

## The influence of isometric exercises of the quadriceps muscle on young female patients with anterior knee pain

### *Wpływ ćwiczeń izometrycznych mięśnia czworogłowego w zespole bólowym przedniego przedziału stawu kolanowego u młodych kobiet*

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**Key words:** anterior knee pain, quadriceps femoris muscle, young women, isometric exercises.

**Słowa kluczowe:** ból przedni stawu kolanowego, mięsień czworogłowy, kobiety w młodym wieku, ćwiczenia izometryczne.

#### Abstract

**Introduction:** Anterior knee pain is a disease associated with abnormalities in the patellofemoral joint. It is a common reason for seeking advice from an orthopaedist. This problem is characterised by chronic pain in the anterior part of one or both knees. This issue often affects women, especially at a young age. The effect of this ailment is deterioration of the quality of life. This dysfunction significantly reduces abilities, and often prevents the performance of daily activities. Pain usually occurs during physical activity, but may also be accompanied by prolonged immobilisation of the knee joint. In defining the type of patellofemoral instability, orthopaedists use magnetic resonance imaging, arthroscopy, ultrasonography, and X-ray examination. A relatively effective method of treatment of pain in the patellofemoral joint is through isometric exercises of the quadriceps. They increase the strength of the quadriceps femoris muscle and reduce instability in the patellofemoral joint.

**Aim of the research:** To evaluate the effectiveness of isometric exercises of the quadriceps muscle on young female patients with anterior knee pain.

**Material and methods:** The study involved 30 women aged 13–44 years (mean age: 26.8 years), who had been diagnosed with pain in the front of the knee.

**Results and conclusions:** Isometric exercises of the quadriceps muscle are an effective method of reducing anterior knee pain. Isometric exercises have a beneficial influence on improving physical activity, including performing basic activities of daily living. Student's *t* distribution showed, that isometric exercises of the quadriceps muscle reduce pain at the front of the knee. Kruskal-Wallis test confirmed a significant reduction of anterior knee pain.

#### Streszczenie

**Wprowadzenie:** Ból w przednim przedziale stawu kolanowego jest zespołem objawów powiązanych z nieprawidłowościami w obrębie stawu rzepkowo-udowego. Stanowi częstą przyczynę zasięgania porad u lekarzy ortopedów. Cechą charakterystyczną tego problemu jest przewlekły ból w okolicy przedniego przedziału jednego lub też obu kolan. Problem ten dotyka częściej kobiet, zwłaszcza w wieku młodzieńczym. Skutkiem tej dolegliwości jest pogorszenie jakości życia. Dysfunkcja ta znacznie ogranicza, a często wręcz nie pozwala na wykonywanie czynności dnia codziennego. Ból przeważnie występuje przy uprawianiu aktywności fizycznej, jednak może również towarzyszyć dłuższemu unieruchomieniu stawu kolanowego. Przy określaniu typu niestabilności rzepkowo-udowej wykorzystuje się magnetyczny rezonans jądrowy, badanie artroskopowe, ultrasonograficzne oraz rentgenowskie. Stosunkowo skuteczną metodą leczenia bólu w przedniej części kolana są ćwiczenia izometryczne mięśnia czworogłowego uda. Pozwalają one na wzmocnienie mięśnia czworogłowego i zmniejszenie niestabilności stawu rzepkowo-udowego.

**Cel pracy:** Ocena efektywności ćwiczeń izometrycznych mięśnia czworogłowego u młodych kobiet z zespołem bólowym przedniego przedziału stawu kolanowego.

**Materiał i metody:** W badaniu wzięło udział 30 kobiet w wieku 13–44 lat (średnia wieku: 26,8 roku), u których zdiagnozowano dolegliwości bólowe przedniego przedziału stawu kolanowego.

**Wyniki i wnioski:** Ćwiczenia izometryczne mięśnia czworogłowego uda są efektywną metodą zmniejszania bólu przedniego przedziału stawu kolanowego, korzystnie wpływają na aktywność fizyczną, w tym wykonywanie podstawowych czynności dnia codziennego. Test *t*-Studenta wykazał, że ćwiczenia izometryczne mięśnia czworogłowego uda zmniejszają ból w przednim przedziale stawu kolanowego. Test Kruskala-Wallisa potwierdził istotne zmniejszenie dolegliwości bólowych przedniej strony kolana.

