Testing with pulsed and continuous emission Ultrasounds

Clinical trial for serious pathologies of the musculoskeletal apparatus treated by electro-medical ultrasound device Sirio

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Dr. Emanuel Paleco, Biologist with Master degree in Sport Science, Electro-medical Technologies, Nutrition

Index

General Data

Name of the device: Sirio

Property: **BAC S.r.l.**

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Period of time of the study: November and December 2010, follow-up after 1 month.

Persons in charge of the study:
Dr. Cristiano Cecchetelli, Surgeon specialized in Sport Medicine, Sonographer, Traumatologist as health director of one of the health facilities involved, and as expert in the diseases of the musculoskeletal system and sonographer.
Dr. Emanuel Paleco, Biologist with Master degree in Sport Science, Electro-medical Technologies, Nutrition as trial manager and expert of electro medical device (involved from years in development and research on ultrasound technologies in physiotherapy and aesthetics sectors).

Description of the device and its use

Sirio is a low frequency ultrasound generator (38 KHz +/- 2KHz), managed by a micro-processor, which emits acoustic waves in continuous or pulsed mode. It is provided with hand probes for non-invasive treatments, which features flat or concave surface.

Sirio is used for non-invasive treatments of the musculoskeletal apparatus. Treatments can be repeated over time according to specific treatment protocols. Treatment protocols change depending on the pathology to treat.

During treatments a gel must be used, since it works as a couplant between transducer and skin and allows the ultrasound irradiation of the area to be treated. The gel is neutral and does not contain medicinal substances.

Therapeutic indications

Diseases of the musculoskeletal system, as, for instance, joint pathologies (shoulder and knee areas), muscle injuries or contractures, meniscus pains, pains resulting from ankle sprain, tendon pains.

Preliminary remarks

The ultrasound therapy is today one of the most used and best-established electro-physical techniques in the physiotherapy-rehabilitative field (Papa 1995, Robertson 2002, Robertson e Baker 2001). Its effectiveness seems to be closely connected to the different absorption capabilities of the sound wave by the tissues; generally it seems that the effects are stronger on tissues which do not completely absorb the energy to which they are exposed to, as for example connective tissues which are rich of collagen – ligaments, tendons, joint capsules and scar tissue - (Sparrow et al 2005, Takakura et al 2002).
Actually the ultrasound application field for therapeutic purposes is much wider considering that also other tissues (as muscular and bones tissues which are not strictly connective tissues) are successfully treated with ultrasound (Clinton et al 2001).
In any case the nature of tissue is still now a critical element in the clinical decision making (Watson 2000, ter Haar 1999, Nussbaum 1998, Frizzel & Dunn, 1982).
Besides this factor, also the way that ultrasound are applied – continuous or pulsed – the frequency and the intensity of the application play a fundamental role to achieve an effective treatment.
It is universally recognized that ultrasound can induce different kinds of effects (mechanic, thermal, chemical and cavitation) which can be separately or jointly stimulated to achieve the desired responses. The localization of these effects is closely connected not only to instrumental factors, but also to the intrinsic characteristics of the ultrasound, as its emission frequency. Due to phenomena of energy absorption by the tissues, the acoustic waves are attenuated by the tissue they cross. Low frequency ultrasounds (KHz) produce their effects deeper than high frequency ultrasounds (MHz), whose action is more superficial (Mitragotri et al.2004, Paliwal et al 2006).

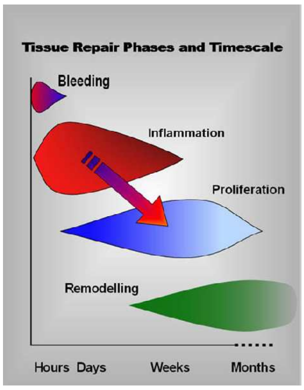
Scientific studies on ultrasound effects have demonstrated that low acoustic frequency and intensity (kHz) allow a faster tissue healing process than high frequency (MHz) ones (Uhlemann C et al. 2003).

As already mention, ultrasounds can be used to induce thermal effects, and as a consequence to stimulate diathermy, or without inducing thermal effects, while taking advantage of other reactions. A diathermy treatment is most effective in heating the dense collagenous tissues and requires a relatively high intensity, preferably in continuous mode. Together with the temperature rise several other reactions take place due to the increase of tissue oxygen intake, which depends on the induced vasodilatation and on the increased enzyme kinetics. All these factors contribute to activate and accelerate all cell regeneration systems.

In non-thermal treatments usually lower power output levels are use, preferably in pulsed mode, to obtain an up-regulation without heating. In this case the regeneration effect is due to the optimization of the normal inflammatory proliferative response (Nussbaum et al.1997, 1998, Watson et al. 2000).

Concerning the soft tissues, Nussbaum , ter Haar , Fyfe & Chahl e Maxwell have showed as, during the inflammatory phase, ultrasounds have a stimulating effect on mast cells, white blood cells, platelets, and macrophages with phagocytic roles (Nussbaum 1997 et al., ter Haar et al.1999, Fyfe & Chahl et al.1982, Maxwell et al.1992).

