

**SIMULTANEOUS USE OF RADIAL SHOCK WAVE THERAPY AND
HYPERBARIC GASEOUS CRYOTHERAPY FOR THE TREATMENT
OF SPORTING INJURIES**

A study of 333 cases.

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Summary

Over a period of 15 months, 333 patients were treated for locomotor system pathologies through the simultaneous use of radial shock waves and hyperbaric gaseous cryotherapy.

Following the description of the two techniques, the author comments on the results based on the patients' satisfaction as well as their return to sporting activities.

The innocuousness, great efficacy and undeniable rapidity of the treatment give good results for certain pathologies: calcareous sub-deltoid bursitis, supraspinous tendinitis, epicondylitis, patellar ligamentitis, and corporeal tendinitis calcanei. Even the treatment of plantar fasciitis gives excellent results. However, with the exception of ischiotibialis, the treatment of enthesopathies does not appear to be a good indication because the results are insufficient or disappointing.

Other cases, still anecdotal, lend support to the idea of the simultaneous use of both treatments, such as for lumbar spondylosis and De Quervain's tenosynovitis, and encourage the continuation of this therapeutic combination in the future.

Since April 2002, we have been treating numerous lesions of the locomotor system by simultaneously using one radial shock wave session and one hyperbaric gaseous cryotherapy session. Before looking at the results of the 333 cases over 15 months, here is a description of these two therapies.

1 – RADIAL SHOCK WAVE THERAPY.

Radial shock wave therapy or RSWT has been known and used since 1992. It is the result of work carried out to dissolve urinary calculi during extracorporeal lithotripsy.

The initial good results described in the literature led us to use the EMS Swiss DolorClast \square **(Im2)** from April 1992. It generates a simple shock wave through direct percussion of the skin. It is a "counterweight" propelled by compressed air **(Schem2)**. A shock wave is propagated. It can irradiate up to 3 - 3.5 cm in depth. The active area is shown by a cone whose peak is located under the tip of the handpiece.

1- a- Presumed modes of action.

There is a *chemical mode of action* which delivers endorphins or pain-inhibiting substances. This action is rapidly perceived: it sometimes has an immediate anaesthetic effect during a shock wave session. In general, it is felt around the five hundredth pulse.

The "*gate-control*" *phenomenon*, well-known in neurology, also appears during the session: the feeling of pain is broken when large-calibre sensitive nervous fibres are being stimulated.

The *mechanical mode of action* is the most sought-after effect using this technique. It is similar to the contra-fibrosis effect found in profound transversal massages used in rehabilitation.

Lastly, an alteration of the cellular membranes which are the cause of the pain also leads to an increase of the local metabolism. The *creation of an acute inflammation* is thereby achieved at the site of the chronic inflammation. This generates neo-lesions with a neo-vascularization and, with subsequent sessions, better wound-healing.

1- b- Technical parameters (Personal protocol).

Since we began using this therapy, we have tried to simplify the utilization protocols. Irrespective of the pathology to be treated and the fact that the associated parameter can be varied, the compressed air pressure used is always 3 bar. The number of pulses applied per session is always 2000. The frequency of the pulses depends on the patient's tolerance and the pathology being treated. The frequency varies between 6 and 15 Hz.

Currently (**Im5**) we use either a large pistol head or "convex" (**Im18**) large tip for large areas or a "concave" (**Im19**) pistol head for narrower areas smaller than 2 cm_. With regard to the latter head, updated in 2003, the shock waves converge directly toward the zone to be treated and the therapeutic efficacy seems to be even faster.

1- c- Contra-indications.

As with any therapy, there are some contra-indications which are as follows: pregnancy, neurological pathologies, vascular pathologies, local infection, tumours, proximity of lung tissue and coagulation disorders or patients undergoing anticoagulation treatment.

1- d- Instructions for use.

Small pistol heads exist, however we currently use only the large calibre head (a large tip provides a better cutaneous protection).

The pressure released by the hand-held tool varies according to the patient's tolerance and the pathology being treated. It goes from a very light pressure (**Im6**) up to a strong maximum pressure (**Im7**).

During the treatment, other parameters come into play, such as the patient's position and the obliquity of the head. Depending on the pathology, the shock wave pistol is aimed more or less directly toward the lesion to be treated. For example, in the case of Achilles Tendinopathy, 1000 pulses are given to the median side and 1000 pulses to the lateral side of the tendon.

This radial shock wave therapy can be used without anaesthetic and on dry skin.

In our case, we always used contact gel similar to that used for ultrasound scans. We often perform ultrasound scans before the sessions to allow us to confirm the diagnosis and determine the area to be treated.

1- e- Frequency of the sessions.

Initially, we performed 3 to 6 sessions at 8-day intervals which meant that the treatment lasted between 15 and 45 days.

