How to Cite:
Mowafy, Z. M. E., Gammal, A. S. E., Elsayeh, S. M. A., & Ewaida, N. M. N. M. I. (2022). Pulsed electromagnetic field therapy versus extracorporeal shock wave therapy in the treatment of iliohypogastric neuralgia postinguinal herniorrhaphy. *International Journal of Health Sciences, 6*(S4), 3778–3788. https://doi.org/10.53730/ijhs.v6nS4.9431

Pulsed electromagnetic field therapy versus extracorporeal shock wave therapy in the treatment of iliohypogastric neuralgia postinguinal herniorrhaphy

Zakaria Mowafy Emam Mowafy
Physical Therapy Department for Surgery, Faculty of Physical therapy, Cairo University, Egypt

Ahmed Sabry El Gammal
Department of General Surgery, Faculty of Medicine, Al Menofia University, Egypt

Shaimaa Mohammed Ahmed Elsayeh
Physical Therapy Department for Surgery, Faculty of Physical therapy, Cairo University, Egypt

Nehal Mohamed Nagib Mohamed Ibrahim Ewaida
Physical Therapy Department for Surgery, Faculty of Physical therapy, Cairo University, Egypt

***Abstract*---**Purpose: to evaluate the efficacy of pulsed electromagnetic field therapy versus extracorporeal shock wave therapy in the treatment of iliohypogastric neuralgia post inguinal herniorraphy. Methods of evaluation: - (Measurement of the serum cortisol level and the carbamazepin medicament intake). Methods: 40 male and female patients with iliohypogastric neuralgia post inguinal herniorraphy were divided into two groups. Group (A) received the thoracolumbar pulsed electromagnetic field therapy .Group (B) received the thoracolumbar extracorporeal shock wave therapy , duration of treatment was 20 minutes , every other day for the 3 months as a total period of treatment in addition to the traditional physical therapy and medical care for 3 months in group (A) and in group (B) the following parameters were used as following : 1,000 impulses; energy flux density (ED) varied from the lowest (0.08 mJ/mm2) to the highest energy level (0.44 mJ/mm2), depending on patient's pain tolerance, on the trigger point area, over the thoracolumbar region paravertebrally once every two weeks for 12 weeks (3 months) on the affected side, the handpiece of the ESWT device was positioned perpendicular on the target area of treatment and moved circular over

Manuscript submitted: 27 March 2022, Manuscript revised: 18 May 2022, Accepted for publication: 9 June 2022

gel that was used over the target area of treatment in addition to the traditional physical therapy and medical care for 3 months. Results: Results showed that both the thoracolumbar PEMFT and the thoracolumbar ESWT, were nearly equivalent and significantly effective in decreasing the postoperative iliohypogastric neuralgia as manifested by the decreased SCL and CMI and that may be attributed to the rapid increase in the endogenous opiates as well as to the rapid decrease in conduction of the A-delta fibers which are the pain mediators. Both the thoracolumbar PEMFT and the thoracolumbar ESWT were acting over the sympathetic outflow through their depressor effects in decreasing the dominant sympathetic tone in painful conditions, decreasing edema and inflammation. Conclusion: both were nearly equivalent and significantly effective in decreasing the postoperative iliohypogastric neuralgia as manifested by the decreased SCL and CMI.

***Keywords*---**pulsed electromagnetic field therapy, extracorporeal shock wave therapy, iliohypogastric postoperative neuralgia, serum cortisol level, carbamazepin medicament intake.

Introduction

Persistent pain (neuralgia) and burning sensations (paraesthesia) from the surgical incision of the inguinal herniorrhaphy extending laterally into the inguinal region and suprapubic region caused by iliohypogastric nerve entrapment after inguinal herniorraphy, appendectomy, or lower quadrant blunt trauma are intractable and when persistent may result in severe morbidity. It is well known that the iliohypogastric nerve can be inadvertently injured during the inguinal herniorraphy, and caution is stressed during the teaching of this common procedure to resident physicians. Persistent postoperative pain and / or paraesthesia in the distribution of the iliohypogastric nerve may occasionally occur. Entrapment of the iliohypogastric nerve may be caused by inadvertent suture placement, fibrous adhesions and cicatricial neuroma. Reexploration of an inguinal hernia incision to perform neurectomy, neurolysis, or remove a neuroma involving the iliohypogastric nerve is sometimes necessary. Persistent pain after remedial iliohypogastric nerve surgery suggests entrapment of neighboring sensory nerves, [3,4,8,10].