Ultrasound application seems to induce degranulation of mast cells, causing the release of arachidonic acid, which itself is a precursor for the synthesis of prostaglandins and leukotreine, which act as inflammatory mediators (Mortimer & Dyson et al. 1988, Nussbaum et al. 1997, Leung et al. 2004).
By increasing the activity of these cells, in general the influence of therapeutic ultrasounds is certainly pro-inflammatory rather than anti-inflammatory. The resulting benefit is not to 'increase' the inflammatory response, but rather to act as an 'inflammatory optimizer".



Picture 2: The improvement of repair inflammatory phase favors tissue repair

Several studies, which have tried to demonstrate the anti-inflammatory effect of ultrasounds, have failed to do so and have suggested that ultrasounds are ineffective (Hashish et al. 1986, 1988). Actually they are effective at promoting the normality of the inflammatory events, and have a therapeutic value in promoting the overall repair events (ter Haar et al.1999).

Employed with an appropriate treatment dose and with optimal treatment parameters (intensity, pulsing and time), the benefit of ultrasounds is to allow an efficient repair phase, with the consequent effect on the healing phase.

For tissues in which there is an inflammatory reaction, but in which there is no 'repair' to be achieved, the benefit of ultrasounds is to promote the normal resolution of the inflammatory events.

Ultrasounds has showed also a stimulant effect on tissues in proliferative phase (scar production), optimizing the reparative efficiency. (Ramirez et al 1997, Mortimer e Dyson et al. 1988, Young & Dyson et al. 1990, 1990b Young & Dyson et al., Nussbaum 1997, 1998 et al., Dyson e Smalley et al. 1983, Maxwell et al. 1992).

Several research groups have demonstrated that a low dose of pulsed ultrasounds increases protein synthesis, showing an enhanced fibroplasia and a stimulation of collagen neogenesis (Harvey et al. 1975, Ng et al 2004, Ng et al 2003, Tsai et al 2005, Enwemeka et al 1989, 1990, Huys et al 1993, Ramirez et al 1997).

Recent tests have also identified the potential role of therapeutic ultrasounds according to their ability to influence different cytokines and repair process mediators; for instance, ultrasound can influence the TGF- β (tissue growth factor) production (Mukai et al 2005).

Ultrasound application during inflammatory and proliferative phases is able to stimulate or enhance these normal events increasing the efficiency of the repair phases and enabling the tissue to reach its endpoint.

Aim of the study

We have tested the effectiveness of Sirio on a group of 10 patients, aged between 13 and 40, both males and females, with musculoskeletal problems in acute or sub-acute phase. We have tried to confirm the antalgic and inductors effects of the inflammatory response, described in the above mentioned literature. Particularly we have dwelled on joint pathologies (shoulder and knee), muscle injuries (adductor region), meniscus pains, pains resulting from ankle sprain.
Please note that the test group was form by both subjects practicing sports as soccer, basketball, volleyball at a competitive level and by sedentary subjects; there was not a control group. Tested patients were chosen to represent a case study of heterogeneous treatments.
Please note also that two patients included in the test did not have acute problems and they were previously treated with other physical therapies (high frequency ultrasounds, laser, tecar therapy) in other rehabilitative centres. According to these two patients the previous treatments did not improve their clinical symptomatological situation (subjects number 1 and 10 on the table below).

	Patient	**Age**	**Sport**	**Pathology and treated area**
1	D. A. Male	33	/	Tenosynovitis of the supraspinatus tendon; subacromial-subdeltoid bursitis right shoulder
2	S. F. Male	24	Basketball	Tendinitis of the long head of the biceps brachii and supraspinatus right shoulder
3	B. R. Female	42	/	Rotator cuff tendinopathy Right shoulder
4	L. P. Male	37	Basketball	Left ankle sprain
5	D. A. Male	13	Soccer	Right adductor syndrome
6	B. D. Male	31	Soccer	I-II degree muscle sprain right great adductor
7	C. G. Male	22	Soccer	Meniscus pain of the anterior horn External meniscus right side
8	L. M. Male	34	/	Meniscus pain Posterior horn of medial meniscus right side
9	F. M. Male	40	Soccer	Extensors tendinopatry and Post-traumatic chondropatry left wrist
10	M. M. Female	25	Volleyball	Recent right ankle sprain with Diffuse perimalleolar oedema

Table 1 Subjects of the study

Materials and methods

The therapeutic protocol employed has been organized in at least 6 sessions, one every 3 days (which is 2 sessions per week for a period of about 20 days). The initial pre-treatment management of each patient has been carried out through a careful medical history, a objective clinical examination and a ultrasound scan of the involved area using an Esaote My-Lab Five device with linear probe (7.5 MHz-12 MHz); the sonographic control has been repeated halfway through the treatment and at the end of the treatment. All patients di not play any sport and did not perform any activity that could overload the involved area until the treatment was completed. Treatments have been carried out with Sirio using three different types of probes and specifically:

- probe with flat surface and continuous emission to achieve a more uniform diathermy of treated tissues and with a wider treatment area;
- probe with concave surface and continuous emission to achieve a deeper effect and with increased diathermy but in a punctiform way;
- probe with concave surface and pulsed emission to achieve a cavitation effect.

