

STUDY REGARDING INCREASED RANGE OF MOTION AND MUSCULAR FORCE IN KNEE JOINT SPRAINS

Neonila Gabriela ȘTEFAN¹, Răzvan Andrei TOMOZEI¹, Raluca Anca TANASĂ¹,
Cristina Elena MORARU¹

¹ “Alexandru Ioan Cuza” University Iasi, Faculty of Physical Education and Sport, Iasi, Romania

*Corresponding author: neonila_gabriela@yahoo.com

<https://doi.org/10.35189/dpeskj.2022.61.1.12>

Abstract. *In sports traumatology, there is a high incidence of disorders at knee joint level, the most common of which are sprains. If the knee joint is impaired, the entire body is misbalanced. The purpose of the study was to decrease the pain, improve strength and mobility of knee joint. In addition, by introducing a therapeutical formula, we also aim to shorten the recovery period. The research subjects were 2 athletes practicing performance handball, with a diagnosis of grade 2 knee sprain (a diagnosis supported by X-rays and the MRI). The tests applied to the subjects were the joint and muscle assessments. The recovery program consisted in the use of kinesiotherapy means associated with Tecar therapy and laser. The patient C.M. recorded a value of 93° flexion - initially, while finally 127°, a value of 17° extension - initially, while in the end 0°. In what concerns muscle force, it increased from 1 initially to 5 in the end. The patient R.M. had a flexion degree of 84° initially and 120° finally, while in extension 15° - initially and 0° in the end. The muscle force increased from 2 - at the beginning to 5 - eventually. In conclusion, it may be stated that the therapeutical formula applied (kinesiotherapy + Tecar therapy + laser therapy) was effective and that it shortened the recovery period from 6 months to 3 month, the functions of the lower limb were recovered.*

Keywords: *modern technologies, recovery, traumatism, sport, knee.*

Introduction

The human body is impressive, while health is the most precious gift of life; everybody wants to be healthy and in shape for as long as possible. The continuous practice of a sport is beneficial for both the body and the psyche. Human destiny should be built on the following tripod: being healthy, living a long life and human's life based on movement.

The concept of recovery, rehabilitation, has enjoyed increased attention within the past decades. This led to the emergence of well-established methodologies of recovery, mostly concerning several conditions, such as the ones of the locomotor system.

Traumatism within sports practice or even during games is defined as any intentional or unintentional trauma on the human body, resulted after participating in any activity requiring physical effort, carried out in recreational or competitive purposes (Meeuwisse et al., 2007).

Knee joint conditions are common. They account for a substantial percentage of all sports injuries. Traumas located at the level of knee joint are common in many sports areas, either during practices or during competitions. Care and attention paid to the structure of this are instrumental for maintaining the health of the knee joint. When knee pain emerges, many people hastily believe that such pain will just go away, that knee pain is actually a normal aspect of life, especially in case of athletes. Sometimes the pain goes away, but it does not mean that the risk of serious disease in the future is reduced.

Knee pain currently represents a major therapeutical challenge, given that every adult has suffered from knee pain at a certain point in their lives. Pain goes away, but because it becomes chronic, the patient starts asking questions and seeking a medical answer. Hence, knee pain may represent one of the main present health problems in sports traumatology and recovery medicine.

Because it is an intermediary joint situated at the level of the lower limb, it has a double role in gait: it ensures static balance – great stability during support, on one hand; it ensures leg elevation for orienting it depending on the uneven character of the field during the swing, on the other hand (Bogdan et. al., 2006).

According to Gornea, knee sprain is defined as a traumatic lesion of the capsulo-ligamentous apparatus and of the soft periarticular tissues through tension caused by a mechanical force, which through its value exceeds their resistance. Depending on the involvement of this traumatism of the capsulo-ligamentous apparatus and of the periarticular structures, knee sprains are ranked as follows: grade I sprains (ligamentous sprains), grade II sprains (partial rupture of the ligaments, decrease in joint stability), grade III sprains (total rupture of the ligaments) (Gornea, 2010).

