

# Ultrasonographic Assessment of Physical Therapy Interventions in the Management of Traumatic Knee Effusion Using

Magdy Elhossieny\*, M. Adel Shafek\*\*, Ahmed Sabry Rageb\*\*\*, Mona Abo Elez\*\*\*\* and Hosam Mansor\*\*\*\*

\*Department of Sports Health Science, Faculty of Physical Education, Zagazig University.

\*\*Department of Orthopedic, Faculty of Medicine, Zagazig University.

\*\*\*Department of Radiology, Faculty of Medicine, Zagazig University.

## ABSTRACT

**Objective:** To evaluate the effectiveness of intensive physical therapy programs among athletes with traumatic knee effusion in an outpatient setting, which includes functional restoration, improves pain and inflammation as quantified by Ultrasonography. **Subjects and Methods:** Forty five top performance athletes thirty four male and eleven female with a mean age of  $21.4 \pm 2.3$  years' old suffering from traumatic knee effusion participated in this study divided into three groups of equal numbers. Group 1: Fifteen athletes received 3 physical therapy settings weekly for six weeks; group 2: 15 athletes received 3 physical therapy settings weekly for six weeks and nonsteroidal anti-inflammatory drugs (NSAID.s) and group 3: fifteen athletes received no treatment and served as a control group. **Outcome measures:** Mean synovial sac thickness (SST) which includes total effusion volume (EV) and synovial thickness (ST), visual analogue scale (VAS), and quadriceps maximal voluntary contraction (QMVC) were measured at baseline and at the end of study using ultrasonography. **Results:** After 18 physical therapy settings, the mean total effusion volume and the synovial thickness were significantly less in both the treatment groups than the initial measurements and the control group ( $P < 0.01$ ). VAS showed significant improvements at the end of program in both treatment groups ( $P < 0.05$ ). QMVC showed also significant improvements post physical therapy program in both treatment groups ( $P < 0.05$ ) for group 1 and  $P < 0.01$  for group 2). No significant difference was found between the treatment groups ( $P > 0.05$ ). **Discussion and conclusion:** The results of the present study indicate that physical therapy modalities in athletes with traumatic knee effusion can significantly reduce effusion volume, synovial thickness, knee pain index and increase QMVC and the addition of NSAID.s does not produce any difference in the functional outcomes. These data suggest that physical therapy modalities may have

a significant effect in athletes with traumatic knee effusion.

## INTRODUCTION

The knee is the most commonly injured joint in sport, accounting for nearly 30% of all sports injuries reported in large series. Clinical diagnosis is often difficult. Conventional radiographic techniques are generally not useful in the diagnosis of soft tissue injuries, while arthrography and arthrotomography are invasive techniques with potential morbidity. Computed tomography (CT) scanning and magnetic resonance imaging (MRI), while being specific, sensitive and non-invasive, are expensive, time consuming and available only in specialized centers. Because of these limitations, ultrasonographic (US) scanning is useful in the diagnosis of soft tissue injuries in and around the knee.

Synovitis defined as an inflammatory process of the surrounding synovium. There exist sophisticated neurovascular networks within the 3 layers of synovial tissues that provide a high density of blood supply<sup>24</sup>. In chronic synovitis, the synovial villi become thickened and excrete more synovial fluid, leading to an increase in synovial sac thickness (which is the total of the thicknesses of synovium and synovial fluid); angiogenesis is an important feature of pannus formation, which has a crucial role in the maintenance of synovitis. Synovitis has been associated with the degree of knee pain and the predicted progression of cartilage loss. Therefore, synovial sac thickness may be regarded as an index of assessing the extent of the synovitis<sup>7,12</sup>.

Physical therapy modalities successfully decreases synovial sac thickness and suggest that it can control synovial inflammation<sup>20</sup>.

## SUBJECTS AND METHOD

Forty five Zagazig University top performance athletes thirty four male and eleven female with a mean age of  $2.1 \pm 2.3$  years old BMI  $22.7 \pm 2.4$  with acute knee effusion of  $5.4 \pm 3.6$  days participated in this study. All subjects were referred to the study from the outpatient department by orthopedic surgeons. Participants were excluded from the study after on-site evaluation if they presented other musculoskeletal problems associated with the knee joint, such as fracture, tendon or ligament tears, or meniscus injury. Initially, all athletes fulfilled the above criteria. After being instructed in the study protocol, the participants were divided into 3 study groups, as determined by the participants' own decision rather than random assignment. Group (1) fifteen participants received 3 physical therapy settings weekly for six weeks; group (2) fifteen participants received 3 physical therapy settings weekly for six weeks plus NSAID. Fifteen participants who did not receive any treatment but were willing to be present for follow-up served as a control group (group 3). Participants in the physical therapy and control groups did not receive any medicine or treatment during the experiment period. Informed consent to participate in the study was obtained from all participants.