## Introduction

The largest joint of the human body, the knee joint, is particularly exposed to diseases, which makes activities of daily living harder. One of these ailments is anterior knee pain. This illness affects 25% of the population [1]. According to other studies, in the age between 14 and 20 years, pain in the patellofemoral joint appears in 36% of people. It is one of the most common problems for runners, and it accounts for between 16% and 25% of all running injuries [2, 3]. In the case of people who have a sedentary lifestyle, the figure is 11% [2]. From all patients with anterior knee pain, 90% are treated by conservative treatment. The remaining 10% of the patients need surgical treatment [4].

The aetiology of this disease is not fully understood [5]. One theory describes the lack of synchronisation and weakness of the quadriceps muscle, which leads to instability in the patellofemoral joint. As a result, there is a pain that occurs at the front of the knee [6–8]. Other theories of anterior knee pain occurring are: mechanical injury experience, disorders in the trajectory of the patella, and changes in lateral retinaculum nerve endings. There is a connection between pain in the front side of the knee and osteoarthritis [9].

Patients often have problems with pinpointing the location of pain. Women are more often exposed to this disease [10–12]. One of the hypotheses says about the influence of oestrogen levels in the women's body. Oestrogens, also called the female hormones, participate in the regulation of calcium. They stimulate the storage of calcium in the bones, and accelerate the growth of bones and cartilage. The level of these hormones varies depending on the phase of menstrual cycle, and it is highest during ovulation. Therefore, the cyclic hormonal changes that occur during menstruation are possible only in sexually mature women.

The primary task of anterior knee pain treatment is the reduction or elimination of pain. We achieve this by conservative treatment, and when it is ineffective, through surgery. Conservative treatment consists of pharmacotherapy, based on nonsteroidal anti-inflammatory drugs, and physiotherapy. Physical therapy includes kinesiology and isometric quadriceps exercises. Isometric exercises play a key role [13]. In some difficult cases, when conservative treatment fails, surgical cure is implemented. Surgical treatments, which are used in the reduction of anterior knee pain, include: arthroscopy and knee joint replacement, reconstruction of the anterior cruciate ligament, meniscus or cruciform ligaments surgical repair, and hamstring graft [14]. In order to isolate the group at risk of anterior knee pain, preoperative magnetic resonance imaging (MRI) scan of the patellofemoral joint geometry is evaluated [15].

## Aim of the research

The influence of isometric exercises of the quadriceps muscle on young female patients with anterior knee pain.

## Material and methods

The studies involved 30 women aged 13–44 years (mean age: 26.8 years), who had been diagnosed with pain in the front of the knee. Moreover, the nature of work they do and whether patients take medicines that reduce pain in the knee was analysed. It was also checked if the pain is a result of trauma, and what kind of trauma it is. The survey was carried out on two dates: 11.06.2010 and 12.07.2010 at the Department of Orthopaedics and Traumatology in the University Clinical Hospital No. 2 in Lodz. Kinesiology testing was based on the use of isometric exercise – a type of strength training in which the joint angle and muscle length do not change during contraction. The influence of this exercise to reduce pain while performing household activities was also analysed. Additionally, the intensification of pain during quadriceps muscle tension was tested.

Analysis took place according to the following scheme: the patient was on a hospital couch in a supine position. Then she performed exercises raising the painful lower limb, straight, to a height of 10–15 cm. Next, the patient was asked to keep the lower limb in this position for 5 s. After this time, the lower limb was returned to the starting position. This exercise was repeated 10 times. The time of rest between each movement was 15 s. The test was carried out every day, by ambulatory care, for 5 days a week, between 11.06.2010 and 12.07.2010. Visual Analogue Scale (VAS) was used in the study; it is helpful to determine the intensity of pain.

## Statistical analysis

Statistical analysis was performed using Student's *t*-distribution and non-parametric Kruskal-Wallis test.

## Results

The test was carried out on a group of 30 women, whose age was as follows: three women (10% of all respondents) were under 18 years old. Four (13.33%) females were in the age range 18 to 25 years. Ten (3.33%) patients were between the ages of 25 and 35 years. The remaining 13 (43.33%) women were more than 35 years old (Figure 1). Twelve (40%) patients performed an intellectual work, and 7 (23.33%) – manual labour. Sixteen (53.33%) women were taking drugs to reduce the pain in the front of the knee. The remaining 14 (46.67%) females had never taken medications to treat the pain. Ache associated with trauma occurred

