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Quadriceps Contracture in Companion Animals - Physical Therapy

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ABSTRACT

***Background*:** Quadriceps muscle contracture (QC) that develops because of orthopedic interventions in the distal femur, proximal tibia or stifle joint is a difficult process and may require a new series of orthopedic surgeries. However, despite everything, the prognosis is considered poor. The use of various physical therapy methods in musculoskeletal system and pain control is becoming more common in veterinary practice. This study aimed to investigate the effectiveness of transcutaneous electrical nerve stimulation (TENS), therapeutic ultrasound (TU) and low-level laser therapy (LLLT) applications in the treatment of QC in 1 cat and 6 dogs.

***Materials, Methods & Results*:** The study was conducted on 6 dogs and 1 cat diagnosed with QC. All animals had undergone previous surgery. TENS+TU+LLLT was applied to the animals in the study for physical therapy for 3 or 4 weeks. The findings of the study were found to be extremely satisfactory, in terms of opening the muscle contracture and regaining the use of the leg. After each case was examined clinically, the relevant extremity was evaluated orthopedically. The hip-stifle joint, femur, tibia and surrounding soft tissues were examined. Quadriceps femoris muscle (QFM) tension, stifle and stifle joint range of motion, QFM atrophy, pain, hip joint function, abduction and adduction ranges were examined. In addition, the patient's history and the development of the disease were noted to determine the etiology. Additionally, craniocaudal and mediolateral X-ray images of the extremity were taken. The diagnosis of quadriceps contracture was made based on clinical examination findings. Physical therapy was then planned with TENS, TU and LLLT sequences. When the cases were evaluated, it was understood that some of them were caused by faulty/insufficient and malpractice practices (4 cases), while some (3 cases) developed QC due to the patient's inability to use their extremities. In all cases, the stifle joint was stiff, and it was very difficult to move the joint. The quadriceps muscles were stiff and atrophied. No problems or difficulties were experienced in the implementation of physical therapy procedures. In the animals that the owner showed interest, it was noticed that the stifle joint gap and contracture started to decrease after the 2nd session and the recommended passive movements were performed at home. In the other patients, there was a significant relief at the end of the 1st week. At the end of the 3rd week, the animal was able to use its extremities clinically and the owner was satisfied. No case required surgical treatment for QC.

***Discussion*:** Treatment options for QC, which often develops after incorrect or poor/insufficient orthopedic interventions, are limited even today. The patient remains in a situation that can lead to amputation of the relevant extremity. In addition, it is known that strain or hyperflexion movements during physical therapy will cause ruptures or fractures at the point where the muscle attaches to the tibia. In our study, different physical therapy applications such as TENS, TU and LLLT were used in combination without applying any force or pressure to the region. Of course, different doses and durations than the ones we chose could have been chosen, but the patient owner constantly stated that the patient's pain was relieved in our applications. In addition, it was clearly seen that the muscle contraction began to resolve significantly at the end of the 1st week of treatment and the stifle joint range of motion began to increase. As a result, it should be known that in cases where QC develops, with effective physical therapy in the early period, the patient can regain his/her former health and surgery will not be necessary.

Keywords: cats, dogs, low level laser therapy, LLLT, transcutaneous electrical nerve stimulation, TENS, therapeutic ultrasound, TU.

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INTRODUCTION

Quadriceps contracture (QC) is a condition that occurs as a congenital deformity or as a complication of femur fractures in puppies [16]. This condition is also known as posttraumatic stifle joint stiffness, quadriceps contracture syndrome, stifle joint hyperextension, hindlimb stiffness, quadriceps ischemic contracture [3,14,16]. Quadriceps contracture is more common in puppies. Because it usually develops because of improper treatment of distal femur fractures in 3-month-old puppies, which is considered the critical period. It is also one of the most important reasons for QC, especially in long-term immobilization with bandages during this period. Similarly, trauma to the distal femur region, ischemia, hematoma, muscle contusion, repeated patellar dislocation, and tibia fractures are among the causes [3,14,16].

