ORIGINAL

The effectiveness of corrective exercises on the KOJI AWARENESS score and activity-related pain intensity

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Abstract : Background : The KOJI AWARENESS™ screening test is a self-administered screening tool for assessment of mobility, stability, and strength. It provides corrective exercises corresponding to the individual's answers to the KOJI AWARENESS™ test questions. However, there is no evidence of the effectiveness of corrective exercises in improving KOJI AWARENESS™ screening test scores and activity-related pain. Methods : Twenty-six healthy subjects (11 female and 15 male ; age 20–50 years) were selected for participation. In a controlled laboratory setting, subjects were administered the KOJI AWARENESS™ test and were provided with individualized exercise programs based on the results of this first test. KOJI AWARENESS™ results were checked on the first day immediately after the first exercise session, and then again after the two-week program. Pain intensity was also assessed during daily training using a numerical rating scale. Results : Compared to pre-intervention, KOJI AWARENESS™ scores were significantly higher immediately after the first corrective exercise session and after 2 weeks of intervention ($p<0.001$). Moreover, pain intensity was significantly lower after 2 weeks of intervention ($p<0.001$). Conclusions : Individualized KOJI AWARENESS™ corrective exercises were effective immediately on the first day and also after the two-week program in improving the KOJI AWARENESS™ score and reducing pain intensity during daily training. J. Med. Invest. 70 : 208-212, February, 2023

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INTRODUCTION

The promotion of sports and exercise participation has spread worldwide as a result of clinical evidence demonstrating the beneficial effects of sports on human health (1-3). However, participation in sports and exercise is known to carry risks of injury and pain in individuals in poor physical condition (4, 5).

In the healthcare setting, there are several methods of assessing an individual's musculoskeletal and functional condition, as well as general physical condition for participating in sports. For example, the Balance Error Scoring System is commonly used by both researchers and clinicians to assess static balance (6) and the star excursion balance test (SEBT) has been used to assess dynamic balance (7). Another example is the Y Balance Test (YBT), a modified version of the SEBT, which is designed to assess dynamic postural control due to poor movement patterns (8). The YBT is the most reliable tool, it has good interrater test-retest reliability and is easy to use from a clinician's standpoint, and it has some potential for injury prediction, especially for assessing anterior reach asymmetry (9-11).

The most well-known and widely researched movement screening test for sports is the Functional Movement Screen (FMS), which can identify functional limitations in basic functional movements (12-14). Furthermore, correction of functional limitations or functional movements of the body is important to maintain functional condition (15). Some reports have shown that scores on screening tools are associated with degree of pain. Reports suggest that the FMS can be used as a functional assessment tool to identify functional deficits in chronic lower back pain patients (16). Moreover, studies on the YBT have demonstrated excellent inter-rater reliability and validity for assessing dynamic balance in patients with chronic low back pain (17). Therefore, it is important to improve screening scores and pain intensity by performing corrective exercises based on screening tool scores.

However, these assessments require experts and special equipment for measurement, which limits the use of these assessments as self-screening tests for all individuals. Shultz *et al*. (18) found low inter-rater reproducibility in FMS assessments, limiting the generalizability of the assessments. Therefore, it is necessary to clarify a method that enables the general public without specialized knowledge or environment to self-assess body movement and function.

KOJI AWARENESS screening test has been developed as a self-administered screening test that can be used without any special equipment or requiring evaluation by an expert. It consists of 11 individual components for the assessment of combinations of mobility, stability, and strength (19). Subjects assess the criteria by themselves, using their own bodies. Murofushi *et al*. (20) reported that analysis of the relationship between KOJI AWARENESS™ score and FMS score showed a strong positive correlation ($r = 0.576$, $p < 0.001$). They also reported that the KOJI AWARENESS™ score of athletes showed a significant negative correlation ($r = -0.507$) with the degree of pain, even when age, body mass index (BMI), gender, and other variables

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were used as control variables (19).