The iliohypogastric nerve arises primarily from the ventral primary rami of L1 and occasionally with a twig from T12. This nerve has a pathway similar to the intercostal nerves in the thoracic region. The iliohypogastric nerve traverses the psoas major muscle to pierce its lateral border anterior to the quadratus lumborum muscle and posterior to the kidney to traverse the lateral abdominal wall. The nerve penetrates the transverse abdominal muscle near the iliac crest, coming between it and the internal oblique musculature. The nerve then supplies the lower fibers of the transverse abdominal muscle and the internal oblique and divides into the lateral and anterior cutaneous branches, [3,4,8,10,12].

Electromagnetic fields are considered as one of the most developing and common used modalities in the field of physical therapy. Physical therapists use almost all types of electromagnetic fields in the management of different cases. Electromagnetic fields are now being used in many diseases such as skin, osseous, ligamental, or nervous reparation, diabetes, as well as myocardial or cerebral ischaemia. It is believed that electromagnetic fields play its role in healing by guiding cellular movements that close wounds. It has been shown that fields can affect orientation, migration and proliferation of cells such as fibroblasts, myofibroblasts and keratinocytes, which are of key importance in healing, [1,2,5,6,7,11].

The biological effects and interactions of magnetic fields with living organisms are very complicated. It is too early to give the mechanism, a lot of research activities are needed to be carried out to give a satisfactory explanation for the phenomena, but the newly findings about the magnetic field effects on the biological and living systems are influences of the magnetic fields on properties of the biological liquid crystals and ionic motion. Pulsed electromagnetic field (PEMF) therapy is a physical therapy modality that has been widely used for increasing permeability of the cell membrane and blood circulation, increasing oxygen supply, increasing ATP production, stimulating healing process and epithelialization of the injured tissues, accelerating bone healing, improving fibroblastic as well as osteoblastic activities, plus its anti-inflammatory and analgesic effect, [1, 2,5,13,17].

Extracorporeal shock wave therapy (ESWT) is a noninvasive method that uses pressure waves to treat various musculoskeletal conditions. High-energy acoustic waves (shock waves) deliver a mechanical force to the body's tissues. Shock wave therapy may treat conditions such as degenerated tendons (Achilles tendonitis), heel pain (plantar fasciitis) and tennis elbow (lateral epicondylitis). Complications are infrequent with shock wave therapy. People who have poor sensation (neuropathy) or hypersensitivity in the target area should not have this procedure. Open sores should also be avoided. Shock wave therapy is not used in patients with heart conditions or seizures. It should not be used during pregnancy. This should be discussed with your physician before undergoing the procedure. A noninvasive probe is applied to the skin. An electrical charge creates an energy wave that is focused on the area of concern, [14,15,20,21].

The shock waves create a force on the tissues that may induce healing. It's not clear why this approach to healing works for some people, but it may be that shock waves cause inflammation and improve blood flow to encourage the body to repair and heal itself. Shock wave therapy is an outpatient procedure. A probe is placed on the skin after a gel is applied to help conduct the shock waves. High- or low-energy waves may be used. High-energy waves may cause pain and require a local or regional anesthetic. Low-energy shock wave therapy often is performed without anesthesia. Therapy is more successful with active patient participation where the patient tells the therapist whether or not the probe is at the area of pain. One or more treatment sessions may be needed. Patients typically bear weight after treatment. Patients are advised to reduce the level of physical activity for one to two weeks after treatment Shock wave therapy may give good outcomes for some tendon problems or chronic degenerative conditions. Examples include Achilles tendinitis and plantar fasciitis,[14,15,20,21,23].

Material and Methods

Subjects

This study was carried out on forty patients of both sexes with postoperative neuralgia of the iliohypogastric nerve were referred from out-clinics of the general surgery departments in Cairo university hospitals (Kasr- El Aini hospital). Their ages were ranged from 30 to 50 years old. They were assigned randomly into two groups; the first experimental group (A) was composed of twenty patients who received the thoracolumbar pulsed electromagnetic field therapy in addition to the traditional physical therapy and medical care for 3 months. The second experimental group (B) was composed of twenty patients who received the thoracolumbar extracorporeal shock wave therapy (ESWT) in addition to the traditional physical therapy and medical care for 3 months. Measurements were conducted before starting the treatment as a first record and at the end of the treatment as a second (final) record.