Previous studies have reported that the prognosis for QC treatment is not very good, but techniques such as isolation of adhesions in regional muscles, "Z" type myoplasty of the quadriceps femoris muscle, femoral cuneiform osteotomy, Kirschner-Ehmer External Skeletal Fixator can be applied [9,11,16].

Physiotherapy methods such as massage, hydrotherapy, transcutaneous electrical nerve stimulation (TENS) [8,10], therapeutic ultrasound (TU) and low-level laser therapy (LLLT) applications are becoming more common in the veterinary field, either alone or in combination [5-12]. It is widely used for pain control, as well as for muscle and joint disorders. Additionally, studies on the usability of these methods continue [8,17].

This study aimed to investigate the effectiveness of TENS, TU and LLLT applications in QC treatment in cats and dogs.

MATERIALS AND METHODS

Animals

This study was carried out on 6 dogs and 1 cat diagnosed with QC in the surgery department of Dicle University Veterinary Faculty Hospital. The conditions of the patients are summarized in Table 1.

Study design

A detailed clinical examination was performed in all cases, and in painful cases, the examination was continued under sedation to benefit from the muscle relaxation effect. The involved extremity was evaluated. The hip-stifle joint, femur, tibia and surrounding soft tissues were examined. Quadriceps femoris muscle (QFM) tension, stifle and stifle joint range of motion, QFM atrophy, pain, hip joint function, abduction and adduction ranges were examined. In addition, the patient's history and the development process of the disease were noted in detail in terms of etiology. Additionally, the extremity was examined radiographically (Figures 1-3), craniocaudally and mediolaterally.

The diagnosis of quadriceps contracture was made based on clinical examination findings. Then, physical therapy was planned in combination with TENS, TU and LLLT sequences (Figures 1-3).

Transcutaneous electrical nerve stimulation (TENS) applications

TENS application was applied once a day for the 1st 3 days, with premode waveform, continuous cycle, 80/150 Hz frequency, 1.3 mA, for 1200 s. In the following days (for 3 or 4 weeks), 1.5 mA was continued and increased to 1.8 mA until the patient showed a reaction.

Therapeutic ultrasound (TU)

TU treatment was administered once a day with the TU device (Intelect Vet; 1 MHz, continuous mode, SATA intensity 1.5 W, exposure time: 900 s)[1]. The intensity continued at 1.8 W during the 2nd week and 2.0 W during the 3 or 4 weeks.

Low level laser therapy (LLLT)

A GaAs (gallium arsenide) laser device (Lasermed 2200)[2] was set to λ=905 μm, 10,000 Hz, 25 mW, and peak power 25 W in continuous mode used for laser therapy. The monodiode laser probe (MLA1/25) was applied once a day from a close distance, holding it perpendicular to the skin. Laser treatment was calculated according to the formula (power/beam area) X time = J/cm^2 and was applied transcutaneously with regional scanning movements of 9 J/cm^2 for 180 s every day for 3 or 4 weeks.

Additionally, passive exercises and massage were recommended to all patients. None of the patients in the study were given any supplements such as muscle relaxants or painkillers.

A scale, previously described [16] for use in QC, was used as an evaluation scale for the limb function of the subjects. Accordingly, "good" means no lameness and comfortable bearing of weight on the limb with each step; there is “sufficient” lameness and the inability to use the extremity in a disturbing way and cannot bear weight for 3-4 steps, “poor” lameness is the absence of use of the limb during walking and rest.

Table 1. The data about etiology, clinical findings obtained from the cases and their treatment results.