Neither medicines nor other instrumental therapies have been administered.

Each session lasted on average 15-20 minutes; the type of hand probe to be used and of the ultrasound power output employed have been evaluated each time from patient to patient according to the area to treat, to the pursued physical effect and to the compliance-tolerability showed by the patients.

After each session the following data have been gathered in appropriate forms: the type of treatment carried out (probe used, time and power output), the immediate post treatment effects, as subjective sensation of diminishing painful symptomatology reported by the patient (as objective improvement of the joint functionality and as objective reduction of a joint oedematous swelling). Mid-long term effects at the end of the treatment cycle have been confirmed by sonographic control.

None of the patients under testing has the following problems, which are not compatible with ultrasound therapy:

High-Turnover Osteoporosis

Metal fragments under their skin

Joint artificial replacements

Varicose veins

Phlebitis and thrombophlebitis

Pacemaker

Haemorrhages

Neoplastic tissue and surrounding areas

Pregnancy

Patients manifestly unable to communicate clearly to the therapist any pain sensation

Result description

Pt. 1

Tenosynovitis of the supraspinatus tendon; subacromial-subdeltoid bursitis at the right shoulder.

6 sessions scheduled a regular intervals. The “Flat-continuous” probe was used in the first and second session, while the “Concave-continuous” probe was used in the following four sessions. Session average time: 15-20 minutes. Average power output: 65-70%.

Patient’s subjective sensations: joint pain reduction since the first day after the first session.

Objective evaluation: gradual improvement of the articular mobility of the right shoulder (elevation and adduction); complete recovery of the ROM (range of motion) at the end of the treatment cycle.

The sonographic control at the end of the treatment cycle has showed the resolution of the bursitis and the almost complete recovery of the echo texture of the supraspinatus tendon (see pictures below). The patient decided on his own to continue a maintenance therapy (1 session per week).

Effective treatment.


Before


After

Pt. 2

Tendinitis of the long head of the biceps brachii and supraspinatus at the right shoulder.

6 sessions scheduled at regular intervals. The “Flat-continuous” probe was used in the first, second and third session; the “Concave-continuous” probe was used in the following three sessions. Session average time: 15-20 minutes. Average power output: 70%.

Patient’s subjective sensations: early and long-lasting reduction of the antalgic symptomatology.

Objective evaluation: improvement of the articular mobility of the right shoulder. Gradual improvement in the LHBB (long head of biceps brachii) and supraspinatus stimulation test.

The sonographic control at the end of the treatment cycle has showed an almost complete recovery of the tendinitis of the long head of the biceps brachii and supraspinatus (see pictures below).

Also patient 2 decided on his own to continue with other sessions after the end of the cycle.

Effective treatment.

Before After

Pt. 3

Rotator cuff tendinopathy at the right shoulder, minor acromioclavicular impingement.

Only 4 sessions scheduled at regular intervals, as the patient was not able to continue the therapy. The "Concave-continuous" probe was used in all sessions. Session average time: 15-20 minutes. Average power output: 60%.

Patient's subjective sensations: reduction of the painful symptomatology in the second session.

Objective evaluation: significant improvement of the internal rotation and of the elevation-adduction of the right shoulder, without achieving the complete recovery of the ROM.

Due to the precocious conclusion of the treatment, it has not been possible to carry out the sonographic control.

Quite effective treatment.

Pt. 4
No recent left ankle sprain; functional limitation of the ankle (uncompleted painful plantar and dorsal flexion).
6 sessions scheduled at regular intervals. The "Flat-continuous" probe was used in the first, second and third session, while the "Concave-continuous" probe was used in the following three sessions. Session average time: 15-20 minutes. Average power output: 70%.
Patient's subjective sensations: the first session has been especially annoying for the patient; poor improvements reported. Gradual improvements of the reported symptomatology started from the third session.
Objective evaluation: gradual improvement of the articular mobility of the treated ankle with the recovery of flexion-extension and lack of pain even performing the sport's specific movement (take off and landing during the jump).
Effective treatment.

Pt. 5
Right adductor syndrome with II degree destructive injury of the right great adductor muscle.
Only 4 sessions were performed(little compliance of the patient, who has not suspended practicing sport despite our recommendations). Only the "Flat-continuous" probe was used. Session average time: 15-20 minutes. Average power output: 65-70%.
Patient's subjective sensations: little reduction of the painful symptomatology.
Objective evaluation: slight improvements of the muscle echo texture after the therapeutic cycle.
Poorly effective treatment.