### Experimental Procedure

Before the experiment, the ultrasonographic images of all 45 participants with acute knee effusion were examined for SST, VAS and QMVC also was undertaken. After this initial examination, 30 participants in both the 2 treatment groups received physical therapy program 3 to 5 times a week for a total of 18 treatment sessions within 6 weeks. Follow-up evaluations were performed on the day after the 18th treatment sessions. For the control group, the same evaluations were performed 6 weeks after the initial evaluation.

### Intervention Protocol

The intervention protocol for the treatment group consisted of 18 sessions of physical therapy program of: ice packs, pulsed ultrasonic with 1 MHz frequency and  $1.5 \text{ w/cm}^2$  power were applied for 5 minutes to the target area with a 3 cm diameter applicator (Sonopuls 590 Enraf-Nonus) for all treated groups, Interferential current and active resisted exercises. The participants were positioned supine and comfortably on the treatment plinth with the affected knee semiflexed. A towel of ice packs was wrapped around the knee joint. All participants received treatments by the same physical therapist.

### Ultrasonographic imaging examination

Initial and post program US was performed by an ultrasonographer using an identical protocol on the affected knees using the Toshiba-Xario ultrasound system. SSA-660 A 7.5-10 MHz broadband linear-array transducer (L12-5 38 mm), and all parameters were set at ranges suitable for assessment of the knee joint. The measurement technique used to assess synovial sac thickness of knee joints was similar to the method described by van Holsbeeck et al. (1988)<sup>13</sup>, except that no pressure or contact or changes in the patient's position was added on the examined area during the testing process to avoid fluid shift toward other synovial recesses. The synovial sac thickness were measured (i.e., the measurement of synovial sac thickness included the thickness of both synovium and synovial fluid) superior, medial, and lateral to the patella, mean total EV was measured as the smallest collections can occasionally be demonstrated only at these levels. The sum of these 3 measurements was taken as the total SST. The athletes were initially position in a relaxed supine position with the tested leg was stabilized on a tripod with the knee joint at 30 degrees of flexion, with a pillow under the knee for support during the whole US measurement process. In such a position, overstretching of the synovial sac was avoided, and the patella did not overlie the suprapatellar recess and thus did not affect the measurement. The transducer is swept in a longitudinal plane, from medial to lateral or

lateral to medial, commencing in the suprapatellar region. Longitudinal and transverse images are obtained of the quadriceps tendon. This structure demonstrates the typical echogenic fibrillar echotexture of tendons. Synovial proliferation a (pannus) formation, for each joint the pannus were classified into anterior (capsular) pannus and posterior (cortical) pannus<sup>9</sup>. These images then were saved immediately on the hard disk of a desktop computer<sup>20</sup>. According to previous studies<sup>1</sup>, thickness of the synovial membrane was considered abnormal when higher than 3 mm. Synovitis or effusion was assigned grades thus: grade 0, normal; grade 1, mild or small; grade 2, moderate to marked<sup>4</sup>.

Quadriceps Maximum voluntary contraction: QMVC was measured using a standard protocol<sup>11</sup>. Subjects sat in a modified Tornvall chair with hips and knees flexed to 90° and pelvis secured with instruction to grip the sides of the seat during the testing. A non-extendable strap attached around the test ankle was connected to a dynamometer (Preston Clifton N.J. U.S.A), horizontal and perpendicular to the ankle, that showed the force generated (in Newton's) during knee extension. Subjects were asked to push as hard

as possible against the ankle strap until a peak value was obtained on the digital display unit. A 30 second rest period was allowed between each attempt and the mean of three QMVCs was calculated for each subject.

Pain index assessment. A visual analog scale was used for the assessment of knee pain. It is an ordinal scale, using a 10-cm line divided into 10 equal sections, with 0 representing "no pain" and 10 representing "unbearable pain". Each participant was asked to indicate on the scale the level of pain in his or her knee joint before and after treatment.

### Data Analysis

SPSS 10.0 statistical software (SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606) was used for all statistical analyses. One-way analysis-of-variance (ANOVA) tests were performed for participants' age, sex, BMI, duration of knee effusion, initial effusion volume, synovial thickness, and pain index to examine the differences among the 3 study groups. A t test was used to analyze the main effect of the three study groups. A P value of .05 or below was considered significant for all statistical analyses.

**Table (I): Demographic and baseline characteristics of all participants.**

Variables	Mean	SD±	Range
Age	21.4	2.3	19-24 Y
Height (cm)	174.2	7.6	169-182
Weight (kg)	74.8	7.6	69-83
BMI	22.7	2.4	-24.5 21.9
Sex M/F	34/11	-	-
MDS (days)	5.4	3.6	2-12

M: Mean. BMI: body mass index. MDS: Mean duration of symptoms in days.