Cases	Age months	Etiology	Clinical findings	Applied FTR	Clinical outcome
1. Dog, male	12	Incorrect treatment after patella dislocation (Figure 1)	Stifle joint is rigid, joint movement is difficult. QFM atrophic, rigid.	Combine, for weeks	Good
2. Dog, male	6	Incorrect treatment after distal femur fracture (Figure 2)	Stifle joint is rigid, does not open. QFM is atrophic, rigid. tarsal joint hyperextension.	Combine, for weeks	Poor
3. Dog, bitch	2	Incorrect treatment after distal femur fracture	Stifle joint is stiff, joint movement is difficult. QFM atrophic, rigid.	Combine, for 3 weeks	Good
4. Dog, male	4	After proksimal tibia fracture	Stifle joint is stiff, joint movement is difficult. QFM atrophic, rigid.	Combine, for 3 weeks	Good
5. Dog, bitch	5	Keeping a bandage after a femur fracture	Stifle joint is stiff, joint movement is difficult. QFM atrophic, rigid.	Combine for 2 weeks	Good
6. Dog, bitch	4	Incorrect treatment after distal femur fracture	Stifle joint is stiff, joint movement is difficult. QFM atrophic, rigid.	Combine for 3 weeks	Good
7. Cat, male	4	Incorrect treatment after distal femur fracture (Figure 3)	Stifle joint is stiff, joint movement is difficult. QFM atrophic, rigid.	Combine for 3 weeks	Good

QFM: Quadriceps femoris muscle; FTR: Physiotherapy; Combine: Tens + TU + LLLT respectively.