The patients with knee sprain suffer from joint instability, enlargement of the joint space, intense pain (mitigating for a while and then accentuating and becoming chronic), joint tumefaction, ecchymoses.

In the modern era, recovery after a sports injury became a huge sector for specialists and its evolution reunited necessarily the kinesiologist, the sports physician and the orthopaedic physician. The key-factors in the successful recovery protocols of sports lesions are the application of modern rehabilitation protocols under proper supervision, adequate and well-timed surgical interventions and the judicious and needs-based use of pharmaceutical agents. The modern recovery protocols highlight team work and the proper planning of recovery. Such an activity is conducted by a well-instructed kinesiologist, with an understanding of the protocols and of the interventions necessary in various stages. The rehabilitation protocols specific to injuries are practiced worldwide, but they should be introduced depending on the nature of sport, as well as on the available facilities (Dhillon et al., 2017).

A study conducted out by Guimaraes and his colleagues has revealed that Tecar Therapy was effective in mitigating muscle pain in the first 24 hours following the application. The authors state that the persons benefitting from Tecar Therapy regained their muscle strength as a consequence of the 72-hour protocol (Guimares et al., 2018).

The study carried out by Traulle and his colleagues states that over the last decades, instrumental therapies have been designed, for the use of recovery experts. Used on a larger scale, such therapies have been used in scientific research to prove their importance in daily care. Tecar Therapy is effective in recovery, in both a capacitive and a resistive way, thus being efficient in various pathologies and traumatisms. Hence, it has made the object of more and more research. An open question dwells: whether Tecar therapy is still the only dominant element considering the musculoskeletal system (Traulle et al., 2019).

The use of high-power laser therapy alongside Tecar Therapy featured in the research study conducted by Osti et al. - focusing on reducing low back pain - was found to be highly

beneficial. Pain reduced significantly, and the quality of life improved significantly in the case of people suffering from degenerative inflammatory diseases (Osti et al., 2015).

Ganzit et al. underscore that most patients undergoing a resistive-capacitive type of therapy have benefitted from great outcomes. This stands to prove that this therapy is a relevant tool for treating pathologies of the locomotor system in the field of sports. Indeed, it overlaps various different therapies regarding the presence or absence of positive outcomes. Tecar therapy overlaps with various therapies regarding the improvement of the subject's health, effective even in cases for which nothing else had worked (Ganzit et al., 2015).

Methodology

The premise for this study is that the use of modern therapies and technologies constitutes an adjuvant of kinesiotherapy for the entire recovery process, not a replacement.

The purpose of this study was to analyse and to highlight the extent to which modern technologies help handball players to shorten the recovery process period in case of grade II knee sprains. The study is based on the idea that the entire recovery process has a fundamental role, reason for which it cannot possibly be ignored. The faster a patient comes to the specialist, the faster the recovery process, to prevent sequelae.

The objectives of are the following: combating pain and the inflammatory process; preventing and combating vascular disorders and circulation; preventing and combating faulty postures; increase muscle tone; recovering muscle force and joint stability; toning soft tissues and joint mobility; regaining bipodal and unipodal stability and gait safety.

Research question: The recovery strategy which involves Tecar Therapy + kinesiotherapy + laser therapy reduce the time allocated to recovery (of grade 2 knee sprain) in male handball players?

The means used to attain the aforementioned objectives are the following: joint rest, painkillers - if applicable, kinesiotherapy, physiotherapy. In order to formulate the correct diagnosis, we took into account the imaging explorations - X-ray and MRI.

Participants

Two patients aged 35, respectively 33, both male, took part in the study. The participants are practicing performance handball, having a diagnosis of grade 2 knee sprain.

Table 1. *Participants of the research*

No.	Last and first name	Age	Height	Weight	Diagnostic
1.	C. M.	35	177 cm	86 kg	Grade II knee sprain
2.	R. M.	33	180 cm	89 kg	Grade II knee sprain
Mean		34 ±	1.785 ±	87.5 ±	
Standard deviation		1.41	0.02	2.121	

Apparatus

The device associated to the recovery program applied to athletes was the one from Liamed, Tecar Fizio Warm 7.0 and the high-power laser Astar Liamed. We grouped Tecar Therapy, high-power laser with kinesiotherapy - active mobilisations, with the following effect: increased mobility, significant pain mitigation during movement, rapid recovery, minimum discomfort, immediate reprisal of practice.