Instrumentation

In this study the measuring equipment were the elexcess twenty ten device for the blood serum analysis that was used for the measurement of serum cortisol level (SCL) and Calculation of the carbamazepin medicament intake (CMI) in mg to determine the improvement of the postoperative neuralgia of the iliohypogastric nerve, while the therapeutic equipment were the JAMAV pulsed electromagnetic field unit and the Shock wave device,[10,16,18,,19,20, 21,24,25].

Procedures

Evaluation

Measurement procedures

Serum cortisol level measurement: (SCL)

Normal cortisol level ranged from 9-25 μg/dL at morning and patients with painful conditions tended to have higher than normal SCL, estimation of serum cortisol level was carried out before and after 3 months of treatment program. A venous blood sample of 8 CC was taken at the morning, centrifuged and stored at 20°C till analyzed ,[3, 4,10,12,19,20,21,24,25].

Calculation of the carbamazepin medicament intake (CMI) in mg

Was done before and after the treatment programme, [3,4,8,12,19].

Treatment procedures

1. All patients in the 2 groups (A) and (B) received the same traditional physical therapy and same medications. Procedures of the pulsed electromagnetic field therapy for group (A); The pulsed electromagnetic field therapy (PEMF) was applied once daily, three times per week for 3 months.

Each session will be conducted for 20 minutes over the thoracolumbar region paravertebrally on the affected side for the first group (A), with the patient will be placed in a comfortable prone position and the active surface of the JAMAVA apparatus will be fixed directly over the treated site. PEMF program for the first group has the following characteristics: Program of mild impulses, soothing North polarity of the magnetic pulses with frequency of 12.5 Hz, [1,2,5,6,13,24,25].

2. Procedures of the extracorporeal shock wave therapy (ESWT) for group (B): The patient was placed in a comfortable prone position, each ESWT session was conducted with the following parameters: 1,000 impulses; energy flux density (ED) varied from the lowest (0.08 mJ/mm2) to the highest energy level (0.44 mJ/mm2), depending on patient's pain tolerance, on the trigger point area, over the thoracolumbar region paravertebrally once every two weeks for 12 weeks (3 months) on the affected side. The handpiece of the ESWT device was positioned perpendicular on the target area of treatment and moved circular over gel that was used over the target area of treatment, ,[14,15,20,21].

Data analysis

Serum cortisol level measurement: (SCL) and calculation of the carbamazepin medicament intake (CMI) in mg were measured pre-treatment as a first record and after three months intervention as a second final record in both groups. Collected data were fed into computer for the statistical analysis; descriptive statistics as mean, standard deviation, minimum and maximum were calculated for each group. The t-test was done to compare the mean difference of the two groups before and after application and within each group. Alpha point of 0.05 was used as a level of significance,[9].

Results

As shown in table (1) and figure (1), the mean value of the SCL in µg /dl before treatment was (36.222 ± 0.412) in the (Pulsed electromagnetic field therapy group), while after treatment was (25.333 ± 0.421) in µg /dl . These results revealed a highly significant decrease in SCL in µg /dl (P < 0.0001). While in the ESWT group (Extracorporeal shock wave therapy group), the mean value of the SCL in µg /dl before treatment was (36.220 ± 0.516) in µg /dl, while after treatment was (25.180 ± 0.154) in µg /dl . These results revealed a highly significant decrease in the SCL in µg /dl (P < 0.0001).

Table (1): Comparison of the mean values of the serum cortisol level in µg /dl of the 2 records before and after treatment in both groups

	Before treatment		After treatment		Mean difference	t-value	P.value	Level of significance
	Mean	SD	Mean	SD				
PEMFT Group	36.222	0.412	25.333	0.421	10.8890	82.67	0.0001	Highly significant decrease
ESWT Group	36.220	0.516	25.180	0.154	11.0400	91.69	0.0001	Highly significant decrease