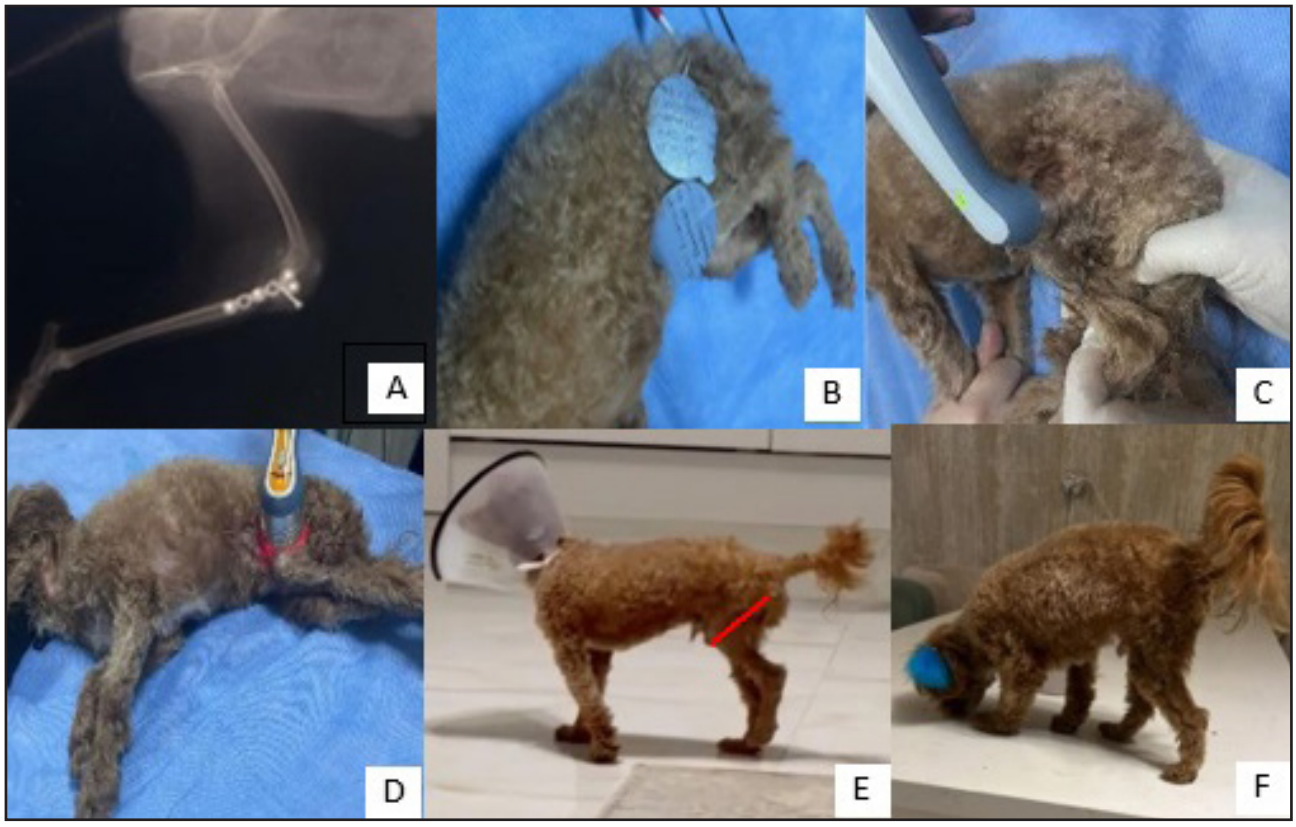

Figure 1. X-ray of the patient and physical therapy application stages. The plaque was removed and physical therapy was applied for 3 weeks. A- Previously, tuberosity tibia transposition was performed for patella dislocation. B- TENS application. C- TU application. D- LLLT application. E- In this case, he holds his leg in the air in a contracted manner. Watch out for the red line. F- Images of the 1st month after completion of physical therapy.

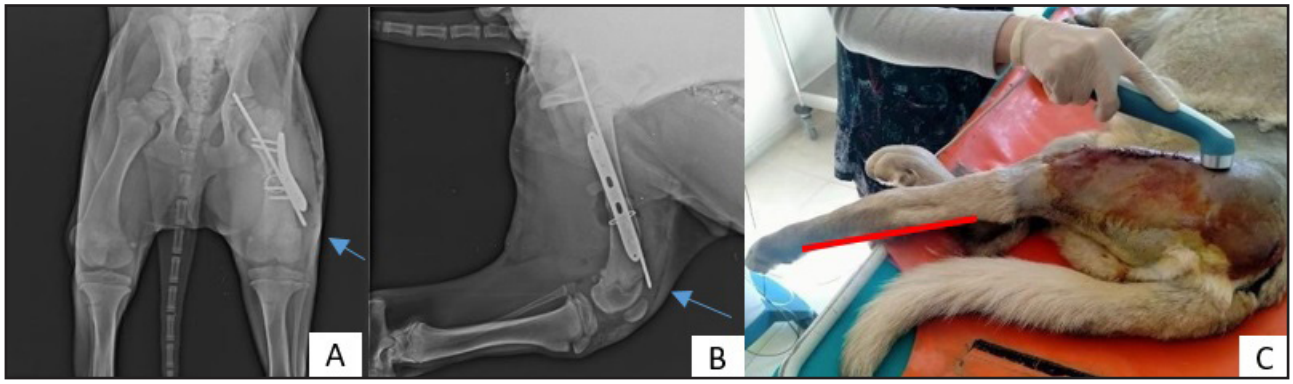

Figure 2. An incorrect osteosynthesis process. A & B- Previously intramedullary pin application and plate were applied. However, the pin is protruding (blue arrows) from the cortex and is a cause for quadriceps muscle contraction. C- An image during TU application. After the pin and plate were removed, physical therapy was started. A tarsal hyperextension of approximately 180 degrees (a red solid line) was notable. Recovery in this patient was poor. The owners subsequently disrupted physical therapy sessions.