The TECAR device is a new modern technology that can exert a high-frequency sinusoidal current to be applied on the patient's body through two stainless steel electrodes, for capacitive and resistive transfer of energy. The Tecar Therapy is a procedure well tolerated by the body, which has provided athletes relaxation. It uses cellular mechanisms through radiofrequency, penetrating the body cutaneously, using the thermoconducting cream on the electrode, thus activated the natural self-repair and anti-inflammatory processes, penetrating all layers down to the bone. The therapy using radiofrequency may be applied immediately after the trauma or in the acute phase of an inflammatory process, guaranteeing a positive effect in a relatively short time.

The contraindications of diathermia and of the Tecar Therapy are as follows: pacemakers, pregnancy, oncological problems-cancer, fever, grafts, cardiac stimulators and artificial organs, coagulation disorders, insensitivity to thermal variations, burns, infectious states, low blood pressure, insensitivity to pain, osteoporosis (Ribeiro et al., 2018).

Laser is a component of physiotherapy, a non-invasive procedure based on the effect of light reaching the human body, with the help of photoreceptors, assisting in the process of absorbing the laser light. High-power laser has many applications in medical recovery, from pain therapy to cell bio-stimulation (Hashmi et al., 2010). The immediate effects of laser for the athletes were as follows: anti-inflammatory effect, pain mitigation, reduction of the oedema. The contraindications of laser therapy are (Hashmi et al., 2010): radiating endocrine gland, cancer, pregnancy, eye lesions, photosensitising and immunosuppressing medication, epilepsy, tattoos (given the emergence of the thermal effect), haemorrhage (the vasodilatation generated by the device may make haemorrhage worse).

Procedure

The study was carried out at the Military Emergency Hospital "Dr. Alexandru Popescu" in Focșani, Vrancea County, for 3 months (August 2019 – November 2019). The therapeutical conduct was divided into two phases: the initial phase took 8 weeks, while the final phase 4 weeks. The ethical principles were assured.

Joint balance (knee flexion and extension were measured using a goniometer) and muscle balance (strength of the affected segment) were measured. We used also the VAS scale - pain measurement (10-maximum stiffness, discomfort, 0-absence of pain).

The first patient (C.M.), 35 years old - complained of intense, nagging tendo-muscular pain during mobilisation of the knee joint; he could not stand on both feet during gait. The orthopaedic physician, following an X-ray and an MRI, set the diagnosis of grad II right lower limb sprain. He recommended kinesiotherapy, Tecar Therapy, laser therapy, ice locally, physical rest for 21 days.

The second patient (R.M.) 33 years old - complains intense right knee joint pain in the morning, the intensity decreasing throughout the day. The orthopaedic physician set the diagnosis of grade II knee sprain (based on an X-ray and an MRI). The physician recommended anti-inflammatory medication (they were only recommended, the subject did not use them), kinesiotherapy, physical therapy, Tecar Therapy + laser therapy, ice locally, physical rest for 21 days.

The physician's prognosis concerning recovery was 4-5 months. Both patients were present in the recovery practice, where they followed a structured and organised program which involved: kinesiotherapy, Tecar Therapy and laser therapy.