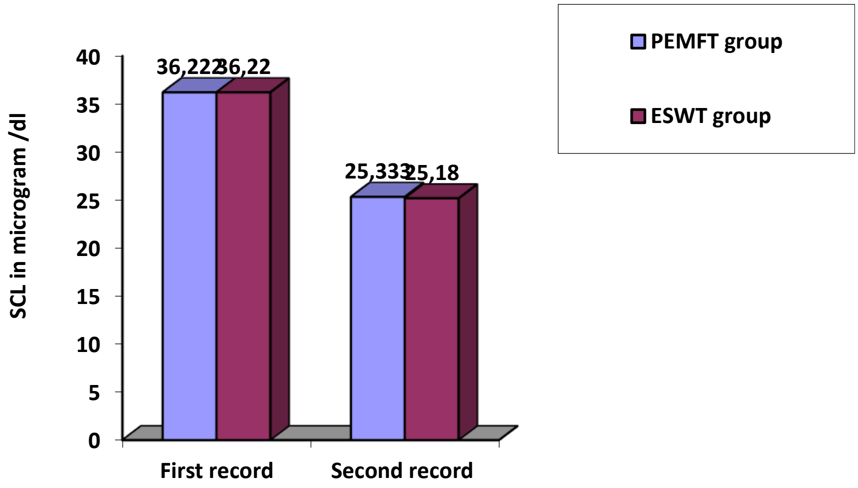

Figure 1. Bars representing the mean values of the serum cortisol level in µg /dl of the 2 records before and after treatment in both groups

As shown in table (2) and figure (2), the mean value of the carbamazepin medicament intake (CMI) in mg before treatment was (1006.0 ± 145.2) mg in the PEMFT group, while after treatment was (316.0 ± 66.4) mg. These results revealed a highly significant decrease, (P > 0.0001), while in the ESWT group, the mean value of the carbamazepin medicament intake (CMI) in mg before treatment was (1009.0 ± 140.5) mg, but after treatment was (300.0 ± 0.02) mg, these results revealed a highly significant reduction in the CMI in mg (P < 0.0001).

Table (2): Comparison of the mean values of the carbamazepin medicament intake (CMI) in mg before and after treatment in the two groups

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
PEMFT Group	1006.0	145.2	316.0	66.4	690.000	19.33	0.0001	Highly significant decrease
ESWT Group	1009.0	140.5	300.0	0.02	709.000	22.57	0.0001	Highly significant decrease

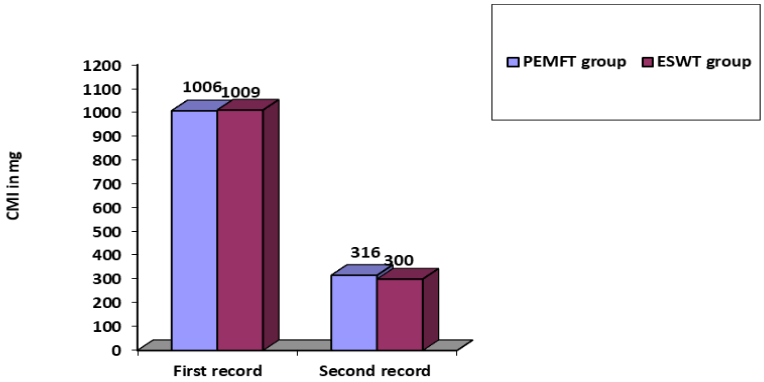

Fig (2): Mean values of the CMI in mg of the 2 records in both groups.

Discussion

The iliohypogastric nerve; it is formed by branches of the 12th thoracic and 1st lumbar nerves. The iliohypogastric nerve appears at the lateral margin of psoas muscle and crosses obliquely on the quadratus lumborum, passes beneath the inferior pole of kidney to pierce the transversus abdominis muscle, and then divides into branches. The most important one is the hypogastric, which lies between the external and internal oblique muscles at the level of the anterior superior iliac spine and reaches the suprapubic skin by piercing the muscular layers. It innervates the skin of the anterior abdominal wall above the pubis. The genitofemoral nerve; the genitofemoral nerve arises from the 1st and 2nd lumbar vertebral plexus and consists mainly of sensory fibers with a motor component to the cremastric muscle. It lies within the fascial lining of the abdomen by piercing the psoas muscles and the psoas fascia near its medial border opposite the 3rd or 4th lumber vertebra. It descends under the peritoneum on the surface of the psoas major muscle, crossing obliquely behind the ureter. At a variable distance above the inguinal ligament, the nerve divides into the genital (external spermatic) and femoral (lumboinguinal) branched. A great variation of nerve is not unusual, with free communication between branches of genitofemoral nerve or the ilioinguinal and iliohypogastric nerves, [3,4,8,12].