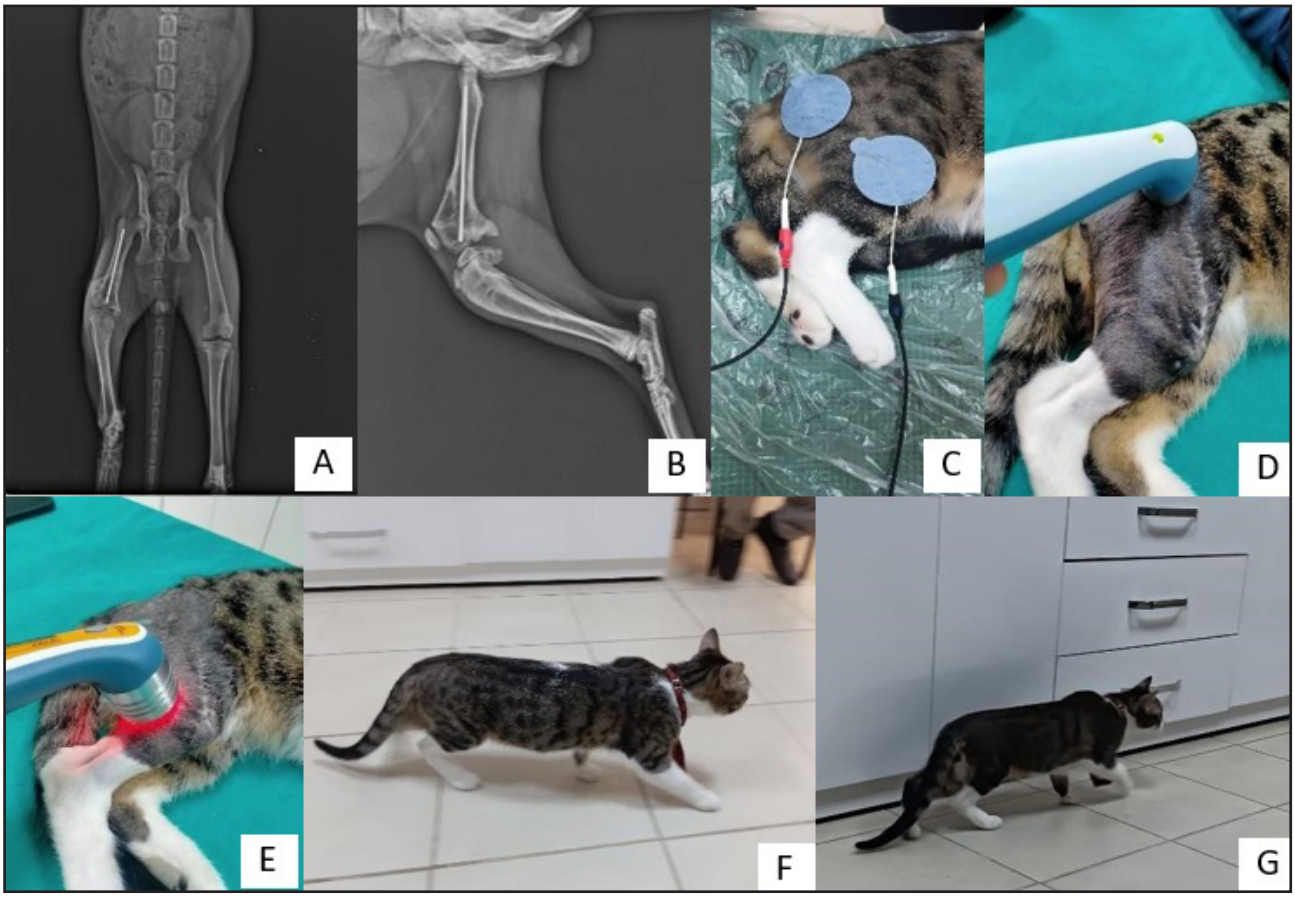

Figure 3. QC developed as a result of incorrect pin application in a cat. A & B- X-ray of the case. The pin could not be removed because it was embedded in the bone. C- TENS application. D- TU application. E- LLLT application. F and G- Images of his walk on the 3rd day after physical therapy was completed. His leg length has shortened but he is in much better shape.

RESULTS

The data obtained from the study, together with the treatment results are shown in Table 1. Treatment for the disorders listed in Table 1 was provided by different people in different centers. While some of these consisted of faulty/inadequate and malpractice applications (cases 2, 3, 6 and 7), it was understood that QC developed in some of them

(cases 1, 4 and 5) because of the patient's inability to use his extremity.