For grade II knee sprain, in case of the subject C. M., the therapeutical conduct was structured as follows: 1. Tecar Therapy, subject on the treatment table, with a roll underneath the right knee joint, Neurodynamic mode, Continuous emission, frequency 500 kHz - 54 Vrms, energy transfer 15.641 Jtot, session duration 20 minutes phase I, 20 minutes phase II; 2. kinesiotherapy: sitting, active mobilisations, active mobilisations with objects (cane, clogged wooden rolls, tennis ball); 3. high-power laser therapy 14.7 J/cm², 10 minutes/session. If the patient experiences discomfort, the value of the frequency of heat intensity crossing that area will be adjusted. The treatment duration was 3 months, the patient benefitted from 5 sessions/week. The kinesiotherapy program was executed for 3 months, from Monday to Friday, while at home, the patient applied it twice more (3x/day) for 3 months. While applying the sessions of Tecar Therapy, we were able to notice the most important particularity of this therapy. When the two electrodes were positioned on one side and the other of the knee joint to "close the joint", besides the local heat phenomenon, the patient also felt a slight "burn" sensation. The "burn" is the main indicator of this therapy, an indicator highlighting the presence of a disorder, the device identified the traumatism, while during the period of recovery, it would disappear. Laser therapy was applied as follows: week 1 - each day, week 2 - x3/week, week 3 - each day, week 4 - x3/week, while in the two following months, the scheme remained the same. Laser therapy was applied: week 1 - x5/week, week 2 - x3/week, week 3 - x5/ week, week 4 - x3 week; on the second and the third month, the same application scheme was observed.

The subject R. M. - diagnosed with grade II knee sprain - recommendations: kinesiotherapy + Tecar Therapy + laser therapy. Tecar Therapy had the following coordinates: Neurodynamic mode, Continuous emission, frequency 500 kHz – 51 Vrms, energy transfer 12.875 Jtot, session duration 20 minutes phase I and 20 minutes phase II. The kinesiotherapy program comprised active mobilisations at bed level, at the edge of the bed (exercises with objects - tennis ball, kettlebell, towel, elastic band, wooden rolls, arch plate). The kinesiotherapy program was executed for 3 months, from Monday to Friday, while at home, the patient applied it twice more (3x/day) for 3 months. For laser therapy, the value of 14.7 J/cm² was used, 10 minutes/session. The treatment duration was 3 months, the patient benefitted from a number of 5 sessions/week. While applying the sessions of Tecar Therapy for the experiment group, it was noted that the two electrodes were positioned on one side and the other of the knee joint to "close the joint", besides the local heat phenomenon, the patient also felt a slight "burn" sensation". This "burn" is the main indicator of this therapy, suggesting the presence of a disorder; the device identified the traumatism, while during the

period of recovery, it would disappear. Week 1, 2, 3 - x5/week, week 4 - x3/week, the two following months observing the same scheme.

Results

Table 2. *Values obtained by C. M. at the initial testing*

Joint assessment (grade)	Normal values	Values Initial testing	Difference
Flexion (active)	130°	93°	37°
Extension (active)	0°	17°	17°
Muscle assessment	Normal values	Values initial testing	Difference
	5	1	4
VAS Scale	Baseline value	Initial testing	Difference
	0	8	8

Table 3. *Values obtained by R. M. at the initial testing*

Joint assessment (grade)	Normal values	Values Initial testing	Difference
Flexion (active)	130°	84°	46°
Extension (active)	0°	15°	15°
Muscle assessment	Normal values	Values initial testing	Difference
	5	2	3
VAS Scale	Baseline value	Initial testing	Difference
	0	9	9

Considering C. M., after applying the two modern therapies in combination with kinesiotherapy, results became noticeable immediately. The pain intensity decreased - initially on the VAS Scale value 8, finally on the VAS Scale value 0, the oedema reduced significantly (using local ice applications 1x/day, for 7 days, and rest), while the exercises of kinesiotherapy became much easier to execute.

When talking about R. M., after applying the two modern therapies in combination with kinesiotherapy, results came rapidly. The handball player recorded initially on the VAS Scale value 9 for the pain scale, finally on the VAS Scale value 0; the pain intensity decreased, the oedema mitigated (using local ice 1x/day for 7 days), while the exercises of kinesiotherapy became much easier to execute.

Table 4. Values obtained by C. M. in the final testing

Joint assessment (grade)	Normal values	Values Final testing	Difference
Flexion (active)	130°	127°	3°
Extension (active)	0°	0°	0°
Muscle assessment	Normal values	Values final testing	Difference
	5	5	0
VAS Scale	Baseline value	Final testing	Difference
	0	0	0

At the final testing, the athlete C. M. obtained the values: VAS Scale value 0, active flexion 127°, active extension 0°, muscle assessment value 5 (Table 4).