Pt. 6
I-II degree muscle sprain of the right great adductor muscle.
6 sessions scheduled at regular intervals. Only the "Flat-continuous" probe was used. Session average time: 15 minutes. Average power output: 80-85%.
Patient's subjective sensations: gradual improvement of the muscle pain and of the athletic functionality when the patient has been allowed to restart his sports activity.
Objective evaluation: significant gradual improvement of the muscle echo texture of the treated area, indicative of an almost complete recovery (see below).
Effective treatment.

Before

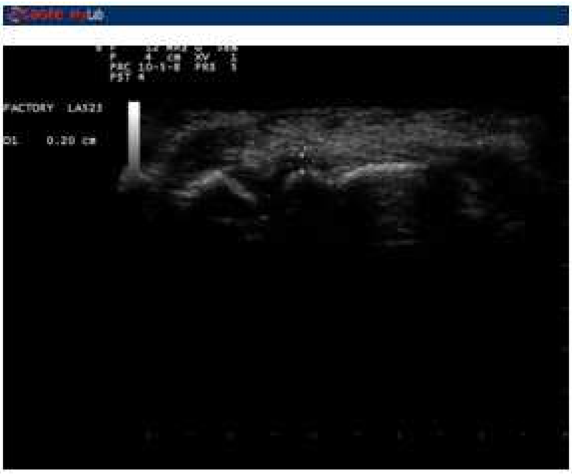
After 3 sessions

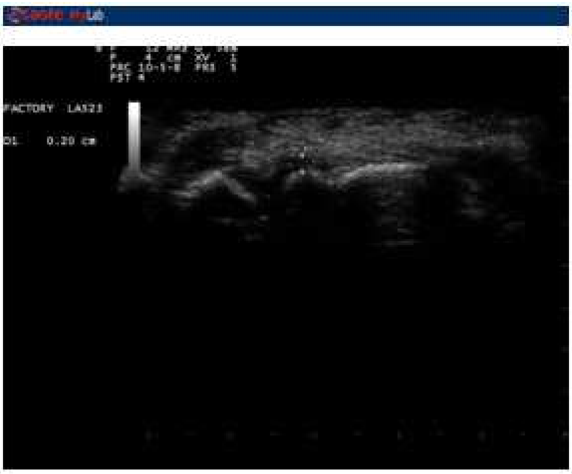
After 6 session

Pt. 7
Meniscus pain of the anterior horn of the right external meniscus. Functional limitation, acute pain of the external area of the right knee while running.
6 sessions scheduled at regular intervals. Both “Flat-continuous” and “Concave-pulsed” probes were alternately used during the same session. Session average time: 15 minutes. Average power output: 80%.
Patient’s subjective sensations: complete disappearance of the knee pain while running after the sessions. The patient was able to restart immediately the sports activity.
Effective treatment.

Pt. 8
Lesion of the posterior horn of the internal meniscus - right knee – indication of selective arthroscopic meniscectomy; significant functional limitation of the right knee (flexion reduced to 10 degree, significant pain while standing up and walking).
4 pre-surgery sessions. Both “Flat-continuous” and “Concave-continuous” probe were alternately used during the same session. Session average time: 15 minutes. Average power output: 60%.
Patient’s subjective sensations: gradual reduction of the painful symptomatology while standing up and walking since the first session.
Objective evaluation: slight improvement of the articular mobility of knee extension.
Quite effective treatment.

Pt. 9
Extensors tendinopatry and post-traumatic chondropatry of the left wrist .
6 sessions. The “Flat-continuous” probe was used. Session average time: 15 minutes. Average power output: 55-60%.
Patient’s subjective sensations: immediate improvement sensation of the wrist articular mobility.
Objective evaluation: clear reduction of the oedematous component of the cartilages already after the first session (see pictures below).
Effective treatment.





Pt. 10
Recent right ankle sprain with diffuse perimalleolar oedema.
6 sessions before doing a NMR. Only the “Flat-continuous” probe was used. Session average time: 15 minutes. Average power output: 65%.
Patient’s subjective sensations: immediate relief sensation after each treatment session, which regularly regressed during the following days.
Objective evaluation: clear reduction of the articular tumefaction already after the first session (see pictures below), but tending to relapse in the following days (the NMR showed the complete fracture of the anterior talofibular ligament and the patient has preferred interrupting the treatment cycle to evaluate an operation).
Partially effective treatment.

Before-session

After-session

	Patient	Age	Sport	Pathology and treated area	N° of sessions	Average time	Efficacy
1	D. A. ♂	33	/	Tenosynovitis of the supraspinatus tendon; subacromial-subdeltoid bursitis right shoulder	6	15-20′	++
2	S. F. ♂	24	Basketball	Tendinitis of the long head of the biceps brachii and supraspinatus right shoulder	6	15′	++
3	B. R. ♀	42	/	Rotator cuff tendinopathy Right shoulder	4	15-20′	+-
4	L. P. ♂	37	Basketball	Left ankle sprain	6	15′	++
5	D. A. ♂	13	Soccer	Right adductor syndrome	4	15-20′	+-
6	B. D. ♂	31	Soccer	I-II degree muscle sprain right great adductor	6	15-20′	++
7	C. G. ♂	22	Soccer	Meniscus pain of the anterior horn External meniscus right side	6	15-20′	++
8	L. M. ♂	34	/	Meniscus pain Posterior horn of medial meniscus right side	4	15′	++
9	F. M. ♂	40	Soccer	Extensors tendinopatry and Post-traumatic chondropatry left wrist	6	10′	++
10	M. M. ♀	25	Volleyball	Recent right ankle sprain with Diffuse perimalleolar oedema	6	15′	+-