## RESULTS

Basic demographic data regarding the 3 study groups is presented in the Table (1), showed no significant differences in age, sex, and BMI ( $P>0.05$ ). The initial EV, ST, VAS and also QMVC were not statistically different ( $P>0.05$ ), indicating that the initial synovium status of all participants in this study was homogenous before the experiment. Changes in ST for the 3 study groups for the pre and post physical therapy program measurements are presented in table (2). After 18 sessions of

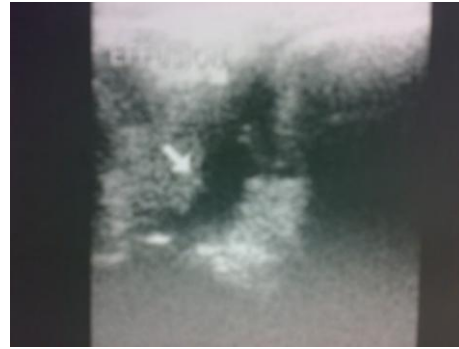
physical therapy, the mean initial joint EV of both treatment groups was  $12.8\pm 3.2$  ml and  $12.9\pm 3.5$  respectively. Post physical therapy program, measurement showed a statistically significant decrease in the EV (56.25 & 59.69%), relative to baseline of group 1 and group 2, was observed (mean change =  $-6.3\pm 2.4$  ml, and  $-7.7\pm 3.1$  respectively ( $P<0.01$ ). Participants in the control group did not experience any changes in joint EV ( $P>0.05$ ). No significant difference were found between the two treatment groups ( $P>0.05$ ).

The ST in both treatment groups decreased to approximately 52.17% to 63.83%

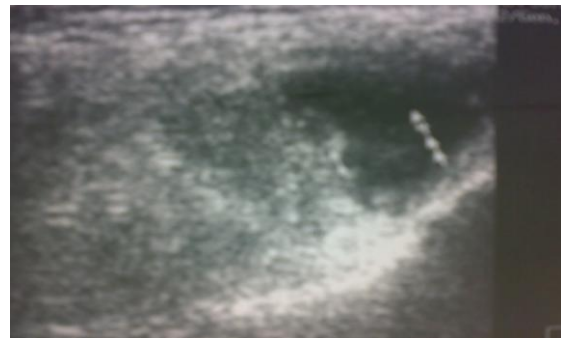
of the initial thickness. The ST in the control group, however, did not showed any significant change at the end of the study ( $P>0.05$ ). Furthermore, analysis of the data revealed that both treatment groups showed a significant decrease in SST with physical therapy program compared with the control group ( $P<0.01$ ). Such a difference, however, did not appear between the two treatment groups ( $P>0.05$ ), suggesting that physical therapy treatment decreases ST regardless of whether NSAIDs are used.

Changes in VAS for 3 study groups are presented in table (2). After 18 sessions of physical therapy, the VAS in the two treatment groups decreased approximately  $-2.1\pm 1.8$  and  $-2.2\pm 1.7$  from the initial status, respectively. The treatment groups showed greater reduction in pain index than the control group ( $P<0.05$ ) at the end of study. However, participants in the control group did not experience any changes in their VAS ( $P>0.05$ ). Comparing both treatment groups for the post-program evaluations showed no statistically significant difference ( $P>0.05$ ).

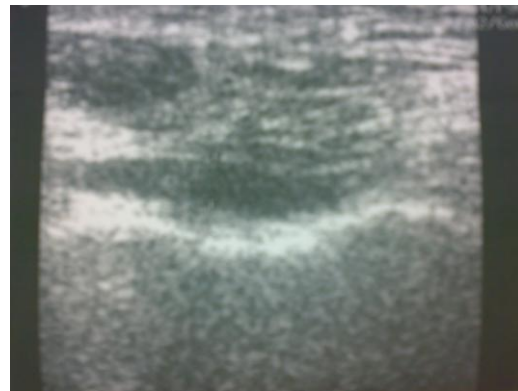
The mean initial QMVC scores showed marked improvement  $+52.6\pm 9.7$  and  $+71.1\pm 11.3$  post physical therapy program for both treatment groups which showed significant improvement ( $P<0.05$ ) for group 1 and ( $P<0.01$ ) for group 2. Comparing both treatment groups for the post-program evaluations showed a statistically significant difference ( $P<0.05$ ) for group 2, However, participants in the control group did not experience any changes in their QMVC ( $P>0.05$ ).



