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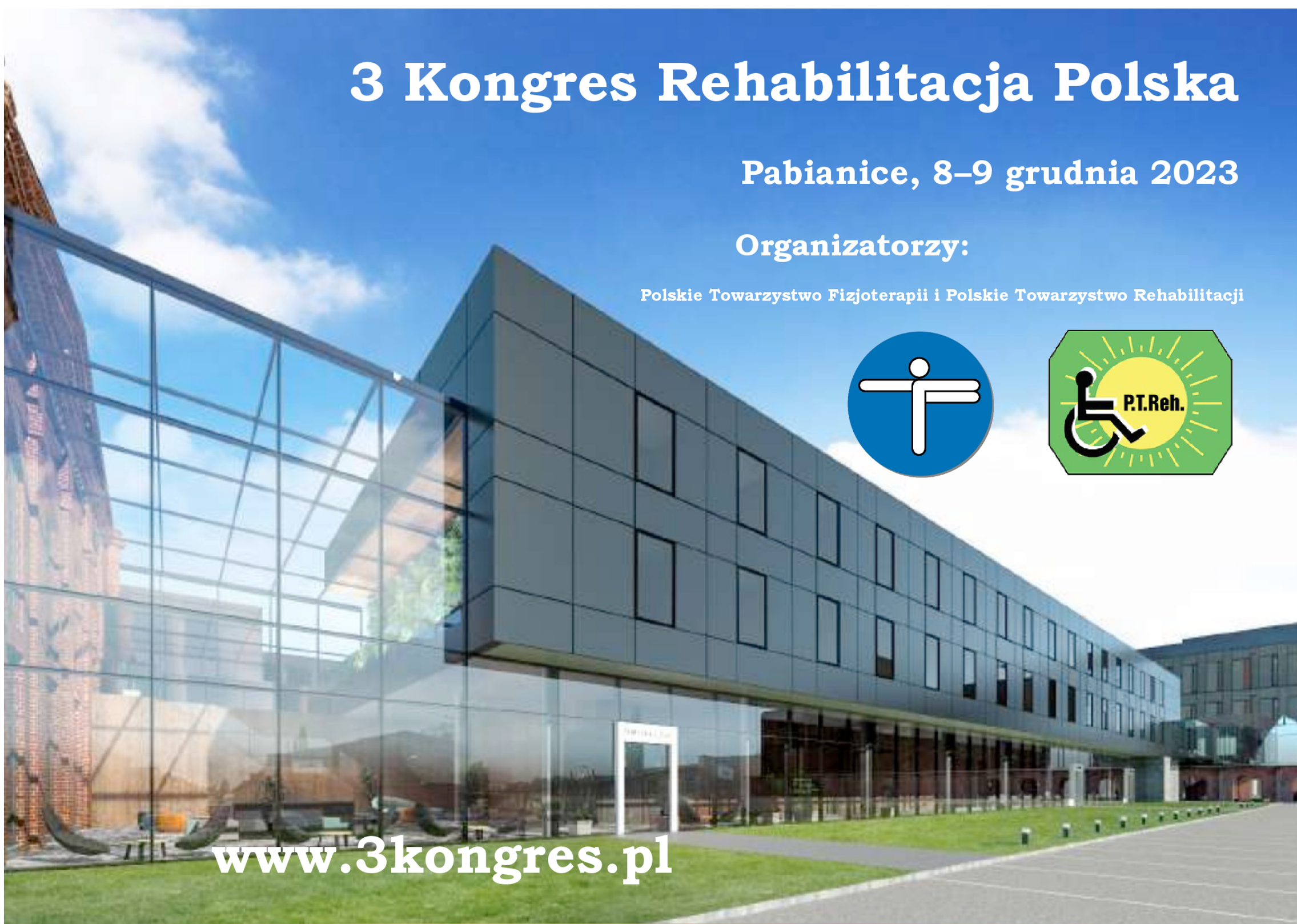

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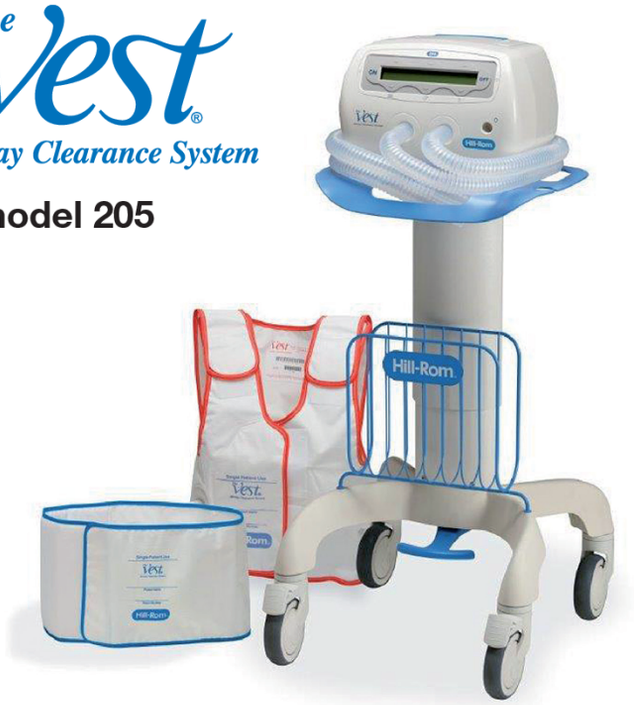