Corrective self-exercises have been developed to improve the KOJI AWARENESS™ score. The corrective self-exercises are provided to the subject that correspond to the responses to the 11 items of the KOJI AWARENESS screening test. For example, if there is a problem with flexibility of the neck, self-care for this is suggested. To date, specialist-supervised assessment and training for athlete pain have shown some degree of effectiveness. However, it is unclear to what extent exercises selected based on self-screening tools, such as KOJI AWARENESS™, are effective in treating athlete pain.

The study aimed to confirm whether the supply of corrective-exercises based on self-checks using the KOJI AWARENESS screening test are effective for reducing subjects' activity-related pain and improving the KOJI AWARENESS™ score. We hypothesized that KOJI AWARENESS™ corrective exercises will improve KOJI AWARENESS™ score immediately (after the first day of the intervention) and after a two-week program. In addition, it will decrease activity-related pain after 2 weeks of intervention.

MATERIALS AND METHODS

Subjects

The subjects were recruited from the Sports Science Center at Tokyo Medical and Dental University. A total of 26 healthy subjects (11 women and 15 men ; age 27.0 [10.5] years ; height 168.6 ± 8.8 cm ; body weight 65.0 [18.5] kg ; body mass index 21.9 [4.6] kg/m^2) participated in this study (Table 1). All subjects were physically active and agreed to participate in three practice sessions per week as part of a regular exercise routine. Subjects were excluded if any of the following conditions were met : (i) severe psychiatric, neurological, or cardiovascular disease ; (ii) orthopedic disorder ; (iii) pregnancy ; and (iv) acute infectious disease. Prior to screening, all subjects provided written informed consent to participate in this study. The subjects were instructed to stop when they felt pain during any part of the test. This study was conducted in accordance with the ethical principles embodied in the Declaration of Helsinki (52nd WMA General Assembly, Edinburgh, Scotland, October 2000) for medical research involving human subjects and was approved by the Research Ethics Committee of Tokyo Medical and Dental University (research protocol identification number : M2019-168).

Table 1. Demographic data (N = 26)

Age, y [α]	27.0 (10.5)
Female : Male, n (%)	11 (42.3) : 15 (57.7)
Height, cm [β]	168.6 ± 8.8
Body weight, kg [α]	65.0 (18.5)
Body mass index, kg/m^2 [α]	21.9 (4.6)

[α] Data are reported as median (interquartile range).
[β] Data is reported as mean ± standard deviation.

KOJI AWARENESS™ screening test

The KOJI AWARENESS™ screening test comprises questions aimed at assessing range-of-motion and muscle strength, and it includes a checklist for self-evaluation of the function of each body part (19). There are 11 designated movements for self-evaluation, and each component has distinct scoring criteria, with a maximum total score of 50 points. Each component of the KOJI AWARENESS™ screening test is divided to reflect the corresponding body segments so that subjects can immediately locate the dysfunctional body region. The intra-observer reliability of the KOJI AWARENESS™ screening test was assessed using the intraclass correlation coefficients (ICCs). The ICC (1, 1) for the intra-observer reliability of the KOJI AWARENESS™ screening test was 0.876 (95% CI, 0.434-0.981), and its high reproducibility was confirmed.

KOJI AWARENESS™ corrective exercise

Further details on the KOJI AWARENESS™ corrective exercises are provided in Appendix 1. KOJI AWARENESS™ corrective exercises were developed to align with each of the 11 components of the KOJI AWARENESS™ screening test. KOJI AWARENESS™ corrective exercise programs were prescribed to the subjects for each of the items for which the KOJI AWARENESS™ score was found to be decreased (Table 2). The method of performing the KOJI AWARENESS™ corrective exercises was explained thoroughly to the subjects before starting the interventions under the guidance of an athletic trainer (ATC) who was certified by the National Athletic Trainers' Association.