Chronic residual neuralgia may result from surgical handling of the sensory nerves of the groin during hernia repairs or after hernia repairs from constricting scar tissue or adjacent inflammatory granuloma. While the intraoperative trauma to the nerve whether division, stretching, contusion, or suture entrapment is usually but not appreciated at time of operation by surgeons. The ilioinguinal nerve arises from the fusion of T12 and L1 nerve roots and emerges from the lateral border of the psoas muscle; it traverses the anterior abdominal wall to the iliac crest just inferior to the hypogastric nerve. Adjacent to the anterior margin of the iliac crest, the nerve pierces the transversus abdominis and internal oblique muscles (providing neural branches to these) and sending neural branches to the iliohypogastric nerve. The nerve then supplies sensory branches to supply the pubic symphysis, the superior and medial aspect of the femoral triangle, and either the root of the penis and anterior scrotum in the male or the mons pubis and labia majora in the female, [3, 4, 8,18,19].

persistent pain (neuralgia) and burning sensations (paraesthesia) from the surgical incision of the inguinal herniorrhaphy extending laterally into the inguinal region and suprapubic region caused by iliohypogastric nerve entrapment after inguinal herniorraphy, appendectomy, or lower quadrant blunt trauma are intractable and when persistent may result in severe morbidity. It is well known that the iliohypogastric nerve can be inadvertently injured during the inguinal herniorraphy, and caution is stressed during the teaching of this common procedure to resident physicians. Persistent postoperative pain and / or paraesthesia in the distribution of the iliohypogastric nerve may occasionally occur. Entrapment of the iliohypogastric nerve may be caused by inadvertent suture placement, fibrous adhesions and cicatricial neuroma. Re-exploration of an inguinal hernia incision to perform neurectomy, neurolysis, or remove a neuroma involving the iliohypogastric nerve is sometimes necessary. Persistent pain after remedial iliohypogastric nerve surgery suggests entrapment of neighboring sensory nerves, ,[3,4, 8,18,19].

symptoms include burning or lancinating pain immediately following the abdominal operation. The pain extends from the surgical incision laterally into the inguinal region and suprapubic region. Discomfort may occur immediately or up to several years after the procedure and may last for months to years. This discomfort is possibly because of the formation of scar tissue in the region. Occasionally, the pain may extend into the genitalia due to the significant overlap with other cutaneous nerves. Loss of sensation is usually minimal and not problematic. Iliohypogastric nerve entrapment causing symptoms similar to trochanteric bursitis refractory to conventional therapy has been reported, [3, 4,8,12, 18,19].

Application of PEMFT for osteoarthritis and another painful condition as inflammatory synovitis has been supported by several trials. 86 patients with knee osteoarthritis were exposed to 9 hours of PEMFT over a 1 month period using a non contact device that delivered 3 signals in stepwise fashion ranging from a 5-Hz to 12-Hz frequency at 10 G to 25 G of magnetic energy. Patients averaged 35%improvement in the tested variables, including pain and function. The presence of biological magnetite particles in the tissues has led to the suggestion that the oscillatory magnetic field affect these particles and provide a mechanism for direct inter action of ELF a magnetic fields with cellular constituents. It may exert transitional forces on magnetic particles with the body. These effects on the atomic and subatomic levels included for instance the electronic resonance conditions. The latter interaction mechanisms may cause changes in the transfer rate of electrons during the electron exchange between single molecules, an event that may either slow down or accelerate chemical reactions,[1,2, 5,6].

Extracorporeal shockwave therapy (ESWT) began with an incidental observation of osteoblastic response pattern during animal studies in the mid-1980 that generated an interest in the application of ESWT to musculoskeletal disorders. In the past 10 to 15 years, shockwave therapy had emerged as the leading choice in the treatment of many orthopedic disorders including proximal plantar fasciitis of the heel, lateral epicondylitis of the elbow, calcific tendinitis of the shoulder and. non-union of long bone fracture ,[14, 15,23].