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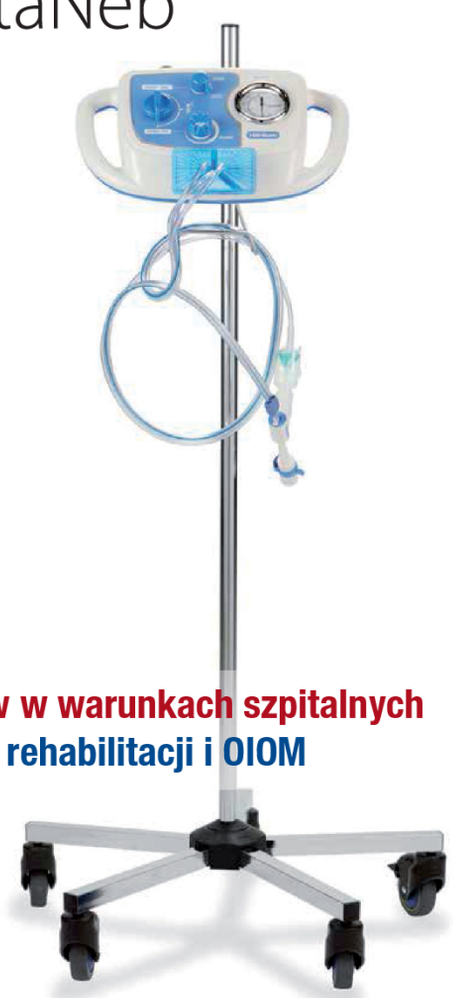

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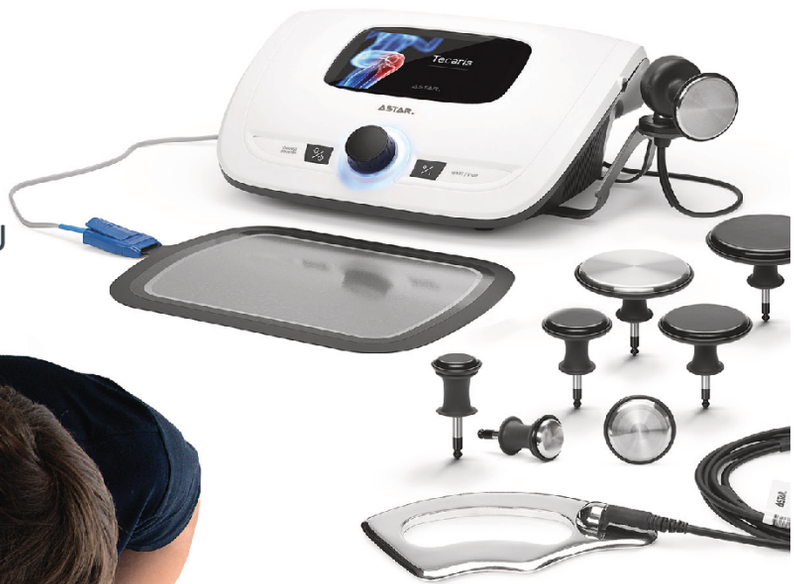