Table 2. Corrective exercise to improve each component of the KOJI AWARENESS™ screening test

Component	Corrective exercise
① Neck Mobility	Archer's rotation, Python squeeze
② Shoulder Mobility	Wall reverse push
③ Shoulder Blade (Scapular) Mobility	Wall angel slider
④ Thoracic Spine Mobility	Flamenco thoracic exercise
⑤ Upper Extremity Stability & Strength	weight shift wall push
⑥ Hip Mobility	Side sitting to lift, Weight shift squat
⑦ Hip and Spine Mobility/ bending forward/bending back	Straight leg lowering (bending forward), Single-leg squat with an ankle hold (bending back)
⑧ Upper and Lower Extremity Mobility & Stability	single-leg squat with an ankle hold
⑨ Mid-section Stability & Strength	straight leg lowering 45°
⑩ Lower Extremity Strength	Weight shift squat, Single-leg squat with an ankle hold
⑪ Ankle Mobility	Koji wall push

Intervention and protocol

The exercise protocol is explained in Table 3. All subjects provided written informed consent before starting the KOJI AWARENESS™ screening test and KOJI AWARENESS™ corrective exercises. The KOJI AWARENESS™ screening test was administered a total of three times for each subject : 1) immediately after written informed consent was provided at the fitness center (phase 1 or week 1a) ; 2) to check for an immediate effect, immediately after the KOJI AWARENESS™ corrective exercise was performed (phase 2 or week 1b) ; and 3) to verify the effect of the KOJI AWARENESS™ corrective exercise, immediately after 2 weeks of intervention (phase 3 or week 2).

For the exercise intervention, each subject performed individualized (or customized) KOJI AWARENESS™ corrective exercise programs after the first screening test (week 1a), targeting problems in each body area. After week 1a, subjects were instructed and learnt the KOJI AWARENESS™ corrective exercises from the ATC. From the next day after the conclusion of week 1b, 2 weeks of exercise intervention were provided to subjects as

Table 3. Protocol for assessment and intervention

Phase	KA screening test week 1 a	KA corrective exercise education	KA screening test week 1 b	two weeks of intervention	KA screening test week 2
Writen informed concent	First KA screening test and activity-related pain assessment (NRS)	KA corrective exercise was given as a prescription for the problematic area after the KA screening test week 1a	Second KA screening test and activity-related pain assessment (NRS), to check immediate effect of corrective exercise	Every second day, three sets of eight times, ATC to check movement in first week	Last KA screening test and activity-related pain assessment (NRS) to check effect of 2-week intervention of corrective exercise

KA : KOJI AWARENESS™, NRS : numerical rating scale, ATC : certified athletic trainer.

homework to be performed every second day (6 times in total) at a rate of three sets of eight for each session. To ensure exercise sessions were not missed, subjects were provided with a checklist and asked to indicate each time a session had been completed. In addition, to ensure that exercises were performed correctly, all subjects attended the fitness center to have their technique checked by the certified ATC at the end of the first week.

Activity-related pain assessment

All 26 subjects completed numerical rating scale (NRS) questionnaires twice to assess pain intensity during their daily training within 1 week of the baseline test : 1) when subjects came to the fitness center (week 1a) ; and 2) after the intervention of the KOJI AWARENESS™ corrective exercise (phase 2 or week 1b). Subjects indicated their pain location and intensity numerically from 0 (no pain) to 10 (worst pain). NRS assessment is a standardized method with high reproducibility and validity (21).

Statistical analysis

The normality of the distribution of each variable was determined using a histogram and the Shapiro-Wilk normality test. The mean ± standard deviation was used to summarize the normally distributed data, and the median (interquartile range) was used for data that were not normally distributed. The analysis of the results obtained in this study was performed using the following statistical methods : a repeated measures analysis of variance (ANOVA) and post-hoc analyses for KOJI AWARENESS™ screening test score and a Wilcoxon signed-rank test for NRS score. The statistical hypothesis testing was performed using double-sided statistical tests at the 5% level of statistical significance. All analyses were performed with IBM SPSS Statistics 23.0 software (IBM Corp., Armonk, NY, USA).