In the final phase of the treatment, the patient R. M. obtained: VAS Scale value 0, active flexion 120°, muscle assessment value 5, Active extension 0° (Table 5).

Table 5. Values obtained by R. M. in the final testing

Joint assessment (grade)	Normal values	Values Final testing	Difference
Flexion (active)	130°	120°	10°
Extension (active)	0°	0°	0°
Muscle assessment	Normal values	Values Final testing	Difference
	5	5	0
VAS Scale	Baseline value	Final testing	Difference
	0	0	0

The findings of the research demonstrated that grade II knee sprain may be recovered within 3 months. Upon applying the treatment (Tecar Therapy+kinesiotherapy+laser therapy), it may be stated that this is a correct formula to be used for a rapid and brief recovery of grade II knee sprains. This modern and unique technology uses modern devices in the treatment of knee sprains; this treatment may be applied in an outpatient setting and it involves no pain.

Table 6. Centralisation of values for active flexion initially and finally, Active extension initially and finally, muscle assessment initially and finally, VAS Scale initially and finally

No.	Last and first name	Age	Active flexion (normal=130°) initial	Active extension (0°) initial	Active flexion final	Active extension final	VAS initial	VAS final	Muscle assessment initial	Muscle assessment final
1.	C. M.	35	93°	17°	127°	0°	8	0	1	5
2.	R. M.	33	84°	15°	120°	0°	9	0	2	5

Table 7. Centralisation of values for Tecar Therapy, initially and finally

No.	Last and first name	Age	Mode	Emission	Frequency initially	Energy transfer initially	Frequency finally	Energy transfer finally	Time
1.	C. M.	35	Neurodynamic	Continuous	500 kHz 54 Vrms	Resistive, Jtot 15.641	500 kHz 66 Vrms	Resistive, Jtot 25.689	20 minutes phase I and 20 minutes phase II
2.	R. M.	33	Neurodynamic	Continuous	500 kHz 51 Vrms	Resistive, Jtot 12.875	500 kHz 63 Vrms	Resistive, Jtot 22.897	20 minutes phase I and 20 minutes phase II

Table 8. Centralisation of values for laser therapy, initially and finally

No.	Last and first name	Age	Diagnostic	Values of laser therapy initially	Values of laser therapy finally	Session duration
1.	C. M.	35	Grade II knee sprain	14.,7 J/cm ²	20.7 J/cm ²	10 minutes
2.	R. M.	33	Grade II knee sprain	17.7 J/cm ²	20.7 J/cm ²	10 minutes

The two subjects mentioned on the VAS Scale, the pain scale, at the beginning of treatment (Tecar Therapy + kinesiotherapy + laser therapy) the value 8, while at the end of the treatment, after applying the two modern technologies, the value 0.

Initially, the two subjects presented values for active flexion of 93° and 84°, respectively, while for active extension 17° and 15°, respectively. After benefitting from the treatment scheme, at the end of the period of de recovery: the subject C. M. reached the value of 127° (active flexion), while the subject R. M. 120° (active flexion); the values of passive extension for both subjects were 0. It is worth noting that both athletes recovered 100%. The difference of active flexion of 37° and active extension of 17° (in the case of C. M.), active flexion 46° and active extension 15° in the case of R. M., respectively, was regained in 3 months using the new therapeutical plan for the recovery of knee sprains.

The most important advantages regained by the two handball players even during recovery were as follows: significant pain and inflammatory process mitigation; combating flawed vascular circulation; increase in the muscle force through the kinesiotherapy program; regaining joint mobility. At bone level, on the other hand, an improvement was noted in the range of motion, accompanied by joint deblocking.

The involvement of Tecar helped to warm the tissues, thus improving blood flow; hence, the tissue provides more oxygen and nutritional substances in a short time, local heat – muscular relaxation, pain mitigation during mobilisation at the knee joint. After using the

Tecar Therapy, it may be stated that it was an effective therapy for the two patients, only when used as additional for other therapies, therapies helping to reduce pain significantly (muscle/bone pain), to mitigate the pain localised on a certain segment or area, thus assisting specialists in their recovery activity.