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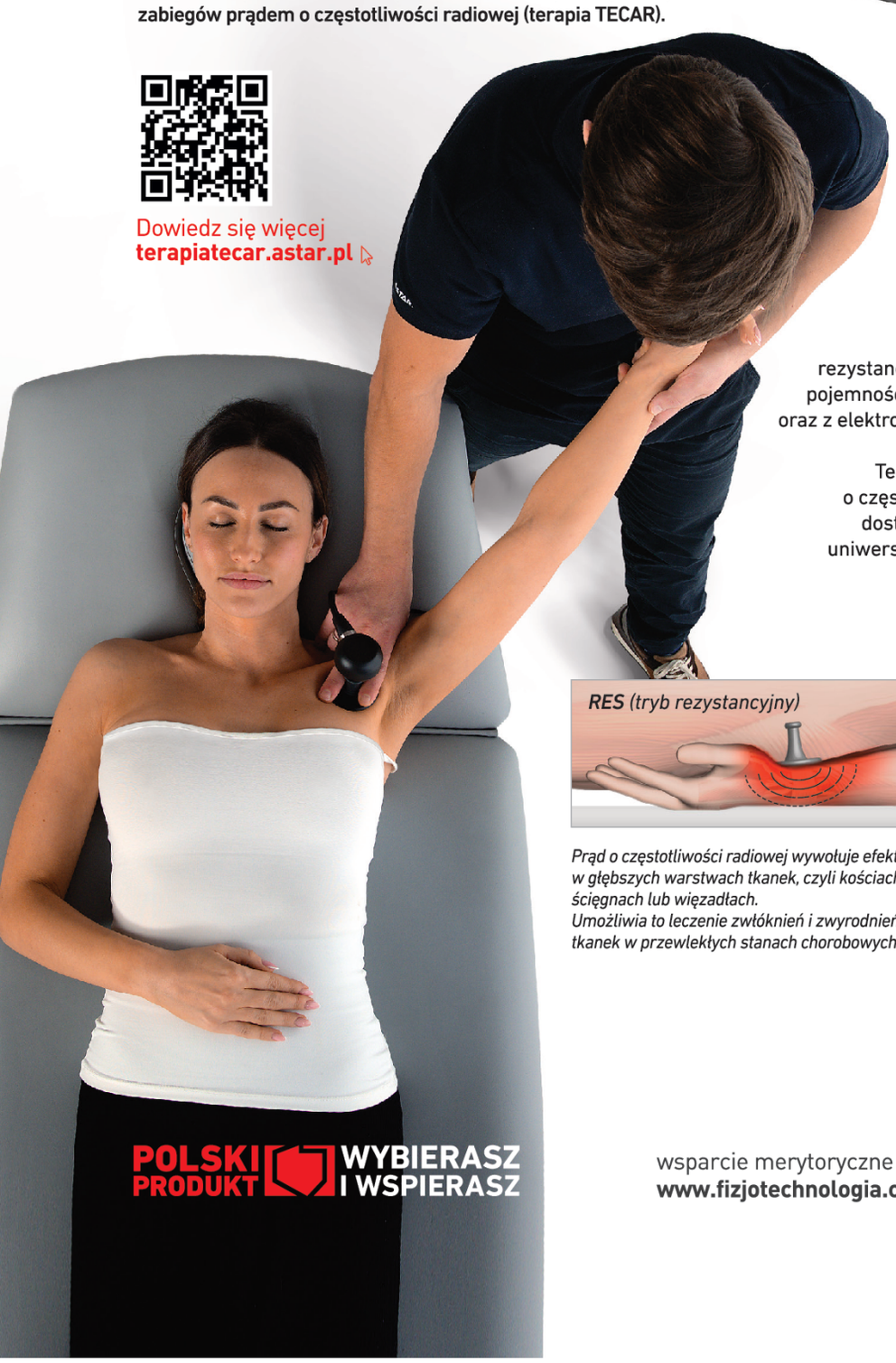

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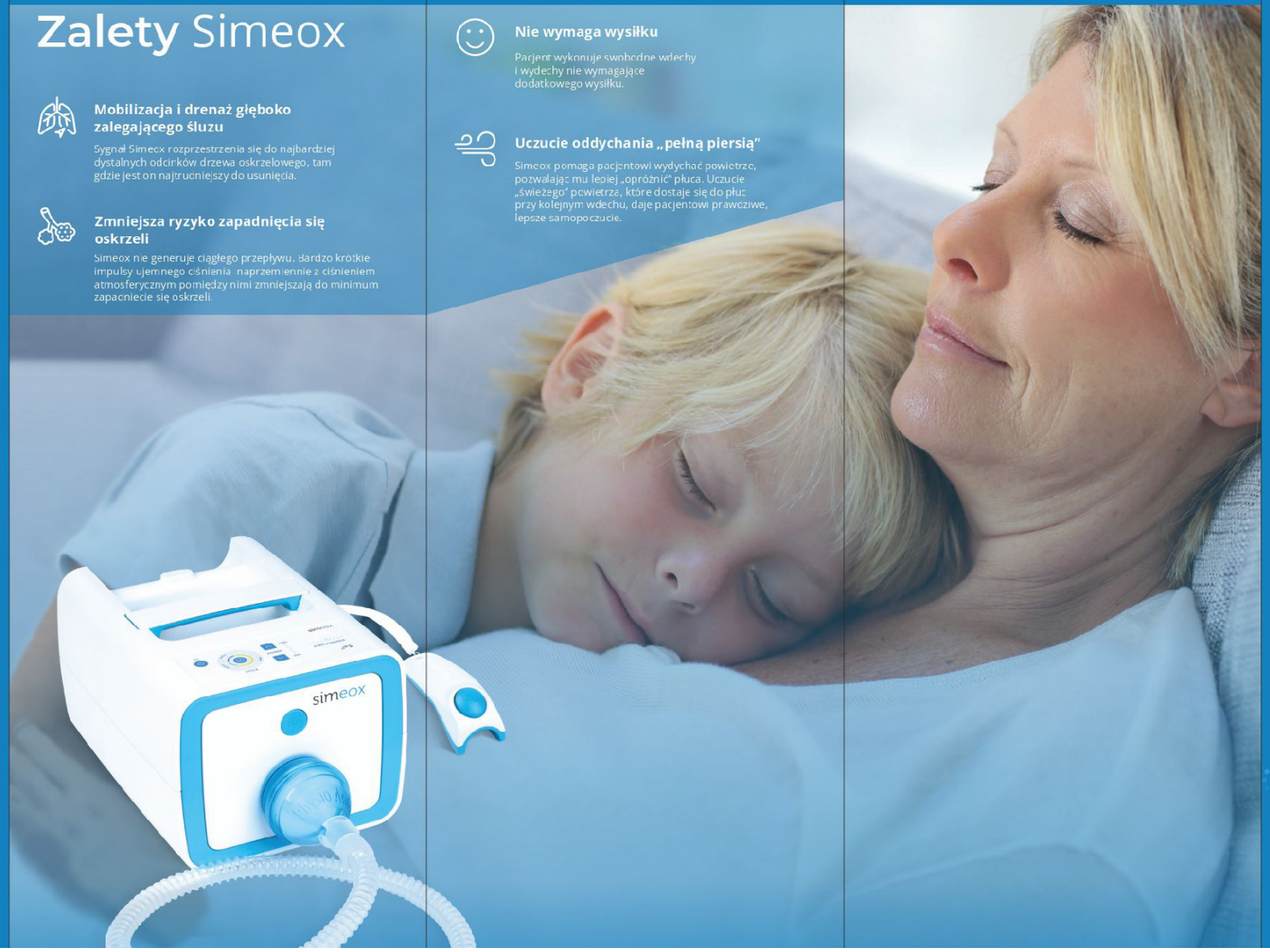