RESULTS

None of the subjects were excluded after entry, and no subjects withdrew their consent. No subject missed any exercises during the 2 weeks of intervention. The KOJI AWARENESS™ screening test scores in week 1a, Week 1b, and week 2 were 37.6 ± 6.0, 39.8 ± 5.3, and 42.5 ± 5.2, respectively. There were no subjects who had no functional disability prior to the intervention and who had a full score on the KOJI AWARENESS™ screening test scores. Therefore, all subjects were instructed to perform corrective exercises to improve the component for which they scored a point decrease. A repeated measures one-way ANOVA on the KOJI AWARENESS™ screening test scores revealed a significant difference between conditions ($F = 46.667$, $p = 0.000$, partial $\eta^2 = 0.651$). Post-test results showed that the scores for week 2 were significantly higher than those for week 1a ($p<0.001$) and week 1b ($p<0.001$) (Figure 1). Week 1b scores were also significantly higher than those of week 1a ($p<0.001$) (Figure 1).

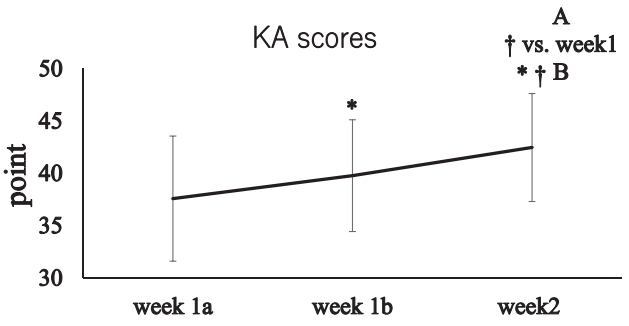

Figure 1. Change in KOJI AWARENESS™ screening test score over the intervention period
KA : KOJI AWARENESS™

The KOJI AWARENESS™ screening test score for each subject showed that corrective exercise improved the score (Figure 2).

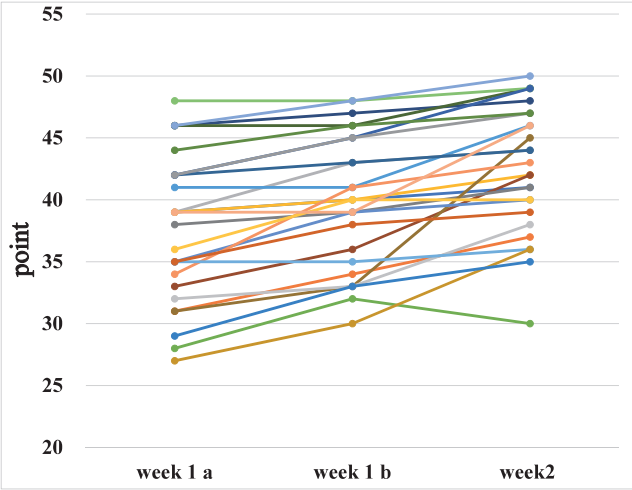

Figure 2. Changes in KOJI AWARENESS™ screening test scores over the intervention period for each subject.

The median and interquartile range for NRS pain intensity scores were 4.0 (6.5) for week 1a and 0.0 (0.0) for week 2. The sites of pain and the number of patients who complained of pain are shown in Table 4. The Wilcoxon signed-rank test showed that the intensity of pain in week 2 was significantly lower than that in week 1a (Table 5).

Table 4. The body part of pain and the number of people in each phase (N = 26).

Body part of pain	Week 1 a	Week 2
Ankle, n	2	0
Calf, n	1	0
Knee, n	3	0
Hamstring, n	3	1
Lower Back, n	1	0
Upper Back, n	1	0
Shoulder, n	1	0
Arm, n	1	1
Wrist, n	1	0
no pain, n	12	24

n : number.

Table 5. Changes in activity-related pain intensity over the intervention period

	Week 1 a	Week 2
Numerical Rating Scale[α]	4.0 (6.5)	0.0 (0.0) *

[α] : Data are reported as median (interquartile range).
* : Significantly lower than Week 1a ($p < 0.05$).