The result of using the two modern therapies – Tecar Therapy and laser wave therapy – may be noticed from the first session, the patient benefitting from a unique combination between the therapeutical effect and the relaxation offered by the massage, given the hands-on technique of the kinesiotherapist.

Discussion

Performance sport has become ever more present nowadays. One of the most important component of sports training – determining productivity during practices and competitions – is physical training, which includes the development of basic and specific motor skills. These elements led to injuries over time and to deficiencies, and such aspects should not be neglected (Sopa, 2019; Szabo et al., 2018).

Kinesiotherapy sessions help to regain muscle tone, to restore muscle balance, to prevent sequelae that may emerge after disorders and which may entail motor and/or mental disabilities.

Just like in our study, Ribeiro et al. analysed the effects of TECAR therapy on musculoskeletal disorders. After performing a literature review, results have shown the beneficial effects of TECAR therapy in numerous musculoskeletal disorders, just like in our case, regarding the revision of knee sprains. With results similar to ours, Ribeiro et al. have proven that Tecar Therapy is an excellent adjuvant therapy, which should be incorporated in the recovery program, with both short-term and long-term effects. In this study, the use of TECAR therapy allows the reduction of mobility-related complications, as it happened in our study, with beneficial effects on regaining flexion and mitigating pain (Ribeiro et al., 2018). Ribeiro et al. have concluded that Tecar Therapy seems efficient in musculoskeletal disorders and that it seems to play an important role in the recovery process, thus being incorporated perfectly in the recovery program.

Kumaran and Watson (2015) analysed knee function and pain after the application of the Tecar Therapy. Just like in our research, pain measured through the VAS Scale mitigated considerably.

Furthermore, Coccetta et al. have shown that this therapy with diathermia improved significantly the resistance, physical function and pain present in the knee joint. Authors revealed at the end of their study that the therapy of capacitive and resistive electrical transfer may reduce pain, stiffness and functional limitation of the knee (Coccetta et al., 2019).

Tsuchiya et al. (1994), Maegawa et al. (2000), Fahmy et al. (1983), Pham and Hull (2007), Raunest and Derra (1995), as well as Grifka et al. (1994), Horan et al. (1999), Atik et al. (2001), Harada et al. (1998), analysed the effect of applying laser therapy. The authors argue that high-power laser is used to mitigate pain intensity, to improve blood flow on the impaired segment of the limb, as well as to regenerate the affected knee cartilage. The findings have supported the idea that the application of laser therapy was effective for training pain within the knee joint.

The kinesiotherapist – before the emergence of the latest technologies on the market – had a great responsibility: to make the patient regain what he had lost in a split second (intentionally or unintentionally). Patients need a nonsurgical pattern, which help them to reduce significantly the time allocated to the period of recovery, to speed up the healing process, thus being able to resume the sports program quickly.

We should never ignore the health of the lower limbs; on the contrary, we should always make sure they are in good shape. Hence, it is recommended to prevent the emergence of traumas in the orthopaedic area. Many times, a consult at an orthopaedist can save a patient from potential complications due to conditions already present, but without causing any symptoms. Without a good shape of the lower limbs, daily activity is totally compromised, as well as the entire body. Therefore, it is best to prevent the emergence of various diseases by taking care of our health, because the smooth unfolding of sports activities depends on it.

Conclusion

The current study responded the research question. Therefore, the recovery strategy which involves Tecar Therapy + kinesiotherapy + laser therapy reduced the time allocated to recovery, in the case of grade 2 knee sprain. The two handball players who benefitted from a personalised recovery program returned almost to normal values in a short period.

The objectives of this study were attained: the pain intensity decreased from the first visit to the recovery practice to the end of the recovery period; the inflammatory process disappeared; the muscle tone improved using kinesiotherapy and modern therapies; muscle power and joint stability were regained. The two modern technologies had an analgesic, myorelaxing effect and they intensified tissue healing, thus allowing patients to advance in their recovery and rehabilitation process. The combination of recovery protocol based on therapeutical physical exercises, Tecar Therapy and laser therapy demonstrates their beneficial effects on knee sprain recovery. The exercises of recovery have far better results when conducted after a session of energy transfer specific to TECAR, the recovery session ending with laser therapy.