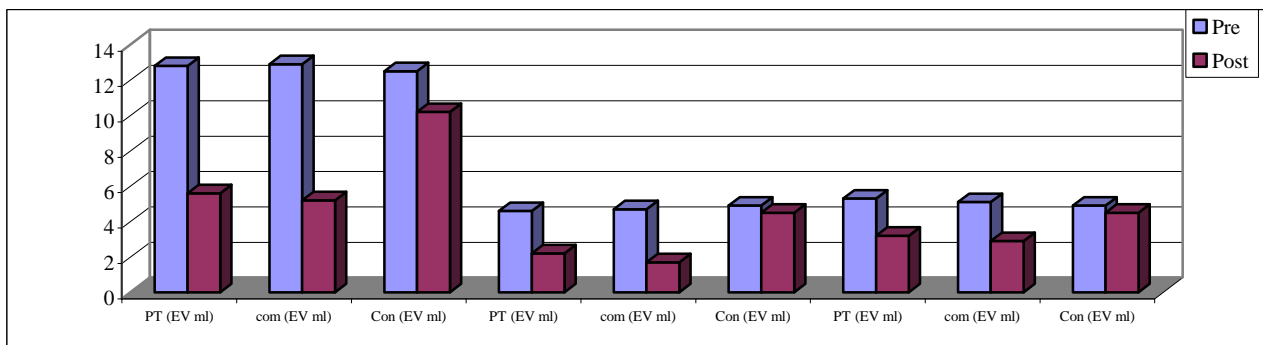
**Fig. (1):** Moderate amount of knee effusion on TS US scan =12mm.



**Fig. (2):** longitudinal US shows mild effusion with thickened hypoechoic synovium at supra patellar pouch region.



**Fig. (3):** Post physical therapy of the same patient shows reduced amount of effusion and reduced thickened synovial membrane.

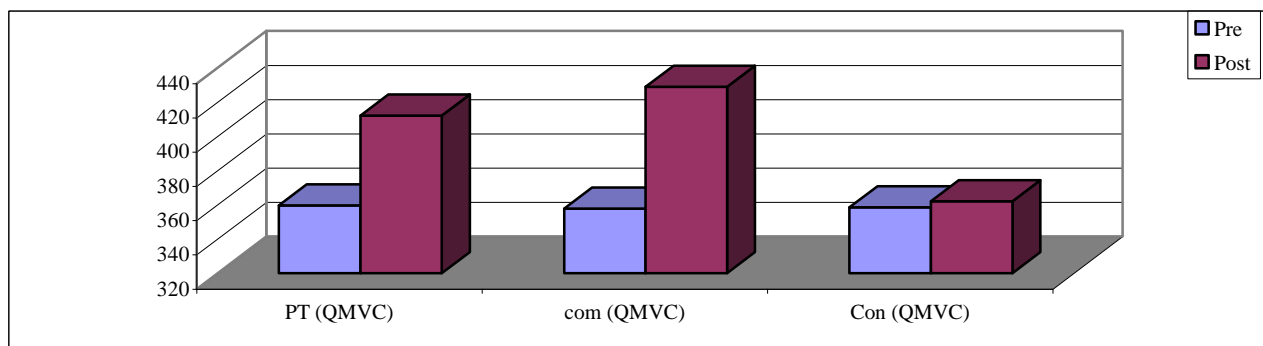


**Fig. (4):** Histogram of the pre-and post program evaluation of Ph Th, combined and control groups for the VAS, ST and EV.

**Table (2): The pre- and post- 6 week's measurements of the study groups.**

Variables	Groups	Pre-program		Post-program		P Value	Changed %
		mean	±SD	Mean	±SD		
EV ml	PT G	12.8	3.2	5.6	2.6	P<0.01**	56.25
	PT & NSAID's G	12.9	3.5	5.2	2.9	P<0.01**	59.69
	Control G	12.5	2.8	10.2	2.7	P>0.05	18.40
ST mm	PT G	4.6	2.9	2.2	1.5	P<0.01**	52.17
	PT & NSAID's G	4.7	2.4	1.7	1.2	P<0.01**	63.83
	Control G	4.9	2.6	4.5	2.5	P>0.05	8.16
VAS	PT G	5.3	1.7	3.2	1.9	P<0.05*	39.62
	PT & NSAID's G	5.1	1.6	2.9	1.8	P<0.05*	43.14
	Control G	4.9	1.9	4.5	2.1	P>0.05	8.16
Mean Q MVC (N)	PT G	359.6	36.4	412.2	42.3	P<0.05*	14.63%
	PT & NSAID's G	357.8	35.7	428.9	41.1	P<0.01**	19.87%
	Control G	358.5	36.2	362.1	39.9	P>0.05	1.0%

\*\*HS: Highly significant P<0.01, \* S: significant P<0.05, QMVC: Mean quadriceps maximum voluntary contraction  
EV=effusion volume, ST: Synovial Thickness VAS, Pain intensity measured with visual analogue scale



**Fig. (5): Histogram of the pre-and post program evaluation of Ph Th, combined and control and groups for the MQMVC.**

## DISCUSSION

Knee joint injuries are commonly associated with activities that demand high levels of stability during dynamic movement. Depending on the mechanism and type of injury, a resultant effusion distends the knee joint capsule resulting in arthrogenic muscle inhibition which may lead to weakness and atrophy in the surrounding musculature<sup>23</sup>.