The findings of the present study showed that there was a highly significant decrease between the means of the second record SCL (2) (after three months of the thoracolumbar PEMFT application) and the first record SCL (1) (pre-application of the thoracolumbar PEMFT) ($P < 0.0001$). Findings of the present study revealed that there was a highly significant decrease between the means of the second record of SCL (2) (after three months application of Thoracolumbar ESWT) and the first record of SCL (1) (pre-application of the Thoracolumbar ESWT), in the second study group (Thoracolumbar ESWT application group) ($P< 0.0001$).

Findings of the present study showed that there was a highly significant decrease between the means of the second record CMI (2) (after three months of the thoracolumbar PEMFT application) and the first record ELI (1) (pre- application of the thoracolumbar PEMFT) ($P< 0.0001$). Also, findings of the present study showed that there was a highly significant decrease in CMI between means of the CMI (2) and CMI (1), in the second study group (application of the thoracolumbar ESWT) ($P<0.0001$).

Results of this study supports the expectation that both the thoracolumbar PEMFT and the thoracolumbar ESWT, were significantly effective in decreasing the postoperative iliohypogastric neuralgia as manifested by the decreased SCL and CMI and that may be attributed to the rapid increase in the endogenous opiates as well as to the rapid decrease in conduction of the A-delta fibers which are the pain mediators. Both the thoracolumbar PEMFT and the thoracolumbar ESWT were acting over the sympathetic outflow through their depressor effects in decreasing the dominant sympathetic tone in painful conditions, decreasing edema and inflammation.

These significant differences, between the first study (Thoracolumbar PEMFT application) and the second study (Thoracolumbar ESWT application) groups, which were in the form of a significant decrease in the SCL and CMI, were consistent with those observed and recorded by Aaron et al., 2004; Adie et al., 2011; Ahmadian et al., 2006; Al-Abbad and Simon, 2013; Athanasiou et al., 2007; Barker et al., 2006; Bervar, 2005; Bianchi et al., 2018; Blank and Goodman, 2008; Bragin et al., 2018; De Mattei et al., 2005; Foldager et al., 2012; Funk,2018; Hao et al., 2018; Holfeld et al., 2014; Korakakis et al., 2018; Kubat et al., 2015; Liao et al., 2019; Lou et al., 2017; Mani-Babu et al., 2015; Moya et al., 2018; Speed,2014; Van der Worp et al., 2013; Verstraelen et al., 2014; Wade, 2013; Wang, 2012 and Zou et al., 2017. Results of this study support the expectation that application of both thoracolumbar PEMFT and thoracolumbar ESWT were effective and nearly equivalent in improving the postoperative iliohypogastric neuralgia as evidenced by the highly significant decreases in SCL and CMI.

Conclusion

Application of both thoracolumbar PEMFT and thoracolumbar ESWT were effective and nearly equivalent in improving the postoperative iliohypogastric neuralgia as evidenced by the highly significant decreases in SCL and CMI.

