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Dynamics in morphological characteristics of femoral muscles in patients with total hip replacement involved in different rehabilitation programs

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Objective Review the dynamics in morphological characteristics of femoral muscles in patients with THR who followed different rehabilitation programs. **Material and methods** Radiological and ultrasonographic assessment was used in 43 patients with THR and pain at the side of the operative intervention. Nineteen outpatients of the index group had manual therapy using the authors' soft tissue manipulation technique. Control group included 24 patients aged 37 to 74 years (mean age of 57.3 ± 2.3 years) who were treated with standard method employing exercise therapy, massage with ischemic compression of trigger points, physioprocedures, nonsteroidal anti-inflammatory drugs, chondroprotective and vascular agents, and vitamins of B-group. **Results** The findings showed changes in optical density of the femoral soft tissues following a course of manual therapy that was likely to be related to the improved ROM in the hip and further decrease in muscle tone and better microcirculation in the interest area. Ultrasonographic assessment of periarticular muscles of the operated hip demonstrated an increase in the belly thickness of the target muscle with decreased echogenicity and recovered oblique and longitudinal fiber striation after the course of manual therapy. Control group exhibited no changes in the radiological and sonographic manifestations. **Conclusion** Manual therapy used for pain arrest showed to be effective in patients with THR and can be advocated as a part of rehabilitation measures.

Keywords: total hip replacement, ultrasonography, optical density of soft tissues, manual therapy

INTRODUCTION

The incidence of severe hip pathology has been increasing among orthopaedic patients over the past decade that brings up a serious medical and social problem [1]. Patients with deforming arthritis are known to have expressed muscle changes around the joint that are to be considered when planning conservative and operative treatment [2, 3, 4]. Among a variety of surgical intervention techniques, total hip replacement (THR) is the treatment of choice for advanced hip arthritis. This surgery results in pain relief, improvements in the hip motion, function of periarticular muscles and soft tissue structures, supportability of the limb, quality of life with a direct impact on patient social and occupational activities [5]. However, durable morphological changes in periarticular tissues tend to persist after hip arthroplasty [6, 7] and cause pain in 17% to 20 % of the patients. Thirty two to thirty five per cent of THR patients reported new pains ranging from mild discomfort to expressed vertebrogenic symptoms or other types of arthralgia with no signs of implant instability and infection [8] that considerably impaired the patient quality of life. An artificial joint completely integrated into a kinematic chain of the operated limb can successfully function with a proper condition of periarticular muscles that would be dependent on the quality of locomotor rehabilitation run to restore the hip motion.

The aim of the study was to explore the dynamics in morphological characteristics of femoral muscles in patients with total hip replacement who underwent different rehabilitation programs.

MATERIAL AND METHODS

Radiological and ultrasonographic assessments were used in 43 patients with THR who reported pain at the side of the operative intervention at regular follow-up visits to the consultation and diagnostic department of the Russian Ilizarov Scientific Center for Restorative Traumatology and Orthopaedics. The patients underwent courses of restorative treatment at different times at the department of rehabilitation after the operative intervention.

Nineteen outpatients of the index group had manual therapy using the authors' soft tissue manipulation technique (RF patent № 2530381). The technique was aimed at identifying trigger points by palpating the femoral and gluteal muscles to be followed by manual vi-

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bration of the painful site with the heel of the hand or finger pads with amplitude of 120 to 180 per minute during 3 to 5 minutes. The session was repeated after a 5-minute break. The course of treatment included 6 to 8 sessions performed once a week.

The mean age of the patients (9 males, 10 females) with the stable implant was 53.4 ± 3.2 years (range, 22 to 74 years). Bilateral hip arthroplasty was performed for 6 patients, right-side implantation for 9 cases and left-side procedure for 4 persons. Duration of the disease prior to THR was 11.9 ± 2.9 years on average; the patients were followed up from 4 months to 6 years with the mean period of 1.7 ± 0.5 years.

Control group included 24 patients aged from 37 to 74 years (mean age of 57.3 ± 2.3 years) who were treated with standard method employing exercise therapy, massage with ischemic compression of trigger points, physioprocedures, nonsteroidal anti-inflammatory drugs, chondroprotective and vascular agents, and vitamins of B-group. There were 9 males and 15 females. The mean duration of the disease prior to THR was 12.0 ± 2.3 years. Right-side THR was performed for 12 patients, left-side arthroplasty for 9 cases, and bilateral intervention for 3 cases. The patients were followed up from 4 months to 6 years with the mean period of 1.9 ± 0.4 years.

Two to three periarticular muscles (*musculus quadriceps femoris*, *iliopsoas*, *musculus adductor brevis*) of the patients enrolled in the study were identified with pathologically changed tone (trigger points, painful muscle shortening) during manual palpation tests. The muscles were marked as target muscles for the manual impact.