Table 2: Summary of the carried out treatments

(++) Effective treatment
(+-)Partially effective treatment
(--) Ineffective treatment
♂ Male
♀ Female

Results remark

In consideration of the above results, we can assert with reasonable confidence, despite the low number of patients we have managed to recruit in little longer than a month, that the use of the device in question pleasantly surprise us. Rarely in the past we had seen such significant results with a low number of sessions and starting from early sessions.

From the data obtained in this short trial on the Sirio ultrasound device, it comes out firstly the absolute efficacy of this device for antalgic purpose, as modulator of pain (effect which was noticed in almost all patients) and as modulator-accelerator of articular acute and sub-acute inflammation processes.

Furthermore the treatment allows an anti-edemigenous “drainage” activity in case of post-traumatic articular effusions with effects visible to the naked eye already during the first session.

Lastly it should be noticed that the treatment has an adjuvant action in the recovery of the muscle fiber texture after a muscle injury, even a mid-moderate injuries.

Safety

Considering the documented effects of Sirio concerning osteoarticular and muscolotendineous problems (even rather heterogeneous problems) we reported as the only undesired effect the occurrence of a significant erythema in the treated area. The erythema has been completely reversible and temporary and occurred in a couple of patients with sensitive skin phototype. It was accompanied by barely visible vesicles. These alterations have always completely disappeared during the first 24 hours following the treatment and for that reason they do not represent a serious limitation to the continuation of the physiotherapy trial.

Conclusions

In this first meta-analysis the use of Sirio has showed to be an effective therapy for some affections (which are reported above) of the musculoskeletal system. It delivered immediate results with a lower number of sessions compared to the traditional ultrasound (1-3MHz) used in physiotherapy and without significant side-effects.

Furthermore at the first monthly follow-up visit the therapy effects persisted in all treated subjects, who were able to completely restart their sport activities (except the two patients to whom surgery was recommended). Considering the results achieved, we intend to go on with the test, increasing the number of treated subjects as to make more significant scientific evidences to confirm Sirio efficacy.

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Clinical Trial Manager
Dr. Emanuel Paleco

Appendix to bibliography

Report on the literature research

1. Name of the device : Sirio

2. Literature research area: Ultrasounds in physiotherapy

3. Methods

(I) Research period: from 01/12/2010 to 31/01/2011

(Ii) Person in charge of the research : Dr. Emanuel Paleco

(Iii) Period of time object of the research: From 1980 till today

(Iv) Bibliographic sources used to identify the data: NCBI, MEDLINE

(V) Research databases: Google, Pub-Med, MEDSCAPE

Key words: Ultrasound in physiotherapy, Ultrasound effects, Low frequency ultrasounds, Diathermy induced by ultrasounds, Ultrasounds side-effects, Cavitation induced by ultrasounds and Cavitation in physiotherapy

- Support: Internet

(Vi) Criteria used for choosing the literature: It were chosen articles that have relevance with:

- Use of ultrasounds in physiotherapy
- Effects of low frequency and high frequency ultrasounds and their applications
- Possible adverse effects

4. Annexes

(I) Quotations and review from the listed articles

(Ii) Flowchart and table A that justifies the relevance of the articles included in the clinical evaluation.

Notes:

NCBI Published by National library of Medicine and National Institute of Health

MEDLINE Published by US National Library of Medicine

Annex: Quotations

1. The ultrasound therapy is today one of the most used and best-established electro-physical techniques in the physiotherapy-rehabilitative field (Robertson 2002, Robertson e Baker 2001).

2. "generally it seems that the effects are stronger on tissues which do not completely absorb the energy to which they are exposed to, as for example connective tissues which are rich of collagen – ligaments, tendons, joint capsules and scar tissue" (Sparrow et al 2005, Takakura et al 2002).

3. Actually the ultrasound application field for therapeutic purposes is much wider considering that also other tissues (as muscular and bones tissues which are not strictly connective tissues) are successfully treated with ultrasound (Clinton et al 2001).

4. "the nature of the tissue is a critical element in the clinical decision making process" (Watson 2006, ter Haar 1999, Nussbaum 1998, Frizzel & Dunn, 1982).

5. "low frequency ultrasounds (KHz) produce their effects deeper than high frequency ultrasounds (MHz), whose action is more superficial" (Mitragotri et al.2004, Paliwal et al 2006).

6. "low acoustic frequency and intensity (kHz) allow a faster tissue healing process than high frequency (MHz) ones" (Uhlemann C et al. 2003).

7. "the regeneration effect is due to the optimization of the normal inflammatory proliferative response" (Nussbaum et al.1997, 1998, Watson et al. 2000).