MEDICAL INNOVATION

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nr 4/2023 (23)

Effects of core exercises on knee pain, disability, proprioception, and quadriceps strength in patients with knee osteoarthritis: A randomized controlled trial

Skutki ćwiczeń mięśni rdzenia na ból kolana, niepełnosprawność, propriocepcję i siłę mięśnia czworogłowego u pacjentów z chorobą zwyrodnieniową stawu kolanowego: Randomizowane badanie kontrolowane

Adel Motawea Elsayed Zedan[1(A,B,C,D,E,F,G)], Mohammed Moustafa Aldosouki Hegazy[2(D,E)], Ahmad Hamdi Azzam[3(A,D,E)], Mohammed Shawki Abdelsalam[2(A,C,D,E)]

[1]Department of physical therapy for musculoskeletal disorders and its surgery, Benha University, Egypt
[2]Department of physical therapy for musculoskeletal disorders and its surgery, Cairo University, Egypt
[3]Department of orthopedic surgery, faculty of medicine, Cairo University, Egypt

Abstract

Aim. This pretest-posttest controlled study investigated the effects of core exercises on knee pain, disability, proprioception, and quadriceps strength in patients with knee osteoarthritis (KOA).

Materials and Methods. Eighty patients aged from 40-65 years with mild to moderate KOA were recruited from Cairo University hospitals. They were randomly assigned into two equal groups; group A received core exercises plus conventional exercises and group B received conventional exercises only. Sessions were done 3 times weekly for 4 weeks. Patients were evaluated, pre-and post-treatment, for knee pain (using visual analogue scale), disability (using aggregate locomotor function), proprioception (using inclinometer), and quadriceps strength (using dynamometer).

Results. There were no significant differences between groups post-treatment (p-value > 0.05). There was a significant improvement in quadriceps strength in group (A&B) and pain and disability in group (A) post-treatment (p-value < 0.05).

Conclusions. Adding core exercises to conventional exercises showed a trend towards significance in reducing pain and disability than conventional exercises alone in KOA. On the other hand, conventional exercises with or without core exercises improved quadriceps strength rather than proprioception. Hence, further studies on a larger sample are promising.

Keywords

core exercises, knee pain and function, knee osteoarthritis, knee proprioception, muscle strength

Streszczenie

Cel. To kontrolowane badanie przedtestowe i potestowe badało wpływ ćwiczeń stabilizujących na ból w kolanie, niepełnosprawność, propriocepcję i siłę mięśni czworogłowych u pacjentów z gonartrozą (KOA).

Materiały i Metody. Osiemdziesięciu pacjentów w wieku od 40 do 65 lat z łagodną do umiarkowanej KOA zostało zrekrutowanych ze szpitali Uniwersytetu Kairskiego. Zostali oni losowo przydzieleni do dwóch równych grup; grupa A otrzymała ćwiczenia stabilizujące wraz z klasycznymi ćwiczeniami, a grupa B otrzymała tylko klasyczne ćwiczenia. Sesje odbywały się 3 razy w tygodniu przez 4 tygodnie. Pacjenci byli oceniani przed i po leczeniu pod kątem bólu w kolanie (za pomocą wizualnej skali analogowej), niepełnosprawności (za pomocą łącznej funkcji lokomocyjnej), propriocepcji (za pomocą inklinometru) oraz siły mięśni czworogłowych (za pomocą dynamometru).