In all cases, the stifle joint was stiff, and it was difficult to move the joint. It was noted that the quadriceps muscles were stiff and atrophic.

It was learned that all the cases were brought to the faculty hospital for the 1st time. It was noticed that there were significant errors in the patients' history and the treatment options they had previously received.

There were no problems or difficulties in the implementation of physical therapy procedures. It was noticed that the opening and contracture in the stifle joint started to decrease after the 2nd session in the animals where the patient owner was interested, and the recommended passive movements were performed at home. In other patients, there was a noticeable relief at the end of the 1st week. At the end of the 3rd week, the animal was clinically able to use its extremities and the patient owner was satisfied. There was no need for surgical treatment for QC in any of the cases.

DISCUSSION

Regardless of the cause, 1st of all, QC should be considered as a complicated disease. When treatment is delayed, the prognosis is not favorable, especially for dogs in the rapid growth period. In addition to the shortening of the femur length, the stiffness in the stifle joint area, the loss of stifle joint movement and the inability to use the extremity, such an extremity becomes a burden for the animal and often leads to a new surgical procedure or even amputation [3,11,14,16]. Physical therapy methods are becoming more common in veterinary practice every day [7,8]. There is information about its use in many patients with musculoskeletal system disorders, especially pain, and neurological disorders. TENS, TU and LLLT applications are popular for both accelerating local healing and development of regional muscles after spinal cord injuries or vertebra surgery. Similarly, this combination is recommended for muscle atrophy [5,6,8,12,15,17]. However, although various surgical methods have been reported [3,9,11,14,16] for QC, which is an orthopedic defect, the results of physical therapy or TENS+TU+LLLT combination applications are not well known. Therefore, the aim of this study, which was conducted on 1 cat and 6 dogs with quadriceps muscle contracture due to different reasons, is to investigate the effectiveness of TENS, TU and LLLT applications in QC treatment and to report the results into practice.

It is known that QC may develop due to various reasons. Among these, distal femur fractures and proximal tibia fractures are more common, but in young dogs of 3-4 months of age, they are bandaged, and the movements of the extremities are limited [9,11,16]. Therefore, surgical procedures performed in distal femur fractures, patella dislocation, proximal tibia fractures or other orthopedic disorders related to the stifle joint must be planned correctly. Additionally, QC measures should be taken in these patients during the postoperative period. Bandages should be avoided if possible. The ages of the patients evaluated in this study were 12 months old in 1 dog and younger in all the others. All these patients were treated in different centers before being brought to the faculty hospital and had complaints of persistent lameness or loss of use of their extremities. In 4 of the cases (3 dogs and 1 cat), surgery was performed for distal femur fracture; in 1 dog, tuberosity tibia transposition was performed for patella dislocation; in 1 dog, surgery was performed for proximal tibia fracture; and in 1 dog, a bandage was applied for femur fracture. They applied to our hospital approximately 2 or 3 weeks after these procedures. Therefore, we think that a period of 2 weeks will be sufficient for QC development.

The most striking findings when QC develops are that the stifle joint is stiff and cannot be opened. Additionally, QFM remains atrophic and contracted. Sometimes the femur length may shorten. In more advanced cases, tarsal joint hyperextension (up to 180 degrees) is inevitable. While the animal is in a sitting position, it keeps the relevant extremity tense by extending it under the abdomen or outside the body [3,4,9,14,16]. In all of the cases in our study, the stifle joint was rigid and could not be opened. The QFM muscle was contracted and atrophic. There was hyperflexion of the tarsal joint in 1 patient who was kept under bandage and in another patient who had a distal femur fracture with improper IM nailing (Figure 2 C, see red solid line). In 1 case, the femur length was shortened, and osteophytic growths or irregular callus were disturbing (Figure 3 A). Additionally, in 1 case, the leg was held in a flexed position in the air;

in 2 cases, the leg was extended under the abdomen; and in 4 cases (3 dogs and 1 cat) the leg was held by extending it away from the body. When we look at the cases subject to the study, diagnosis of QC contracture is extremely easy, but it should be based on clinical and radiological examination.