Morphological muscle characteristics of the operated femur were assessed ultrasonographically with *LogiQe* ultrasound equipment (*General Electric Co*., U.S.A.) measuring the thickness of the muscle belly (mm), echogenicity (dB) and echotexture (characteristic oblique and longitudinal striation and pennation angle).

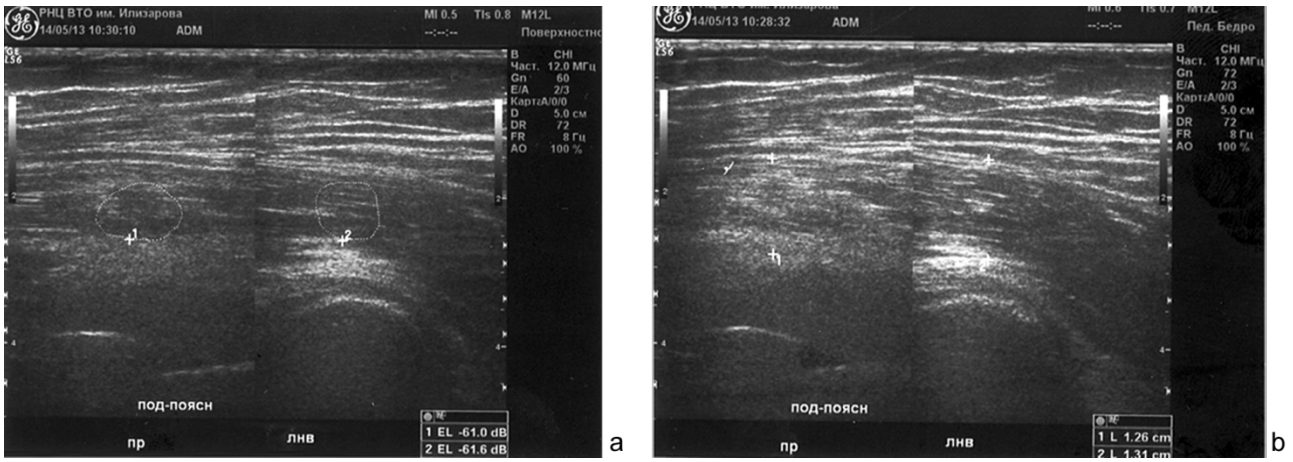
Optical density of the soft tissues at the medial side of the proximal femur operated on was evaluated with *DiaMorph* equipment (PPP *DiaMorph-Cito*, Russia). An area of soft tissues (approximately 31.4 ± 2.4 cm^2) was interactively delineated in the upper third of the femur medially to the bone using digitized radiographs of the pelvis to calculate the mean optical density (in standard conventional units according to the technique, patent of RF № 2513150).

Statistical data analysis was performed with nonparametric tests of *Attestat* application program incorporating W- and T-Wilcoxon tests. The level of statistical significance was 0.01; 0.05.

RESULTS

Preoperative ultrasonographic measurements of the muscle belly of the operated hip in the index group were 14.9 ± 0.8 mm (upper third) and 13.4 ± 0.7 mm (middle third) for *musculus rectus femoris*, 11.8 ± 0.8 mm for *musculus adductor brevis*, 13.8 ± 0.9 mm for *iliopsoas*, with normal values measuring 14.0 ± 1.0 mm, 13.8 ± 0.6 mm, 13.9 ± 0.9 mm and 14.4 ± 0.6 mm, correspondingly. The thickness of the target muscle belly was shown to be significantly ($p < 0.01$) decreased by 21.3 ± 2.0 % on average in 71.4 % observations. There were no deviations from the norm in all the rest of the cases.

Baseline measurements of the target muscle echogenicity in index group were 58.8 ± 1.6 dB in the upper third of *musculus rectus femoris*, 56.4 ± 1.9 dB in the middle third of *musculus rectus femoris*, 57.9 ± 1.7 dB for *musculus adductor brevis*, 61.0±2.2 dB for *iliopsoas*, with normal values measuring 62.6 ± 1.7 dB, 59.9 ± 1.4 dB, 61.7 ± 1.4 dB and 67.3 ± 1.3 dB, correspondingly (**Fig. 1**). Echogenicity of the muscles was shown to be increased by 11.6 ± 1.2 % ($p < 0.01$) in 81.0 % of the cases.



a b

Fig. 1 Ultrasound image of iliopsoas of a 52-year-old female patient M. measuring echogenicity (**a**), thickness of the muscle belly (**b**)

Oblique and longitudinal striation being characteristic of the muscles appeared to be vague.

The thickness of target muscle belly was shown to be increased by 15.7 ± 2.8 % in most of the cases (76.2 %). The thickness of the belly measured 15.6 ± 0.7 mm in the upper third of *musculus rectus femoris*, 13.9 ± 0.8 mm in the middle third of *musculus rectus femoris*, 12.7 ± 1.0 mm for *musculus adductor brevis*, and 14.2 ± 0.8 mm for *iliopsoas*.