The recovery time for an athlete who suffered a traumatism may be reduced if kinesiotherapy, Tecar high performance technology and high-power laser are applied - in the case of the present study, the recovery of grade II knee sprains took only 3 months.

You have a perfect body! Your body is so strong and resilient; you cannot possibly imagine what your body is capable of without any assistance! It has a fantastic regenerative power of reviving, of eliminating toxins from the body, and – most importantly – of self-healing.

References

- Atik, O. S., Erdogan, D., Omeroglu, Tali, S. T., Korkusuz, F., Uslu, M. M., & Eksioglu, F. (2001). Histological and magnetic resonance imaging alterations after irradiation of meniscus using Holmium: YAG laser. *Journal of Clinical Laser Medicine & Surgery*, 19, 245-250. DOI: 10.1089/10445470152611973

- Bogdan, R., Bucur, A., Chiriac, M., Ciobanu, D., Cristea, D., Dan, M., Ianc, D., Lozincă, I., Marcu, V., Mărcuț, P., Matei, C., Pasztai, Z., Pâncotan, V., Pețan, P., Serac, V., Șerbescu, C., & Tarcău, E. (2006). *Kinetoterapie [Physiotherapy]*. Editura Universității din Oradea.
- Cocchetta, C., Sale, P., Ferrara, P. E., Specchia, A., Maccauro, G., Ferriero, G., & Ronconi, G. (2019). Effects of capacitive and resistive electric transfer therapy in patients with knee osteoarthritis: a randomized controlled trial. *International Journal of Rehabilitation Research*, 42(2), 106–111. <https://doi.org/10.1097/MRR.0000000000000324>
- Dhillon, H., Dhillon, S., & Dhillon, M. S. (2017). Current Concepts in Sports Injury Rehabilitation. *Indian Journal of Orthopaedics*, 51(5), 529–536. DOI: 10.4103/ortho.IJOrtho_226_17
- Fahmy, N. R., Williams, E. A., & Noble, J. (1983). Meniscus pathology and osteoarthritis of the knee. *The Journal Bone & Joint Surgery British volume*, 65(1), 24-28. <https://doi.org/10.1302/0301-620X.65B1.6687393>
- Ganzit, G. P., Stefannini, L., & Stesina, G. (2000). *Tecar therapy in the treatment of acute and chronic pathologies in sports*. <https://docplayer.net/59319138-Tecar-therapy-in-the-treatment-of-acute-and-chronic-pathologies-in-sports.html>
- Gornea, F. (2010). *Ortopedie și Traumatologie [Orthopedics and Traumatology]*. Central Editorial-Poligrafic.
- Grifka, J., Boenke, S., Schreiner, C., & Löhnert, J. (1994). Significance of laser treatment in arthroscopic therapy of degenerative gonarthrosis. A prospective, randomised clinical study and experimental research. *The Knee Surgery, Sports Traumatology, Arthroscopy*, 2(2), 88-93. <https://doi.org/10.1007/BF01476479>
- Guimares, B., Bareto, J., Martins, A. U., Silva, J., Matos, J., Cardoso, R., Melo, F., & Branco, C. A. (2018). The role of tecar therapy in the delayed onset muscle soreness and functional recovery. *Annals of Physical and Rehabilitation Medicine*, 61, 75-76. <https://doi.org/10.1016/j.rehab.2018.05.162>
- Harada, T., Ohkuni, I., & Tsuruoka, H. (1998). A Clinical Application of the 1 W Ga-Al-As diode laser: Double Blind Study. *Journal of Physical Medicine*, 9(2), 99-103.
- Hashmi J. T., Huang Y. Y., Osmani B. Z., Sharma S. K., Naeser M. A., & Hamblin M. R. (2010). Role of Low-Level Therapy in Neurorehabilitation. *PM&R*, 2(12S), S292-S305. <https://doi.org/10.1016/j.pmrj.2010.10.013>
- Horan, P. J., Popovic, N. A., Islinger, R. B., & Kuklo, T. R., Dick Jr, L. A., & McKinney (1999). Acute and long-term response of the meniscus to partial meniscectomy using the holmium: YAG Laser. *Arthroscopy*, 15(2), 155-164. <https://10.1053/ar.1999.v15.015015>
- Kumaran, B., & Watson T. (2015). Thermal build-up, decay and retention responses to local therapeutic application of 448 kHz capacitive resistive monopolar radiofrequency: A prospective randomized crossover study in healthy adults. *International Journal of Hyperthermia*, 31(8), 883-895. <https://doi.org/10.3109/02656736.2015.1092172>
- Maegawa, Y., Itoh, T., Hosokawa, T., Yaegashi, K., & Nishi, M. (2000). Effects of near infrared low level laser irradiation on micro-circulation. *Laser in Surgery and Medicine*, 27(5), 427-437. [https://doi.org/10.1002/1096-9101\(2000\)27:5<427::AID-LSM1004>3.0.CO;3-A](https://doi.org/10.1002/1096-9101(2000)27:5<427::AID-LSM1004>3.0.CO;3-A)
- Meewisse, W. T., Tyreman, H., Hagel, B., & Emery, C. (2007). A dynamic model of etiology in sport injury: the recursiveness of risk and causation. *Clinical Journal of Sport Medicine*, 17(3), 215-219. DOI: 10.1097/JSM.0b013e3180592a48
- Osti, R., Pari, C., Salvatori, G., & Massari, L. (2015). Tri-length laser therapy associated to Tecar therapy in the treatment of low-back pain in adults: a preliminary report of a prospective case series. *Lasers in Medical Science*, 30(1), 407-412. <https://doi.org/10.1007/s10103-014-1684-3>