8. "During the inflammatory phase, US has a stimulating effect on the mast cells, platelets, white cells with phagocytic roles and the macrophages (Nussbaum 1997 et al., ter Haar et al.1999, Fyfe & Chahl et al.1982, Maxwell et al.1992).

9. "the application of ultrasound induces the degranulation of mast cells, causing the release of arachidonic acid which itself is a precursor for the synthesis of prostaglandins and leukotreine – which act as inflammatory mediators" (Mortimer & Dyson et al. 1988, Nussbaum et al. 1997, Leung et al. 2004).

10. "Studies which have tried to demonstrate the anti inflammatory effect of ultrasound have failed to do so and have suggested that US is ineffective" (Hashish et al. 1986, 1988).

11. "It is effective at promoting the normality of the inflammatory events, and as such has a therapeutic value in promoting the overall repair events" (ter Haar et al.1999).

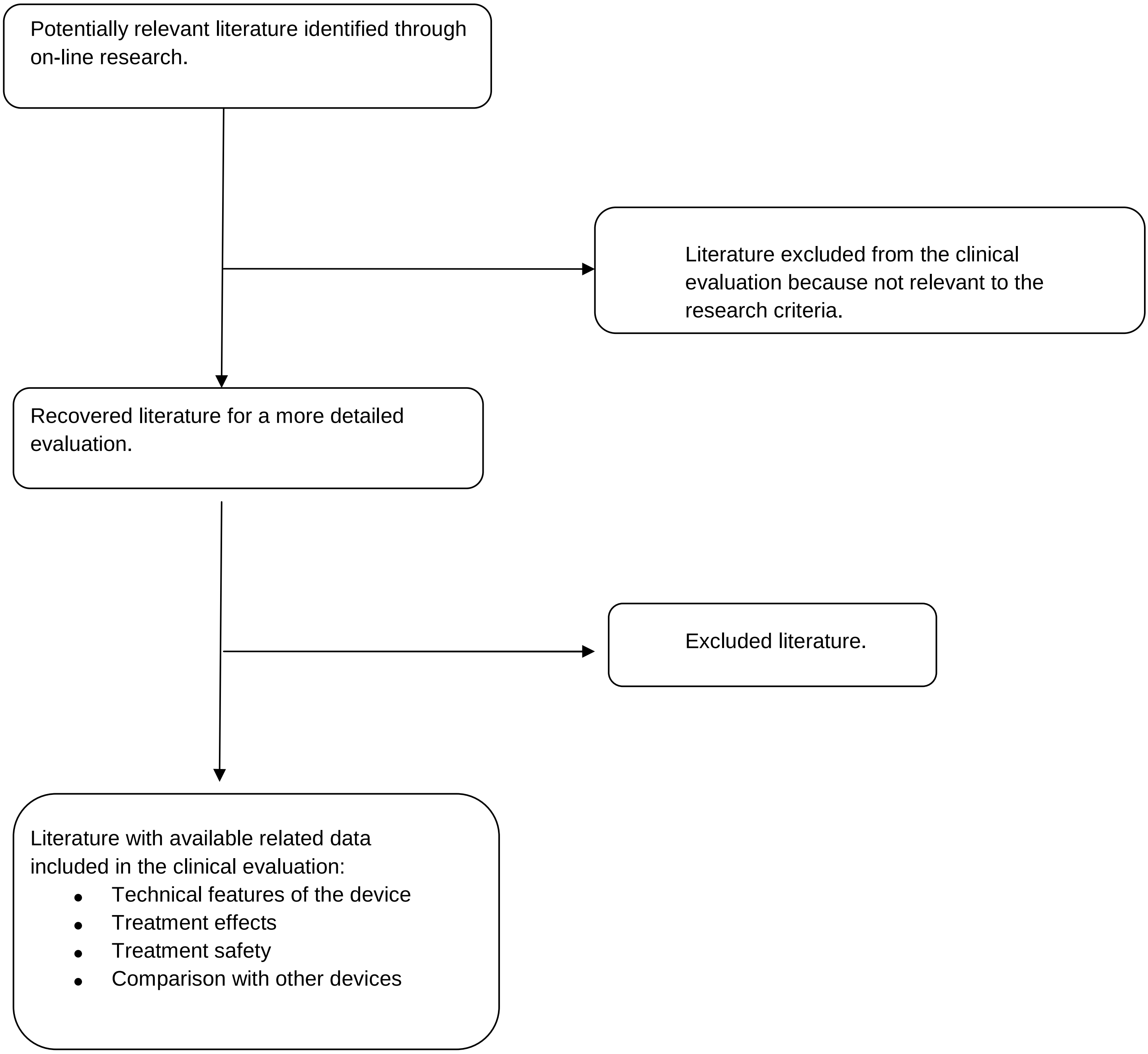
12. "optimizing the reparative efficiency" (Ramirez et al 1997, Mortimer e Dyson et al. 1988, Young & Dyson et al. 1990, 1990b Young & Dyson et al., Nussbaum 1997, 1998 et al., Dyson e Smalley et al. 1983, Maxwell et al. 1992).