**Table 1.** Assessment of pain according to VAS scale

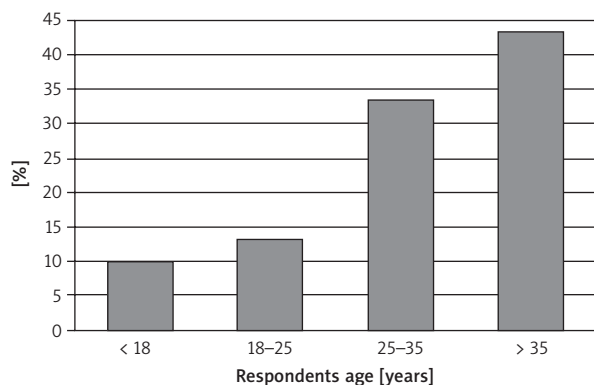
Pain intensity scale	Level of pain before rehabilitation X	Level of pain after rehabilitation Y
0	0	0
1	0	0
2	0	1
3	0	2
4	2	5
5	5	7
6	11	10
7	5	1
8	3	4
9	4	0
10	0	0

Student's *t*-distribution:  $t = 11.2174$ ,  $df = 29$ ,  $p\text{-value} = 2.289e-12$ ;  
Kruskal-Wallis:  $\chi^2 = 25.4853$ ,  $df = 6$ ,  $p\text{-value} = 0.0002776$ .

in 16 (53.33%) patients, and in 14 (46.67%) people there was no relationship between the injury and the appearance of pain. In 5 (31.25%) women pain was a result of twisting, and in 7 (43.75%) patients it appeared as a consequence of fracture. The other 4 (25%) persons paid attention to another type of injury. The average values of intensity of pain, before and after exercises, according to a VAS scale, were 6.47 and 5.4, respectively. A one-tailed test was carried out to ascertain the average value for a pairing attempt of the null hypothesis  $-\mu_{X-Y} \geq 0$ , in terms of alternative hypothesis  $\mu_{X-Y} < 0$ . In the case of Student's *t*-distribution at a significance level 0.05, the *p*-value was  $2.29 \times 10^{-12}$ . Therefore, the null hypothesis was rejected in favour of an alternative hypothesis, which says that the average value of the sensation of pain in patients after treatment is less than before. To confirm the results, a non-parametric Kruskal-Wallis test was also carried out. For the Kruskal-Wallis test, the *p*-value was  $2.78 \times 10^{-4}$ , which confirms the result of Student's *t*-distribution. Before treatment, 16 (53.33%) women had problems with household activities. After the treatment, the number of females complaining of pain decreased to 14 (46.67%). Before treatment, 25 (83.33%) patients felt pain during a quadriceps muscle tension. Eleven (36.67%) women felt pain after the treatment.

## Discussion

The main objectives of isometric exercises are the prevention of muscular atrophy, increasing muscle mass and strength, and the preservation of their activities within the immobilised body sections. They are used for various kinds of immobilisations, as well as in muscle atrophy and in cases where the move-

**Figure 1.** Age of the patients under study

ment in the joint is not recommended. They can be performed under any conditions. Other advantages resulting from the application of this treatment are the ability to precisely determine the angular position that triggers the maximum tension, and also the influence on the selection of muscle use of a suitable tension on the muscle. In addition, using these exercises increases muscle strength relatively quickly. An undoubted advantage is also the shorter time of the exercises during training conducted by this method. There were no contraindications to use this kind of treatment. Very often the anterior knee pain was revealed in patients aged between 25 and 35 years, and also above 35 years. This is confirmed by the same theory, which means that the pain in the patella femoral joint is detected mostly in young females [8, 10]. Pain in the front of the knee was most common in women who performed intellectual work, which is confirmed by the research of Dixit *et al* [2]. Patients applied mainly pharmacological treatment based on non-steroidal anti-inflammatory drugs. Pain associated with trauma appeared in 16 (53.33%) women. In 5 women the pain was a result of twisting, and in seven patients it appeared as a result of the fracture. The other four females showed a different type of injury. Before using isometric exercises 16 people had problems with the activities of daily living. After treatment the number of women with such problems dropped to 14. Also, during the quadriceps muscle tension, the number of women complaining of pain decreased. This is compatible with the research carried out by Garrison *et al.*, who showed a primary role of isometric exercises in anterior knee pain treatment [13]. The studies showed that pain intensity before treatment was 6.47 in a VAS scale. After treatment the number decreased to 5.4. Studies showed that the statistical average increased after the test.

## Conclusions

Isometric exercises of the quadriceps muscle are an effective method in reducing anterior knee pain. Isometric exercises have a beneficial influence on improv-

ing physical activity, including performing basic activities of daily living. Student's *t*-distribution showed that isometric exercises of the quadriceps muscle reduce pain at the front of the knee. Kruskal-Wallis test confirmed a significant reduction of anterior knee pain.

### Conflict of interest

The authors declare no conflict of interest.

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