In veterinary practice, in addition to traditional treatment, many electrotherapy methods are increasingly used as complementary and alternative treatment options. These methods commonly use electric current to affect nerves, muscles, bones or other tissues. Transcutaneous electrical nerve stimulation (TENS) is 1 of the types of electrotherapies. This method can be used as part of the rehabilitation process or as a stand-alone treatment [8]. TENS applications are applied to many different muscles, but all the cases in our study were QC cases. Although the etiologies of our cases were different, the QFM muscle was atrophic and contracted. The origin and insertion points of this muscle were our selection site. It would be a deficiency to attribute the successful results in our study only to TENS application, because we applied TENS, TU and LLLT as a combination. While the prognosis is poor even when QC treatment is performed surgically, the results of this study of 7 cases were satisfactory.

Therapeutic ultrasound (TU) is also one of the physical therapy methods [12]. TU has 2 main features. The 1st of these is its anti-inflammatory feature. This feature consists of high-frequency vibrations that create TU cavitation, increasing cell permeability and thus aiding cell communication between joint membranes and linings [5,12]. The 2nd important feature of TU is that it reduces pain by decreasing the nerve conduction velocity of C fibers through stable cavitation. Additionally, TU may increase intra-tissue temperature when used in continuous mode. Therefore, the important benefits of the thermal effects of ultrasound are the reduction of muscle spindle activity and, accordingly, the reduction of muscle spasms and pain [4,12]. We think that TU, especially its effect on the muscles and control of pain, is largely effective in the cases in our study. An important step after TU is that the opening in the stifle joint increases gradually, not suddenly, and the contracted muscle begins to open slowly. We attribute these effects to the known effects of TU on muscles.

Low-level laser therapy (LLLT) has been used in many clinical applications since the 1980s. The main therapeutic advantages of LLLT are to increase tissue repair, reduce inflammation, edema, and pain [12,17]. It can be used to stimulate cell function. Laser photons are thought to be absorbed by chromophores within cells, such as cytochrome C oxidase located in the mitochondria. Changes in cytochrome C oxidase activity lead to increased production of adenosine triphosphate, the main source of cellular energy, resulting in normalization of metabolism [1,2,7,12,13,17]. In our study, LLLT was the last stage of the treatment plan. Energy metabolism is undoubtedly very important in a healthy muscle or joint structure or tissue. In addition, we believe that if inflammation occurs in a muscle, this situation should be quickly returned to normal and be sustainable. Therefore, LLLT application aimed to alleviate local inflammation, edema, and pain, and to regulate energy metabolism in the muscle and joint structure. Thus, we planned LLLT application as a complement to TENS and TU applications.

Treatment options for QC, which develops after various orthopedic interventions, are limited and there is always a risk of permanent lameness. It is also known that straining or hyperflexion movements during physical therapy will cause ruptures or fractures at the attachment point of the muscle to the tibia. For this reason, in our study, different physical therapy applications such as TENS, TU and LLLT were used in combination without any force or force application. Of course, different doses and durations could have been chosen than the ones we chose, but the patient's owner constantly stated that the patient's pain was relieved during our practices. In addition, it was clearly seen at the end of the 1st week that the muscle contraction began to resolve, and the stifle joint opening began to increase. As a result, it should be known that in cases where QC develops, if not too long has passed since a surgical method is planned, the patient can regain his/her former health with an effective physical therapy application and there will be no need for surgery.

MANUFACTURERS

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Ethical Approval. This study was carried out with the permission of Dicle University HADYEK dated 04/04/2024 and numbered E- 14891685-020-687700. In addition, patient owners were informed, and consent was obtained.

Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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