13. "low dose pulsed ultrasound increases protein synthesis and several research groups have demonstrated enhanced fibroplasia and collagen synthesis" (Harvey et al. 1975, Ng et al 2004, Ng et al 2003, Tsai et al 2005, Enwemeka et al 1989, 1990, Huys et al 1993, Ramirez et al 1997).

14. "ultrasound has a capacity to influence the production of TGF-β (tissue growth factor)" (Mukai et al 2005).

Flowchart

Criterion for choosing the bibliography



NB: Research criteria were based on the following key words: Ultrasound in physiotherapy, Ultrasound effects, Low frequency ultrasounds, Diathermy induced by ultrasounds, Ultrasounds side-effects, Cavitation induced by ultrasounds and Cavitation in physiotherapy. This way we found at once article that are closely relevant and basically few not relevant articles.

Table A summarizing used bibliography

N	TITLE	RELEVANCE
1	Baker, K. G., V. J. Robertson, et al. (2001). "A review of therapeutic ultrasound: biophysical effects."	Use in physiotherapy
2	Byl, N. N., L. Hill Toulouse, et al. (1996). "Effects of ultrasound on the orientation of fibroblasts: an in-vitro study."	Effects on tissues
3	Ciccone, C., B. Leggin, et al. (1991). "Effects of ultrasound and trolamine salicylate phonophoresis on delayed-onset muscle soreness."	Effects on tissues
4	Doan, N., P. Reher, et al. (1999). "In vitro effects of therapeutic ultrasound on cell proliferation, protein synthesis, and cytokine production by human fibroblasts, osteoblasts, and monocytes."	Effects on tissues
5	Draper, D., S. Sunderland, et al. (1993). "A comparison of temperature rise in human calf muscle following applications of underwater and topical gel ultrasound."	Effects with diathermy
6	Draper, D. O., J. C. Castel, et al. (1995). "Rate of temperature increase in human muscle during 1 MHz and 3 MHz continuous ultrasound."	Effects with high frequencies
7	Draper, D. O. and M. D. Ricard (1995). "Rate of temperature decay in human muscle following 3 MHz ultrasound: the stretching window revealed."	Effects with high frequencies
8	Draper, D. O., S. Schulties, et al. (1995). "Temperature changes in deep muscles of humans during ice and ultrasound therapies: an in vivo study."	Effects on tissues
9	Dyson, M. and D. Smalley (1983). Effects of ultrasound on wound contraction. Ultrasound Interactions in Biology & Medicine.	Effects on tissues
10	Enwemeka, C. S. (1989). "The effects of therapeutic ultrasound on tendon healing."	Effects with diathermy
11	Enwemeka, C. S., O. Rodriguez, et al. (1990). "The biomechanical effects of low-intensity ultrasound on healing tendons."	Effects with low frequencies
12	Frizzell, L. A. and F. Dunn (1982). Biophysics of ultrasound. Therapeutic Heat and Cold.	Effects with heat
13	The Use of Low-Intensity Ultrasound to Accelerate the Healing of Fractures	Effects with low frequencies
14	S. Mitragotri and J. Kost, “Low-frequency sonophoresis: a review,”	Effects with low frequencies
15	S. Paliwal and S. Mitragotri, “Ultrasound-induced cavitation: applications in drug and gene delivery,”	Effects with low frequencies
16	Fyfe, M. C. and L. A. Chahl (1982). "Mast cell degranulation: A possible mechanism of action of therapeutic ultrasound (Abstract	Use in physiotherapy
17	Hashish, I., H. K. Hai, et al. (1988). "Reduction of postoperative pain and swelling by ultrasound treatment: a placebo effect."	Use in physiotherapy
18	Hashish, I., W. Harvey, et al. (1986). "Anti-inflammatory effects of ultrasound: Evidence for a major placebo effect."	Anti-inflammatory effects
19	Hill, J., M. Lewis, et al. (2002). "Pulsed short-wave diathermy effects on human fibroblast proliferation."	Effects with heat
20	Huys, S., B. S. Gan, et al. (1993). "Comparison of effects of early and late ultrasound treatment on tendon healing in the chicken limb."	Effects on tissues
21	Leonard, J., M. Merrick, et al. (2004). "A comparison of intramuscular temperatures during 10-minute 1.0-MHz ultrasound treatments at different intensities."	Effects with heat
22	Leung, M. C., G. Y. Ng, et al. (2004). "Effect of ultrasound on acute inflammation of transected medial collateral ligaments."	Anti-inflammatory effects
23	Markert, C. D., M. A. Merrick, et al. (2005). "Nonthermal ultrasound and exercise in skeletal muscle regeneration."	Regeneration effects
24	MartinMaxwell, L. (1992). "Therapeutic ultrasound: Its effects on the cellular & mollecular mechanisms of inflammation and repair."	Anti-inflammatory effects
25	Meakins, A. and T. Watson (2006). "Longwave ultrasound and conductive heating increase functional ankle mobility in asymptomatic subjects."	Effects with heat
26	Merrick, M. A., K. D. Bernard, et al. (2003). "Identical 3-MHz ultrasound treatments with different devices produce different intramuscular temperatures."	Comparison among devices