Initial evaluation of all participants of the study revealed marked weakness of the quadriceps muscles at the injured knee, this is explained by Hopkins et al. (2001)<sup>14</sup> who reported that knee effusion has been shown to cause inhibition of the quadriceps muscle resulting in weakness and atrophy; this muscle inhibition not only slows strength gains during rehabilitation it also slows gains in proprioception and increases susceptibility to further injury. Torry et al. (2000)<sup>27</sup> study observed a decrease in knee flexion; they claimed it to quadriceps inhibition following

the effusion that resulted in an associated change in the knee flexion angle. Authors have described patients as having a 'quadriceps avoidance type gait pattern' due to the inability of the quadriceps to be activated following effusion. These was further explained with Palmieri et al. (2005)<sup>23</sup> study who find that the presence of an effusion with associated inflammation and pain in acute and chronically injured subjects may be responsible for the loss of proprioception and muscle inhibition as observed in clinical situations. Also Hassan et al. (2001)<sup>11</sup> reported that joint effusion, pain and arthrogenic muscle inhibition reportedly reduce activation, and in turn the force generated, by as much as 60%. The study of Kenneth et al. (2006)<sup>18</sup> revealed that increasing synovitis accounted for at least some of the flare in joint pain. Curtis et al. (2005)<sup>4</sup> reported that only effusion, however, showed a positive correlation with pain.

The results of this study revealed a significant decrease in SSA ( $P < 0.01$ ) in group 1 and 2, (for both ST and EV) compared with the control group which showed no significant change ( $P > 0.05$ ). These improvements were induced with use of a series of physical therapy treatments in athletes with traumatic knee effusion. These results demonstrated that physical therapy modalities successfully decrease SST and suggested that it can control synovial inflammation. Jan et al. (1993)<sup>16</sup> and Kitchen (1992)<sup>19</sup> documented that physical therapy may result in vascular dilation and increased blood flow. Consequently, through the application of physical therapy, the inflammatory response in the synovium of the knee joint is reduced and both SST and pain are decreased. In this study, participants in the physical therapy and NSAIDs group did not show better results than those in the physical therapy group, suggesting that physical therapy treatment decreases synovial thickness regardless of whether NSAIDs are used.

Results of the present study indicate that physical therapy settings to the knee joint may improve the patient's condition significantly by decreasing joint pain and swelling, leading to improved function. In the present study the utilization of active resisted exercises resulted in improvement in QMVC and pain relief which reached a statistical significance after 6 weeks in both the treatment groups ( $P < 0.05$ ) for group 1 and ( $P < 0.01$ ) for group 2, compared with the control group which showed no significant change ( $P > 0.05$ ). This finding indicated that relief of pain played an important role for increase in muscle strength and suggesting that the double analgesic effects of physical therapy and NSAIDs treatment decreases quadriceps inhibition reflex and so increases QMVC scores in knee synovitis subjects. In agreement with these results, the study of Falconer et al (1992)<sup>6</sup> on the effects of exercise program and ultrasound in the mobility of osteoarthritic knees revealed improvements in motion (11%), pain (33%), and gait speed (11%) after 12 treatment settings of manual therapy procedures, strengthening, and mobility exercises combined with US. Furthermore the findings of Deyle et al. (2000)<sup>5</sup> study suggest that

physical therapy intervention including exercise improves knee function and quadriceps muscle strength and may reduce the need for knee arthroplasty and intra-articular injections in osteoarthritic subjects. Also Fitzgerald et al (2004)<sup>8</sup> reported that a growing body of evidence shows that physical therapy improves knee joint function and decreases symptoms in various knee pathologies.

The addition of pulsed US and cryotherapy to the physical therapy program in the present study, lead to a significant improvement in the functional outcomes of the study these findings are parallel with findings of Huang et al. (2005)<sup>15</sup> who find that pulsed ultrasound treatment could increase the effectiveness of isokinetic exercise for functional improvement of knee OA, and periarticular soft tissue disorders associated with increase in walking speed and decrease in disability after treatment and at follow-up. They found also gains in muscular strength in 60°/s angular velocity peak torques.

Also in agreement of our results Deyle et al. (2000)<sup>5</sup> controlled, randomized, single-blinded study on the effects of manual physical therapy and exercise in osteoarthritis of the knee demonstrated that manual therapy techniques and exercises applied by physical therapists for 8 clinical visits resulted in 52% improvement in self-reports of function, stiffness, and pain as measured by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scale and a 12% improvement in 6-minute walk test scores. A placebo control group that received equal clinical attention showed no improvement in WOMAC scores or 6-minute walk test scores.