Wyniki. Nie było istotnych różnic między grupami po leczeniu (wartość p > 0,05). Stwierdzono znaczącą poprawę w sile mięśni czworogłowych w grupie (A&B) oraz bólu i niepełnosprawności w grupie (A) po leczeniu (wartość p < 0,05).

Wnioski. Dodanie ćwiczeń stabilizujących do klasycznych ćwiczeń wykazało tendencję do znaczenia w zmniejszaniu bólu i niepełnosprawności niż same klasyczne ćwiczenia w KOA. Z drugiej strony, klasyczne ćwiczenia z lub bez ćwiczeń stabilizujących poprawiły siłę mięśni czworogłowych raczej niż propriocepcję. Dlatego dalsze badania na większej próbce są obiecujące.

Słowa kluczowe

ćwiczenia stabilizujące, ból i funkcja kolana, gonartroza, propriocepcja kolana, siła mięśni.

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Introduction

Knee osteoarthritis (KOA) is a chronic degenerative joint disease that affects up to 41% of the adult population. It can cause significant pain and disability in more than half of the patients, leading to large economic burdens [1].

The lumbar spine is related to the knee joint both neurologically and mechanically. Nerve roots supplying the mid-lumbar region converge with those that supply the quadriceps muscle. Static or dynamic mal-alignment of the trunk alters knee joint angles and loading [2].

Core exercises are crucial for KOA as their fatigue or weakness is related to quadriceps weakness, poor posture, and balance, and increased knee loading and symptoms [3,4]. Core exercises may enhance strength, stability, function, and reduce knee loading and symptoms [5-10].

Few studies have been found that address the effect of core exercises in treating KOA and are limited by factors such as small samples, single gender, and/or the incorporation of complex programs [5-10].

Aim

This study investigated the effects of core exercises on knee pain, disability, proprioception, and quadriceps strength in patients with KOA.

Materials and methods

This pretest-posttest controlled study was conducted at Cairo University Hospital between June 2020 and November 2021. Eighty patients with KOA were enrolled and were randomly allocated (using a random number generator with closed opaque envelopes) and equally divided into two groups: Group A (core and conventional exercises) and Group B (conventional exercises only). The sample size was determined based on a power analysis using G*power software, calculating the effect size from a previous study [10]. The power was set to 0.8, and alpha was set to 0.05.

Ethical approval and consent to participate

This study protocol was approved by the research ethical committee of the Faculty of Physical Therapy, Cairo University, with the Project-ID: #012/002731. The study was also recorded at ClinicalTrials.gov with the Identifier: NCT04458753.

Eligibility criteria

Patients with knee OA of grade II/III (according to the Kellgren-Lawrence grading) unilaterally, who experienced pain for most days of the previous month, aged between 40-65 years, and had a body mass index (BMI) between 25-32 kg/m^2 were included.

Patients were excluded if they had symptoms primarily from a joint or area other than the knee, traumatic, infectious, congenital or developmental issues, rheumatic causes at or around the knee, had received an intra-articular injection within the last three months, had previous surgery on the affected knee or spine, had spinal canal stenosis, unstable medical conditions, or had suffered a stroke.

Outcomes

The outcomes were measured at baseline and after four weeks of treatment.

Pain (average pain perceived during the last week) was assessed with a visual analogue scale (in mm) that is valid and reliable [11]. Patients were asked to mark a point on the line that expressed their average pain during the last week.

The aggregate locomotor function scale demonstrated high accuracy and reliability for functional assessment. It sums the times (in seconds) of 3 activities that patients carry out at a natural pace: "eight-meter walk", "stair ascent and descent", and "transferring from sitting to standing" [12].

Proprioception was conducted in the sitting position using an inclinometer as active knee angular reproduction at 30° knee flexion based on the work of Suner-Keklik et al. [13].

Quadriceps strength (in kilograms) was assessed from a supine position with the knee flexed 30° using a hand dynamometer based on the work of Holm et al. [14].

Interventions

All patients received 2 exercises. The first, quadriceps strengthening, was performed concentrically from sitting based on the work of Sayers et al. [15]. The second one, calf and hamstring stretching, was performed from a supine position based on the work of Shah and Shukla [16].

In addition to that, patients in group A received four exercises. The first, transversus abdominis activation, was performed from a hook-lying position using a stabilizer (Chattanooga™, USA) [17]. The second, abdominal strengthening exercise, was carried out as a curl-up from a single leg hook-lying position [17]. The third, multifidus activation, was carried out as an overhead arm lift from a prone position [18]. The fourth, back extensors strengthening, was based on the work of Daud et al. [5].

