2022;3:830166.
Wolfson L, Whipple R, Derby CA, Amerman P, Nashner L. Gender differences in the balance of healthy elderly as demonstrated by dynamic posturography. J Gerontol 1994;49:160-167.
Wu WT, Hong CZ, Chou LW. The kinesio taping method for myofascial pain control. Evid Based Complement Alternat Med 2015;2015:950519.
Yeung SS, Yeung EW, Sakunkaruna Y, Mingsoongnern S, Hung WY, Fan YL, Iao HC. Acute effects of kinesio taping on knee extensor peak torque and electromyographic activity after exhaustive isometric knee extension in healthy young adults. Clin J Sport Med 2015;25:284-290.
Zarychta P. A new approach to knee joint arthroplasty. Comput Med Imaging Graph 2018;65:32-45.
Zvetkova E, Koytchev E, Ivanov I, Ranchev S, Antonov A. Biomechanical, healing and therapeutic effects of stretching: a comprehensive review. Appl Sci 2023;13:8596-8603.

https://doi.org/10.12965/jer.2442254.127