The application of cryotherapy in our study goes in parallel with that of Yurtkuran et al. (1999)<sup>28</sup> and Brosseau et al. (2003)<sup>2</sup> Cochrane Database Systemic Review in the thermotherapy for treatment of athletes with knee synovitis revealed that Ice massage and cold packs decrease knee swelling improves range of motion, function, and knee strength. According to Hopkins et al. (2001)<sup>14</sup>, ice backs not only decreases general nerve conduction velocity, muscle spasm, and pain, but it has a definite

slowing and blocking effect on sensory nerve fibers at certain nerve tissue temperatures (10<sup>0</sup> C).

Hopkins et al. (2001)<sup>14</sup> claimed the positive effects of cryotherapy facilitating the quadriceps to that since it stimulates cutaneous receptors, including mechanoreceptors (pressure) and thermoreceptors, these receptors may play a role in facilitating the quadriceps motoneuron pool.

Geborek et al. (1989)<sup>10</sup> and Saito et al. (2000)<sup>24</sup> reported that the possible physiological mechanisms underlying such significant changes synovium may be associated with improvement in circulation of vascular network in synovial membrane. It has been found that synovial vascular density is lower in athletes with chronic synovitis, adversely affecting the flow of blood and lymph fluid and reduced retention of synovial fluid, which became more evident after a series of physical therapy treatments, whereas the long term effect may be associated with the reduction in synovial inflammation. The results of this study represent direct evidence of the effect of physical therapy on SST. We hypothesized that physical therapy can reduce the synovial inflammation, but that it might be not relieve athletes' pain completely.

In the present study assessment of the SSTs was done with ultrasonography. The validity and reliability of data obtained with the ultrasonographic imaging technique in determining the SST in patients with inflammation of the knee joint has been established in previous studies. In the studies by Karim et al. (2004)<sup>17</sup> and Holsbeeck et al. (1988)<sup>13</sup>, ultrasonographic imaging techniques were shown to yield valid and reliable data as well as more accurate data than clinical examination only, although only examination of thickness of the synovium, rather than the whole synovial sac, was performed they came to the conclusion that ultrasonographic imaging is a valuable tool in the evaluation of the severity and progression of synovitis. It is relatively easy to perform, less expensive than CT scanning and MRI<sup>3,22</sup>, with advantages of being viable imaging modality in the diagnosis and assessment of the musculoskeletal system, simple to use, easy multiplanar capability<sup>9</sup>, can detect treatment response<sup>26</sup>, it allows direct

visualization of the structures of the soft tissues and joint compartments as well as repeated measurements without the risk of exposure to ionizing radiation<sup>20,25</sup> and it is acceptable to athletes<sup>22</sup>.

The studies of Mei-Hwa et al. (2006)<sup>20</sup> had revealed that US had high intrarater and interrater reliability for detecting synovitis in the knee joint. The US analysis reliably detects both abnormalities and also it is thus considered an accurate imaging method for the study of synovitis. No other imaging modality shares all these features. Previous studies by Annamaria et al. (2006)<sup>1</sup> demonstrated that US measurements of synovial thickness in the suprapatellar bursa are reliable and accurate methods for the quantification of the severity of the inflammatory process in knee synovitis patients. Of interest, is that US can detect persistently active synovitis that may be underestimated by clinical assessment.

US may be regarded as useful adjunctive tools for assessing short term soft tissue changes after treatment with physical therapy modalities in the knee joint of athletes with traumatic synovitis. Results of the present study suggest that physical therapy treatment decreases knee inflammation and improve function regardless of whether NSAIDs are used.

## Conclusion

US are a relatively new tool in the investigation of local inflammation. It appears to be a useful adjunctive tool for assessing short term soft tissue changes induced by physical therapy treatment modalities in athletes with traumatic knee joint effusion. Physical therapy modalities in athletes with traumatic knee effusion can significantly reduce effusion volume, synovial thickness, knee pain index and increase QMVC. These data suggest that physical therapy modalities may have a significant anti-inflammatory effect in athletes with traumatic knee effusion.

## REFERENCES

- 1- Annamaria Iagnocco, Angela Cerioni, Giulio Coari, Alejandra Ossandon, Guido Valesini: Intra-articular methotrexate in the treatment of rheumatoid arthritis and psoriatic arthritis: a