Statistical analysis

Differences within and between groups were tested using dependent and independent t-tests, respectively. The chi-square test was used to test the differences in sex and disease severity distribution between groups. The level of significance was set to less than 0.05. All analyses were applied using SPSS (v.24).

Results

One hundred patients were enrolled; among them, 80 were eligible, randomized, treated, and analyzed.

Demographic data of the patients in both groups are shown in table 1, which showed insignificant differences between the groups.

Within and Between Group Differences

Descriptive statistics of all outcomes at pre- and post-treatment were presented in table 2. There was significant improvement in pain and function within group A only and quadriceps strength within both groups ($P < 0.05$). However, there were no significant differences between groups either at pretreatment or at post-treatment (Table 2).

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Table 1. Demographic data of patients of both groups

Demographics	Group A (n = 40)	Group B (n = 40)	P- value
Age[a], years	50.7 ± 8	50 ± 9.7	0.78
Weight[a], kg	83 ± 16	77.5 ± 11	0.1
Height[a], cm	167 ± 8.3	164.2 ± 6	0.1
Body mass index[a], kg/m^2	29.6 ± 4.6	29.8 ± 4.8	0.5
Gender[b]			
Male	19 (47.5)	18 (45)	0.65
Female	21 (52.5)	22 (55)	
Kellgren Lawrence grading[b]			
II	30 (75)	28 (70)	0.19
III	10 (25)	12 (30)	

[a]: mean (standard deviation); [b]: count (percentage)

Table 2. Comparison of all outcomes within and between groups

Outcomes		Pre	Post	P
Knee pain [mm]	Group A	59 (± 20)	42 (± 24)	< 0.001
	Group B	57 (± 21)	50 (± 22)	0.08
	P	0.72	0.09	
Knee disability [second]	Group A	25.4 (± 6.7)	22.6 (± 5.4)	< 0.001
	Group B	24.1 (± 5.6)	23 (± 6.6)	0.06
	P	0.32	−0.7	
Knee proprioception [degree]	Group A	4.97 (± 3)	4.6(± 2.78)	
	Group B	4.9 (± 2.9)	4.54 (± 2.8)	0.5
	P	0.85	0.8	0.76
Quadriceps strength [kg]	Group A	7.8 (± 4.3)	10.9 (± 5.5)	< 0.001
	Group B	9.89 (± 6)	11.6 (± 6)	0.014
	P	−1.7 (0.08)	−0.52 (0.6)	

Data presented as mean (± standard deviation)

Discussion

This study investigated the effects of adding core exercises to conventional exercises (Group A) compared to conventional exercises alone (Group A) on knee pain, disability, proprioception, and quadriceps strength in patients with mild to moderate KOA. Post-treatment, results showed non-significant differences between groups, but pain and disability improved within group A and quadriceps strength improved within both groups, partially rejecting the hypotheses.

Patients with KOA had core weakness and impaired postural control [4, 20]. This may increase neuropathic pain (from nerve roots mechanical compression) and lead to impaired loading response and quadriceps activation [21, 22, 23], and hence increased knee moments. Core exercises improve trunk, pelvic, and knee stability that might decrease knee loading and pain and improve muscle activation [4, 23, 24].

Regarding improved pain and disability in group A (core), it came in line with Holm et al. [25] who reported improved knee pain and function when adding neuromuscular exercises, including core training to the treatment program of KOA. Likewise, Sartipzadeh et al. [6] found that core strengthening significantly improved knee pain. Moreover, Hernandez et al. [10], Bartholdy et al. [26], and Sharma et al. [27] reported that combining knee and core exercises improved function, but not more than knee exercises alone in KOA.

Improved knee pain significantly within the core group only

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may explain why function improved within this group as pain reduction may normalize muscle firing, hence reducing knee loading and improving function.

Pain did not differ significantly post-treatment between groups. This study contradicted with Hernandez et al. [10] who found that combining core and conventional exercises improved pain more than conventional exercises alone. This can be explained by differences in the applied program (larger in the previous study) and its duration (longer). However, it trended toward significance in favor of the core group. In addition, Flowers et al. [28] reported that one session of core training did not improve pain.

Furthermore, the present study contradicts with Hernandez et al. [10] and Sharma et al. [27] who reported improved pain and function in the control group. This may be due to differences in the applied conventional program.

Knee proprioception is impaired in knee OA and may inhibit muscles (e.g., quadriceps). However, proprioception did not significantly improve post-treatment, perhaps due to short treatment duration without proprioceptive exercises.

The finding of the current study regarding improved pain but not proprioception came in line with de Oliveira et al. [29] who found that pain did not influence the proprioception in patients with KOA.