DISCUSSION

This study aimed to investigate how the KOJI AWARENESS™ screening test score and activity-related pain may change following intervention in the form of KOJI AWARENESS™ corrective exercises among healthy subjects. The results indicated a significantly improved KOJI AWARENESS™ screening test score immediately after the first day of intervention in week 1b and after 2 weeks of intervention (week 2). Furthermore, the results demonstrated significantly decreased activity-related pain after 2 weeks of intervention. Overall, the findings support our hypothesis. These results suggest that implementation of an individually oriented corrective exercise program corresponding to an individual's issues is critical.

Several studies have investigated methods of correcting functional limitations or functional movements of the body (15). One study reported that an eight-week intervention program improved FMS scores in professional male soccer players, particularly for advanced movement and mobility subscales (22). In another study, implementation of an eight-week intervention program for mixed martial arts athletes resulted in improvements in functional movement screen test scores in the initial test period ; however, there was no significant improvement between weeks 4 and 8 (23). The results of the current study support these previous studies in terms of the finding that exercise intervention can improve movement screening scores.

Several reports have shown that movement screening test scores are associated with degree of pain. For example, there are differences in FMS scores and YBT results in patients with chronic low back pain and healthy subjects (16, 17). Murofushi *et al*. (19) reported that the KOJI AWARENESS™ scores of athletes showed a significant negative correlation ($r = -0.507$) with the degree of pain ; therefore, our results support these findings. Similar to FMS scores and YBT results, the KOJI AWARENESS™ scores were related to pain. These findings suggest that KOJI AWARENESS™ corrective exercises, provided as individualized exercises based on the results of the KOJI AWARENESS™ screening test may improve both motor function and pain. On the other hand, some reports suggest that exercise intervention programs do not contribute to improved motor function scores. Frost *et al*. (24) examined the effects of an intervention program on firefighters and reported that FMS scores before and after the intervention were unchanged. However, this was considered to be due to the intervention program not being tailored to the individuality of the subject.

In this study, KOJI AWARENESS™ corrective exercises were provided as a tailored exercise program, and because KOJI AWARENESS™ scores reflect an individual's task performance, the KOJI AWARENESS™ scores improved. Consequently, because KOJI AWARENESS™ provides tailored corrective exercise prescriptions for each individual, this possibly increased the effectiveness of the interventions.

The KOJI AWARENESS™ screening test is highly versatile because it is a test that an individual can perform independently without using special equipment. In addition, tailored corrective exercises linked to the KOJI AWARENESS™ screening test score can directly address the areas with a problem (mobility, stability, and strength). In the future, it is possible that the KOJI AWARENESS™ screening test and its corresponding tailored corrective exercises can be used as a clinical diagnostic and movement prescription tool that connects the medical care setting and the sporting industry.

There were several limitations to this study. First, this study did not include a control group, so it does not compare the effects of the KOJI AWARENESS™ tool with other methods. Second, whilst we were able to show that KOJI AWARENESS™ corrective exercises improved KOJI AWARENESS™ screening test scores, we still do not know whether it can improve physical fitness ability as this was not measured. Third, the relationship between the KOJI AWARENESS™ score and the risk of sports injury or trauma remains unknown. Fourth, collective exercises were suggested according to the KOJI AWARENESS™ scores subitems that were found to be decreased. Exercises were not selected according to the site of pain. Therefore, the relationship between pain location and KOJI AWARENESS™ score remains unknown. Lastly, the intervention period was 2 weeks, so we could not identify the mid- to long-term effects of intervention.

In conclusion, the KOJI AWARENESS™ screening test and associated corrective exercise program presents a promising method for athletes to assess their own mobility, stability, and strength independently and receive tailored exercise programs to improve these factors and reduce pain. In the future, it will be necessary to examine the mid- to long-term effects of the KOJI AWARENESS™ interventions using outcomes other than scores, such as physical fitness, sports performance, and risk of sports injury. These factors should be analyzed in future studies.

CONFLICT OF INTEREST

The authors certify that there are no conflicts of interest with any financial organization regarding the material discussed in the manuscript.

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