- clinical and sonographic study. *Clin Rheumatol*, 25: 159-163, 2006.
- 2- Brosseau, L., Yonge, K.A. and Robinson, V.: Thermotherapy for treatment of osteoarthritis. *Cochrane Database Syst Rev.*, (4): CD004522, 2003.
  - 3- Clement, H., Grechenig, W., Peicha, G. and Grechenig, S.: Ultrasound diagnosis in knee and foot trauma. *Orthopade.*, 31(3): 332-335, 2002.
  - 4- Curtis W. Hayes, David A. Jamadar, Gavin W. Jannausch, Diana C. Capul and MaryFran R. Sowers: Osteoarthritis of the Knee: Comparison of MR Imaging Findings with Radiographic Severity Measurements and Pain in Middle-aged Women. *Radiology*, 237: 998-1007, 2005.
  - 5- Deyle, G.D., Henderson, N.E. and Matekel, R.L.: Effectiveness of manual physical therapy and exercise in osteoarthritis of the knee: a randomized, controlled trial. *Ann Intern Med.*, 132: 173-181, 2000.
  - 6- Falconer, J., Hayes, K.W. and Chang, R.W.: Effect of ultrasound on mobility in osteoarthritis of the knee: a randomized clinical trial. *Arthritis Care Res.* 5: 29-35, 1992.
  - 7- Fillippucci, E., Farina, A., Carotti, M., Salaffi, F. and Grassi, W.: Grey scale and power Doppler sonographic changes induced by intra-articular steroid injection treatment. *Ann Rheum Dis.*, 63: 740-743, 2004.
  - 8- Fitzgerald, G.K. and Oatis, C.: Role of physical therapy in management of knee osteoarthritis. *Curr Opin Rheumatol.*, 16: 143-147, 2004.
  - 9- Friedman, L., Finlay, K. and Jurriaans, E.: Ultrasound of the knee. *Skeletal Radiol.*, 30(7): 361-377, 2001.
  - 10- Geborek, P., Forslind, K. and Wollheim, F.A.: Direct assessment of synovial blood flow and its relation to induced hydrostatic pressure changes. *Ann Rheum Dis.*, 48: 281-286, 1989.
  - 11- Hassan, B.S., Mockett, S. and Doherty, M.: Static postural sway, proprioception, and maximal voluntary quadriceps contraction in patients with knee osteoarthritis and normal control subjects. *Ann Rheum Dis.*, 60: 612-618, 2001.
  - 12- Hill, C.L., Gale, D.G. and Chaisson, C.E.: Knee effusions, popliteal cysts, and synovial thickening: association with knee pain in osteoarthritis. *J Rheumatol.*, 28: 1330-1337, 2001.
  - 13- Holsbeeck, V.M., van Holsbeeck, K. and Gevers, G.: Staging and follow-up of rheumatoid arthritis of the knee: comparison of sonography, thermography, and clinical assessment. *J Ultrasound Med.*, 7: 561-566, 1988.
  - 14- Hopkins, J.T., Christopher D. Ingersoll and Jeffrey Edwards: Cryotherapy and Transcutaneous Electric Neuromuscular Stimulation Decrease Arthrogenic Muscle Inhibition of the Vastus Medialis after Knee Joint Effusion. *J Ath Train*, 37(1):25-31, 2001.
  - 15- Huang, M.H., Lin, Y.S., Lee, C.L. and Yang, R.C.: Use of ultrasound to increase effectiveness of isokinetic exercise for knee osteoarthritis. *Arch Phys Med Rehabil.*, 86(8): 1545-1551, 2005.
  - 16- Jan, M.H., Yip, P.K. and Lin, K.H.: Change of arterial blood flow and skin in temperature after direct and indirect shortwave heating on knee. *Formosan J Ph Th.*, 18: 64-71, 1993.
  - 17- Karim, Z., Walefield, R.J. and Quinn, M.: Validation and reproducibility of ultrasonography in the detection of synovitis in the knee: a comparison with ultrasonography and clinical examination. *Arthritis Rheum.*, 50: 387-194, 2004.
  - 18- Kenneth D. Brandt, Steven A. Mazzuca and Kenneth A. Buckwalter: Acetaminophen, like conventional NSAIDs, may reduce synovitis in osteoarthritic knees. *Rheumatology*, 45: 1389-1394, 2006.
  - 19- Kitchen, S. and Partridge, C.: Review of shortwave diathermy continuous and pulsed patterns. *Physiotherapy.*, 78: 243-252, 1992.
  - 20- Mei-Hwa Jan, Huei-Ming Chai, Chung-Li Wang, Yeong-Fwu Lin and Li-Ying Tsai: Effects of Repetitive Shortwave Diathermy for Reducing Synovitis in Athletes with Knee Osteoarthritis: An Ultrasonographic Study. *Ph Th.* 86(2): 236-244, 2006.
  - 21- Naredo, F., Cabero, M.J., Palop, P., Collado, A. Cruz and M. Crespo: Ultrasonographic findings in knee osteoarthritis: A comparative study with clinical and radiographic assessment. *Osteoarthritis and Cartilage*: 13(7): 568-574, 2005.
  - 22- Nicola Maffulli, DSMSA, Renato Regine, Francesco Carrillo, Salvatore Minelli, Tina Beaconsfield: Ultrasonographic scan in knee pain in athletes. *Br J Sp Med*, 26(2), 1992.
  - 23- Palmieri, R.M., Weltman, A., Edwards, J.E., Tom, J.A., Saliba, E.N., Mistry, J. and Ingersoll, D.: Pre- synaptic modulation of quadriceps arthrogenic muscle inhibition. *Knee Surg. Sport Traumatol. Arthrosc.* 13: 370-376, 2005.
  - 24- Saito, T. and Koshino, T.: Distribution of neuropeptides in synovium of the knee with