Contrarily, the result of the present study regarding improved muscle strength that was not associated with improved proprioception contradicts with de Zwart et al. [30] who found that balance is related to muscle strength. However, balance is a multisystem task that does not represent proprioception alone.

Unfortunately, no studies could be identified by the researcher that compared between core training and conventional exercises in improving knee proprioception in patients with knee OA, to be compared with the finding of the present study. However, it can be expected that core exercises without knee proprioceptive exercises might not be effective in improving knee proprioception in KOA.

Quadriceps strength improved within both groups, but the increased strength after core training (40%) was greater than the control group (17%) and higher than that found after total knee arthroplasty (16.7%) and neuromuscular exercises (10.4%) [24, 31].

The current study supported the reporting that resistance training increases the sensitivity in the sensorimotor structures of the quadriceps, which may decrease knee loads by increasing quadriceps mass and strength, coordination, and timing of eccentric contraction [26, 32, 33]. This may explain the improved quadriceps strength in both groups.

The present study finding did not agree with Hall et al. [34] who stated that strengthening exercises (with/without balance) non-significantly improved quadriceps activation. This may be explained by the difference in the program and measurement tools.

Al-Khlaifat et al. [35] found that the exercise program (hip and knee strengthening exercises plus balance training) reduced pain and vastus lateralis and biceps femoris co-contraction, which might increase knee stability, perhaps through increased muscle strength.

The present study has several strengths in that it included a wide and common category of KOA, applied a specific, simple, and brief core exercise program, included both sexes, and assessed function using an objective outcome (ALF).

A limitation of the current study has been the small effect size and short program duration. Authors recommend repeating this work on a larger sample and for a longer duration of treatment and follow-up.

Conclusion

In light of this study, physiotherapists can add lumbar core strengthening exercises to the conventional treatment of patients with mild and moderate KOA to improve the pain and disability more. Researchers are suggested to further repeat this study with a larger sample and longer treatment duration and follow-up.

Adres do korespondencji / Corresponding author

Adel Motawea Elsayed Zedan

E-mail: adel.zidan@fpt.bu.edu.eg

Piśmiennictwo/ References

1. Litwic A, Edwards MH, Dennison EM, Cooper C. Epidemiology and burden of osteoarthritis. Br Med Bull 2013; 105:185-199.
2. Tauchi R, Imagama S, Muramoto A, et al. Influence of spinal imbalance on knee osteoarthritis in community-living elderly adults. Nagoya J Med Sci 2015; 77: 329-337.
3. Dabholkar T, Dabholkar A, Sachiwala, D. Correlation of the core stability measures with the hip strength and functional activity level in knee osteoarthritis. Int J Ther Rehabil Res 2016; 5(5), 37-43.
4. Joshi SM, Sheth MS, Jayswal MM. Correlation of core muscles endurance and balance in subjects with osteoarthritis knee. Int J Med Sci Public Health 2019; 8(5): 1-6.
5. Daud D, Liau S, Sudi S, et al. A case report on core muscles training for knee osteoarthritis through core muscles activations and gait analysis. Cureus 2023; 15(1).
6. Sartipzadeh M, Moazami M, Mohammadi M. The effect of core stabilization training on elderly balance and knee pain with knee osteoarthritis. Journal of Paramedical Sciences & Rehabilitation 2016; 5(3), 7-17.
7. Subramanian S, Suganthi S. Impact of core exercises and alignment correction exercises of bilateral osteoarthritis knee on an Octogenarian subject–evidenced study. Case Studies Journal 2017; 6 (7): 9-14.