References

1. Aaron RA, Ciombor DM, and Simon BA, (2004): "treatment of non-union fractures with electric and electromagnetic fields" Clin. Orhtop. Relat. Res. (419): 21-29.
2. Adie S, Harris IA and Naylor JM et al., (2011): Pulsed electromagnetic field stimulation for acute tibial shaft fractures: A multicenter, double-blind, randomized trial. J Bone Joint Surg Am;93(17):1569-1576.
3. Courtney CA, Duffy K, and Serpell MG, (2002): "Outcome of patients with severe chronic pain following repair of groin hernia". Br J Surg 89:1310-1314.
4. Dabbas N, Adams K and Pearson K et al., (2011): Frequency of abdominal wall hernias: is classical teaching out of date? JRSM Short Rep; 2:5.
5. De Mattei MI, Galliano NO and Dellavia CL, (2005): "Changes in polyamines, C-myc and C-fos gene expression in osteoblast-like cells exposed to pulsed electromagnetic fields" Bio electromagnetics 26 (3): 207-214.
6. Deitz LA, Schwardt JH and Chen DA, (2002): "Effects of pulsed electromagnetic fields (PEMF) on late phase osteotomy gap healing in a canine tibial model" J Orthop Res 20 (5): 1106-1114.
7. Detavs ID, Dombrovska LL and Klavinsh ID, (2002): "Experimental study of the effect of electromagnetic fields in early stages of wound healing" Bioelectrochem. Bioenerg 35: 113-117.
8. Nilsson H, Stranne J and Stattin P et al., (2014): Incidence of groin hernia repair after radical prostatectomy: a population-based nationwide study. Ann Surg; 259:1223.
9. Pipkin FB, (1984): "Medical statistics made easy". Edinburgh. London. Melbourne and New York.
10. Poobalan AS, Bruce JK and Smith WC, (2001): "Chronic Pain and Quality of Life Following Open Inguinal Hernia Repair" Br J Surg 88:1122-1126.
11. Prochazka MA, (2002): "Clinical testing of the JAMAVA device intended for pulsed magnetic field therapy, featuring criteria of a double-blind study". Jarov health care facility. Kone vova 205. Prague (3).
12. Rosemar A, Angerås U and Rosengren A et al., (2010): Effect of body mass index on groin hernia surgery. Ann Surg; 252:397.
13. Saadat AA, Lall AC and Battaglia MR, et al., (2019): Prevalence of Generalized Ligamentous Laxity in Patients Undergoing Hip Arthroscopy: A Prospective Study of Patients' Clinical Presentation, Physical Examination, Intraoperative Findings, and Surgical Procedures. Am J Sports Med; 47:885.
14. Selvam R, Ganesan K and Narayana KV, et al., (2007): Low frequency and low intensity pulsed electromagnetic field exerts its ant inflammatory effect through restoration of plasma membrane calcium ATPase activity. Life Sci 80(26): pp. 2403-2410.
15. Speed CA, (2014): systematic review of shockwave therapies in soft tissue conditions: focusing on the evidence. Br J Sports Med;48(21):1538–42.

16. Steven AS, (2003): "Role of Endorphins in Pain Modulation" JOSPT 3:200-205.
17. Strauch BA, Herman C and Dabb R et al., (2009): Evidence-Based Use of Pulsed Electromagnetic Field Therapy. Aesthet Surg J 29(2): pp. 35–143.
18. Suarez JC, Ely EE and Mutnal AB, et al., (2013): Comprehensive approach to the evaluation of groin pain. J Am Acad Orthop Surg; 21:558.
19. Thomsen HF, Bendix JH and Kehlet HS, (2004): "Convalescence after Inguinal Herniorrhaphy" B J Surg 91:362-367.
20. Van der Worp H, Van den Akker-Scheek I and Van Schie H et al., (2013): ESWT for tendinopathy: technology and clinical implications. Knee Surg Sports Traumatol Arthrosc;21(6):1451–8.
21. Verstraelen FU, Kleef NJ and Morrenhof JW et al., (2014): High-energy versus low-energy extracorporeal shock wave therapy for calcifying tendinitis of the shoulder: which is superior? A meta-analysis. Clin Orthop Relat Res;472(9):2816–25.
22. Wade B, (2013): A review of pulsed electromagnetic field (PEMF) mechanisms at a cellular level: a rationale for clinical use. Am J Health Res 1(3): pp. 51-55.
23. Wang CJ, (2012): Extracorporeal shockwave therapy in musculoskeletal disorders. J Orthop Surg Res;7:11.
24. Wolfman AG, Midura RH and Powell KR, (2004): "Bone mass is preserved in a critical sized osteotomy by low energy pulsed electromagnetic fields as quantities by in vivo micro-computed Tomography" J orthop Res (22): 1086-1093.
25. Zou J, Chen Y and Qian J, et al., (2017): Effect of a low-frequency pulsed electromagnetic field on expression and secretion of IL- 1β and TNF-α in nucleus pulposus cells. J Int Med Res 45(2): npp. 462-470.
26. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Get vaccinated when it is your turn and follow the local guidelines. *International Journal of Health Sciences*, *5*(3), x-xv. https://doi.org/10.53730/ijhs.v5n3.2938
27. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Health and treatment of diabetes mellitus. *International Journal of Health Sciences*, *5*(1), i-v. https://doi.org/10.53730/ijhs.v5n1.2864
28. Permana, A. T., Suroto, N. S., Parenrengi, M. A., Bajamal, A. H., Lestari, P., & Fauzi, A. A. (2022). Current update on stroke ischemic management: Stem cell as emerging therapy. *International Journal of Health & Medical Sciences*, *5*(1), 122-128. https://doi.org/10.21744/ijhms.v5n1.1851