Echogenicity of the muscles was shown to be decreased by 8.1 ± 0.9 % ($p < 0.05$) on average in most of the cases (76.2 %) after THR. No significant dynamics in echogenicity of target muscles was observed in the rest of the cases. Echogenicity measurements were 61.0 ± 1.8 dB in the upper third of *musculus rectus femoris*, 59.4 ± 1.6 dB in the middle third of *musculus rectus femoris*, 60.5 ± 1.8 dB for *musculus adductor brevis*, and 63.0 ± 2.5 dB for *iliopsoas* after THR.

There was a tendency for recovery of oblique and longitudinal striation of the muscles and increase in pennation angle (α) (**Fig. 2**).

No dynamics in radiological and ultrasonographic findings of the muscles was observed in control group.

Assessment of the soft tissues of the femur with *DiaMorph* equipment exhibited preoperative mean optical density (MOD) of the region of interest measuring 0.34(0.42) ± 0.05 SCU being up 47.8 % from the normal level (0.23±0.05 SCU). MOD appeared to decrease by 47.1 % ($p < 0.01$) measuring 0.18(0.14) ± 0.04 SCU at the end of the manual therapy course.

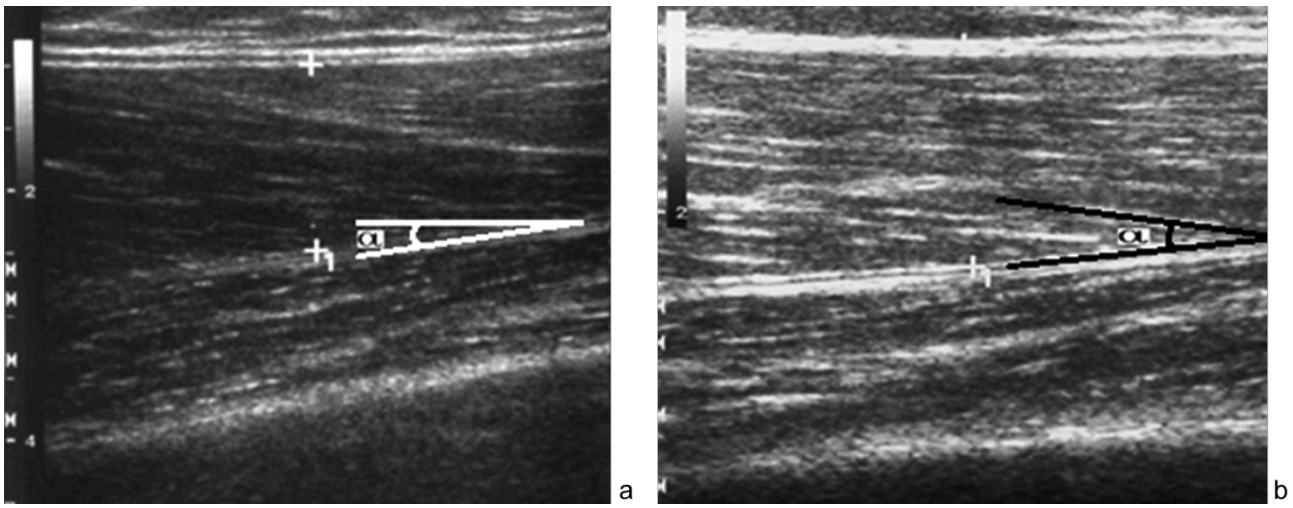


Fig. 2 Preoperative (**a**) and postoperative (**b**) ultrasound image of *musculus rectus femoris* and *musculus vastus intermedius* of a 22-year-old male patient showing pennation angle (α)

DISCUSSION

Our findings showed that the recorded changes in optical density (decrease by 47.1 %) of the soft tissues of the femur after the course of manual therapy were likely to be associated with pain relief and improved motion in the joint and further decrease in muscle tone and better microcirculation in the interest area. Ultrasonographic assessment of periarticular muscles of the operated hip demonstrated increase in the belly thickness of the target muscles (by 15.7 %) with decreased echogenicity (by 8.1 %) and partially recovered oblique and longitudinal fiber striation after the course of manual therapy. Control group exhibited no changes in the radiological and sonographic manifestations. Absence of positive dynamics in ultrasonographic findings in several observations of the index group could be attributed to contralateral hip arthritis, severe ipsilateral knee arthritis, evident vertebrogenic symptoms or severe scarry changes in the soft tissues of the femur due to earlier surgical intervention.

CONCLUSION

Ultrasonographic assessment of periarticular muscles of the operated hip demonstrated increase in the belly thickness of the target muscles with decreased echogenicity and partially recovered oblique and longitudinal fiber striation, and radiological changes in optical density of the soft tissues of the femur were observed after the course of manual therapy. Control group demonstrated no changes in the findings.

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