doi.org/10.56984/8ZG20A27A

8. Barghamadi M, Abdollahpour Darvishani M, Behboodi Z. The effect of core stability and strength training on knee pain and function in elderly women with osteoarthritis. Research on Biosciences and Physical Activity 2017; 4(6), 1-9.
9. Selistre L, Gonçalves G, Petrella M et al. The effects of strengthening, neuromuscular and lumbopelvic stabilization exercises on strength, physical function and symptoms in men with knee osteoarthritis: A pilot study. Isokin Exercise Sci 2017; 25(3): 161-169.
10. Hernandez D, Dimaro M, Navarro E et al. Efficacy of core exercises in patients with osteoarthritis of the knee: A randomized controlled clinical trial. J Bodywork Mov Ther 2019; 23(4): 881–887.
11. Delgado DA, Lambert BS, Boutris N, et al. Validation of Digital Visual Analog Scale Pain Scoring With a Traditional Paper-based Visual Analog Scale in Adults. J Am Acad Orthop Surg Glob Res Rev. 2018 Mar 23;2(3):e088.
12. Chen, H., Wang, C., Wu, J., et al. Measurement properties of performance-based measures to assess physical function in knee osteoarthritis: A systematic review. Clin Rehabil 2022, 36(11), 1489-1511..
13. Suner-Keklik S, Cobanoglu-Seven G, Kafa N, et al. The validity and reliability of knee proprioception measurement performed with inclinometer in different positions. Journal of Sport Rehabilitation 2017; 26(6), 1-7.
14. Holm P, Nyberg M, Wernbom M, et al. Intrarater reliability and agreement of recommended performance-based tests and common muscle function tests in knee osteoarthritis. Journal of Geriatric Physical Therapy 2021; 44(3), 144-152.
15. Sayers S, Gibson K, Cook C. Effect of high-speed power training on muscle performance, function, and pain in older adults with knee osteoarthritis: a pilot investigation. Arthritis Care & Research 2012; 64(1): 46–53.
16. Shah S, Shukla Y. Effect of kinesthetic exercises versus agility exercises in unilateral osteoarthritis knee on pain, function and proprioception - an interventional study. International Journal of Science and Healthcare Research 2020; 5(4), 165–180.
17. Kisner C, Colby L. Therapeutic exercise foundations and techniques. 7th ed. Philadelphia: Davis, 2017.
18. Sweeney N, O'Sullivan C, Kelly G. Multifidus muscle size and percentage thickness changes among patients with unilateral chronic low back pain (CLBP) and healthy controls in prone and standing. Manual Therapy 2014; 19(5), 433-439.
19. Petrella M, Gramani-say K, Serrão P, et al. Measuring postural control during mini-squat posture in men with early knee osteoarthritis. Hum Mov Sci 2017; 52(2017): 108–116.
20. Zolio L, Lim K, Mckenzie J et al. Systematic review and meta-analysis of the prevalence of neuropathic-like pain and / or pain sensitization in people with knee and hip osteoarthritis. Osteoarthr Cartil 2021; 29(8):1096–1116.
21. Iijima H, Shimoura K, Aoyama T, Takahashi M. Biomechanical characteristics of stair ambulation in patients with knee OA: A systematic review with meta-analysis toward a better definition of clinical hallmarks. Gait & Posture 2018; 62: 191–201.
22. Preece S, Algarni A, Jones R. Trunk flexion during walking in people with knee osteoarthritis. Gait & Posture 2019, 72: 202–205
23. Hiyama Y, Asai T, Wada O. Effect of improvement in quadriceps strength asymmetry on trunk movement asymmetry after total knee arthroplasty. Gait & Posture 2020;79: 21–25.
24. Holm P, Schrøder H, Wernbom M, Skou S. Low-dose strength training in addition to neuromuscular exercise and education in patients with knee osteoarthritis in secondary care: a randomized controlled trial. Osteoarthr Cartil 2020; 28: 744-754.
25. Bartholdy C, Skou S, Bliddal H, Henriksen M. Changes in physical inactivity during supervised educational and exercise therapy in patients with knee osteoarthritis : A prospective cohort study. The Knee 2020; 27(2020): 1848–1856.
26. Sharma S, Sheth M, Vyas N. Effect of walking versus resistance exercise on pain and function in older adults with knee osteoarthritis. Indian J Pain 2015; 29: 162-165.
27. Flowers D, Brewer W, Ellison J, et al. Transversus abdominis activation does not alter gait impairments in patients with and without knee osteoarthritis. Clin Biomech 2021; 82: 1-7.
28. de Oliveira D, Barboza S, da Costa F, et al. Can pain influence the proprioception and the motor behavior in subjects with mild and moderate knee osteoarthritis? BMC Musculoskelet Disord 2014; 15, 321.
29. de Zwart A, van der Esch M, Pijnappels M et al. Falls associated with muscle strength in patients with knee osteoarthritis and self-reported knee instability. Int J Rheum Dis 2015; 42(7), 1218–23.
30. Bennell K, Kyriakides M, Metcalf B et al. Neuromuscular versus quadriceps strengthening exercise in patients with medial knee osteoarthritis and varus malalignment: A randomized controlled trial. Arthr Rheumatol 2014; 66(4), 950–959.
31. Mujika I, Rønnestad B, Martin D. Effects of increased muscle strength and muscle mass on endurance cycling performance. J Sports Physiol Perform 2016; 11(3), 283 289.
32. Bartholdy C, Juhl C, Christensen R, et al. The role of muscle strengthening in exercise therapy for knee osteoarthritis: A systematic review and meta-regression analysis of randomized trials. Seminars in Arthritis and Rheumatism 2017; 47(1), 9–21.
33. Hall M, Dobson F, Plinsinga M et al. Effect of exercise on pain processing and motor output in people with knee osteoarthritis: a systematic review and meta-analysis. Osteoarthritis and Cartilage 2020; 28, 1501–1513.
34. Al-Khlaifat L, Herrington L, Hammond A, et al. The effectiveness of an exercise programme on knee loading, muscle co-contraction, and pain in patients with medial knee osteoarthritis: A pilot study. Knee, 2016; 23(1), 63–69.

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