- Pham, M., & Hull, M. L. (2007). Dehydration rates of meniscus and articular cartilage in vitro using a fast and accurate laser-based coordinate digitizing system. *Journal of Biomechanics*, 40(14), 3223-3229. DOI: 10.1016/j.jbiomech.2007.04.015
- Raunest, J., & Derra, E. (1995). Morphological, biomechanical and experimental in vivo studies of laser-assisted meniscus resection. *Langenbeck's Archives of Surgery*, 380(1), 12-21. <https://doi.org/10.1007/BF00184411>
- Ribeiro, S., Henriques, B., & Cardoso, R. (2018). The Effectiveness of TECAR Therapy in Musculoskeletal Disorders. *International Journal of Public Health and Health Systems*, 3(5), 77-83.
<http://solmemo.pt/documentos/Publicacoes/The%20Effectiveness%20of%20Tecar%20Therapy%20in%20Musculoskeletal%20Disorders.pdf>
- Sopa, I. S. (2019). Developing attack point in volleyball game using plyometric exercises at 13–14 years old volleyball players. *Bulletin of the Transilvania University of Braşov. Sciences of Human Kinetics*, 12(61), 67-76.
<https://doi.org/10.31926/but.shk.2019.12.61.2.41>
- Szabo, D. A., Sopa, I. S., Stoica, R. S., & Ivănescu, A. (2018). The effectiveness of physiotherapeutic treatment in the recovery of the collateral ligament lesion. *Discobolul - Physical Education, Sport and Kinetotherapy Journal*, 52(2), 16-24.
- Traulle, M., Forelli, F., Chibani, A., & Champain, V. (2019). La Tecarthérapie: principes, indications et littérature. *Kinésithérapie scientifique*, 609, 33-37.
- Tsuchiya, K., Kawatani, M., Takeshige, C., & Matsumoto, I. (1994). Laser Irradiation Abates Neuronal Responses to Nociceptive Stimulation of Rat-paw Skin. *Brain Research Bulletin*, 34(4), 369-374. [https://doi.org/10.1016/0361-9230\(94\)90031-0](https://doi.org/10.1016/0361-9230(94)90031-0)