27	Miller, D. L. and R. A. Gies (1998). "The interaction of ultrasonic heating and cavitation in vascular bioeffects on mouse intestine."	Anti-inflammatory effects
28	Mortimer, A. J. and M. Dyson (1988). "The effect of therapeutic ultrasound on calcium uptake in fibroblasts."	Effects on bone tissues
29	Mukai, S., H. Ito, et al. (2005). "Transforming growth factor-beta1 mediates the effects of low-intensity pulsed ultrasound in chondrocytes."	Anti-inflammatory effects
30	Ng, C. O. Y., G. Y. F. Ng, et al. (2003). "Therapeutic ultrasound improves strength of Achilles tendon repair in rats."	Regeneration effects
31	Ng, G. Y. F., C. O. Y. Ng, et al. (2004). "Comparison of therapeutic ultrasound and exercises for augmenting tendon healing in rats."	Comparison among devices
32	Nussbaum, E. (1998). "The influence of ultrasound on healing tissues."	Effects on tissues
33	Nussbaum, E. L. (1997). "Ultrasound: to heat or not to heat - that is the question."	Effects with heat
34	Ramirez, A., J. A. Schwane, et al. (1997). "The effect of ultrasound on collagen synthesis and fibroblast proliferation in vitro."	Effects with heat
35	Reher, P., N. Doan, et al. (1999). "Effect of ultrasound on the production of IL-8, basic FGF and VEGF."	Anti-inflammatory effects
36	Reher, P., M. Harris, et al. (2002). "Ultrasound stimulates nitric oxide and prostaglandin E2 production by human osteoblasts."	Anti-inflammatory effects
37	Robertson, V. J. (2002). "Dosage and treatment response in randomised clinical trials of therapeutic ultrasound."	Use in physiotherapy
38	Robertson, V. J. and K. G. Baker (2001). "A review of therapeutic ultrasound: effectiveness studies."	Use in physiotherapy
39	Sparrow, K. J., S. D. Finucane, et al. (2005). "The effects of low-intensity ultrasound on medial collateral ligament healing in the rabbit model."	Effects on tissues
40	Takakura, Y., N. Matsui, et al. (2002). "Low-intensity pulsed ultrasound enhances early healing of medial collateral ligament injuries in rats."	Effects on tissues
41	ter Haar, G. (1999). "Therapeutic Ultrsound."	Effects on tissues
42	Tsai, W. C., C. C. Hsu, et al. (2005). "Ultrasound stimulation of tendon cell proliferation and upregulation of proliferating cell nuclear antigen."	
43	Uhlemann C, Heinig B, Wollina U. Therapeutic ultrasound in lower extremity wound management.	Effects with low frequencies
44	Wang, E. D. (1998). "Tendon repair."	Effects on tissues
45	Watson, T. (2006). "Tissue repair - the current state of the art."	Effects on tissues
46	Wilkin, L. D., M. A. Merrick, et al. (2004). "Influence of therapeutic ultrasound on skeletal muscle regeneration following blunt contusion."	Regeneration effects
47	Young, S. R. and M. Dyson (1990). "Effect of therapeutic ultrasound on the healing of full-thickness excised skin lesions."	Regeneration effects
48	Young, S. R. and M. Dyson (1990). "Macrophage responsiveness to therapeutic ultrasound."	Antiboby responses

Training course program on the use of low frequency ultrasounds

ULTRASOUNDS

Ultrasound

- Ultrasound characteristics
- Physical effects of ultrasound
- Biological effects of ultrasound
- High frequency and low frequency ultrasounds
- Sirio fields of application

Ultrasounds in physiotherapy

- Low, medium and high frequency ultrasound in aesthetics medicine
- Effects of diathermy
- Effects of cavitation
- Field of application for low frequency ultrasounds
- Applicative protocols
- Tolerance, contraindications and side effects
- Medical legal aspects and informed consent
- Practice on patients

Treatment of adiposity and cellulite with low frequency ultrasounds

- Lipolysis induced by diathermy
- Adipocytolysis induced by cavitation
- Fat metabolism biochemistry
- Applicative protocols
- Tolerance, contraindications and side effects
- Nutritional integration and dietary aspects
- Medical legal aspects and informed consent
- Practice on patients

Conclusions

NB: Sirio is an EC medical certified device therefore it should be used only under medical supervision.
Sirio as medical device can be used in healthcare facilities both public and private.

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Training attendance form

General data

Candidate's name: ______________________________

First name *Second name* *Last name*

Firm/Company: ______________________________

Headquarters: ______________________________

Job title: ______________________________

Declares that he/she took part in the training course for the use of electro-medical technologies.

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Candidate's signature *Date*

Confirmation

____

Training director's signature *Date*