- osteoarthritis. Clin Orthop. 376: 172-182, 2000.
- 25- Schmidt, W.A., Volker, L., Zacher, J., Schlafke, M., Ruhnke, M. and Gromnica-Ihle, E.: Color Doppler ultrasonography to detect pannus in knee joint synovitis. Clin Exp Rheumatol 18: 439-444, 2000.
- 26- Terslev, L., Torp-Pedersen, S., Qvistgaard, E., Kristoffersen, H. and Danneskiold-Samsøe, B.: Effects of treatment with etanercept (Enbrel, TNRF: Fc) on rheumatoid arthritis evaluated by Doppler ultrasonography . Ann Rheum Dis., 62: 178-182, 2003.
- 27- Torry, M.R., Decker, M.J., O'Connor, D.D. and Steadman, J.R.: Intra-articular knee effusion induces quadriceps avoidance gait patterns. Clin. Biomech. 15: 147-159, 2000.
- 28- Yurtkuran, M. and Kocagil, T.: TENS, electroacupuncture and ice massage: comparison of treatment for osteoarthritis of the knee. Am J Acupunct. 27: 133-140, 1999.

### الملخص العربي

#### دراسة تقييم وسائل العلاج الطبيعي لحالات إرتشاح الركبة الزلالي للرياضيين باستخدام الموجات فوق الصوتية

لتقييم كفاءة برنامج للعلاج الطبيعي لحالات إرتشاح الركبة الزلالي للرياضيين يتضمن وسائل للاستعادة الوظيفية وتحسين الوظيفة باستخدام الموجات فوق الصوتية التشخيصية. تم اختيار خمسة وأربعون حالة ، أربعة وثلاثون من الذكور وأحدى عشر من الإناث من رياضيي المستويات العالية متوسط أعمارهم  $21.4 \pm 2.3$  عاما الذين يعانون من إرتشاح زلالي بمفصل الركبة. تم تقسيم الحالات عشوائيا إلى ثلاث مجموعات: المجموعة الأولى (15 فرد) تلقت 18 جلسة علاج طبيعي بواقع 3 جلسات أسبوعيا لمدة ستة أسابيع والمجموعة الثانية (15 فرد) تلقت العلاج الدوائي التقليدي من مضادات الالتهاب و18 جلسة علاج طبيعي بواقع ثلاث جلسات أسبوعيا لمدة ستة أسابيع والمجموعة الثالثة (المجموعة الضابطة) (15 فرد) لم يتلقوا أي من البرنامجين السابقين . وتم اختيار متوسط حجم الإرتشاح الزلالي ومتوسط سمك الغشاء الزلالي للركبة (تم تقييمهم باستخدام الموجات فوق الصوتية التشخيصية) وكذا مقياس الألم المرئي ومقياس أقصى قوة لعضلة الفخذ الأمامية ذات الأربعة رؤوس قبل بداية وبعد نهاية البرنامج . وقد أظهرت نتائج القياس عقب انتهاء البرنامج لهذه الدراسة وجود تحسن واضح ذو دلالة إحصائية لكلا من المجموعتين العلاجتين بالنسبة لحجم السائل الزلالي وسمك الغشاء المخاطي للركبة أو مقياس الألم المرئي وكذلك قوة العضلة الفخذية الأمامية ذات الأربعة رؤوس وعدم وجود أي تحسن ذو دلالة إحصائية للمجموعة الضابطة في أي من الاختبارات السابقة ولم تظهر القياسات أي دلالة إحصائية بين المجموعتين العلاجتين سواء قبل أو بعد العلاج . وقد خلصت هذه الدراسة إلى كفاءة الموجات فوق الصوتية التشخيصية في تقييم وسائل العلاج الطبيعي لحالات الإرتشاح الزلالي للرياضيين سواء قدم منفردا أو بمصاحبة العلاج الدوائي بمضادات الالتهاب وأنه يمكن استخدامه لتخفيض حجم الإرتشاح الزلالي للرياضيين وكذا حجم الغشاء المخاطي للركبة إضافة إلى تحسين الألم وزيادة قوة العضلة الفخذية الأمامية ذات الأربعة رؤوس، وأن العلاج الطبيعي يقدم وسيلة علاجية ذات فاعلية وأمان لحالات إرتشاح الركبة الزلالي .