The simultaneous use of hyperbaric gaseous cryotherapy and the initial results achieved led us to opt for this frequency of treatment.

We are currently performing one to two sessions a week.

The number of sessions depends on the individual results but it rarely goes beyond six sessions.

1- d- Undesirable effects described in the documentation.

Some patients notice an increase in pain during and after the session. This is sometimes associated with a reactive edema.

In our cases, the simultaneous use of hyperbaric gaseous cryotherapy during the same session prevents edemas.

A local ecchymosis is often described. We noticed that this happens mainly with the use of the "concave tip".

2- HYPERBARIC GASEOUS CRYOTHERAPY.

It has been in use since 1993. Cold therapy has been well known since at least the time of Hippocrates, who described it as being an efficient means of therapy for any injury to the locomotor system.

The cooling scale (**Schem1**) clearly shows the efficacy of hyperbaric gaseous cryotherapy as a therapeutic method using the fundamental physiological data of thermal shock starting at

-60°C. This procedure has nothing in common with classical cryotherapy which is more soothing in nature.

We employ the Cryotron□ from Medical Cryonic (**Im3**) using sublimation of medical CO₂ which is colourless, odourless, non-flammable, dry and bacteriostatic. It can therefore be used on wounds or immediately post-operation.

The goal is to achieve a rapid thermal shock and to descend from 36°C to 2°C in 20 to 40 seconds. This involves a cutaneous pressure of about 5 bar applied by the tool.

The temperature being very low, it is imperative to use a sweeping movement on the zone being treated (**Im1**) to avoid the formation of permanent frost which could cause a burn or cutaneous necrosis.

The session ends when the thermal shock has been achieved. This is notified on the control display screen of the apparatus or on an illuminated display on the cryotherapy pistol (**Im4**) through the recording of the cutaneous temperature of the zone treated.

2- a- Physiological effects.

These are well-known. A vasoconstriction happens rapidly followed by reflex vasodilatation at the time of the thermal shock.

Analgesia is of course quasi-immediate, but more interestingly, it lasts several minutes or even several hours.

The *muscle relaxant effect* of this therapy cannot be denied. Although this is not the topic here, our practice is to systematically couple the hyperbaric gaseous cryotherapy with a session of manual medicine. This makes the treatment session more efficient allowing an almost immediate muscular relaxation and less undesirable effects.

Finally, the *anti-inflammatory effect* is almost the same as could be achieved using infiltrations of corticosteroids but without the disadvantages.

2- b- Contra-indications.

The contra-indications for hyperbaric gaseous cryotherapy are the following:

Cold allergy, Raynaud's syndrome, cutaneous sensitivity disorders, cryoglobulinemia, diabetes and metabolic illnesses due to the risk of cutaneous lesion on more delicate skin.

3- SIMULTANEOUS USE OF BOTH THERAPIES.

We had been using hyperbaric gaseous cryotherapy on its own since June 2001. But since the acquisition of radial shock wave equipment in April 2002, we are now systematically using both therapies together.

The radial shock wave session always precedes the gaseous cryotherapy session even during a consultation which includes a clinical examination of the zone to be treated.

In France, the national health system does not cover the sole or simultaneous use of both these therapies at the moment.

A "session" proceeds as follows: first of all, we perform an ultrasound scan to locate the zone to be treated. Then comes the radial shock waves session (**Im17**) followed immediately by a hyperbaric gaseous cryotherapy session.

Between the two procedures, the contact gel on the skin is meticulously cleaned off to make sure it does not generate burns when using hyperbaric gaseous cryotherapy.

The coupling of these two procedures has allowed an often demanding and impatient sporting population to be treated.

In this document, various cases of chronic pathologies of the locomotor system are reported. They have evolution periods of more than 3 months: tendinopathies, muscular lesions sequelae, ligament lesions sequelae and also primary arthropathies (lumbar arthrosis) and "rheumatological" lesions.

4- THE RESULTS:

Over a 15-month period from April 2002 to June 2003, 333 patients were treated at the Coralie Centre in Ozoir la Ferrière.

There were 171 men and 162 women with a mean age of 32 (ranging from 18 to 65 years old). 88 patients partook in competitive sport (27%), 99 in leisure sport (30%) and 103 only

occasionally (active = 31%). 43 patients (13%) did not practice any sport at all but wished to use the therapeutic methods "of sportsmen and women" either upon recommendation from their doctor or on their own initiative (**Graph1**).

The mean evolution time before the start of therapeutic treatment is given in detail for each of the pathologies dealt with. Radial shock waves and hyperbaric gaseous cryotherapy are seldom used simultaneously as a first treatment. These therapies are sometimes first suggested to patients who consult us directly without going through other practitioners (in less than 10% of the cases).

Details on the average number of sessions, the extremes as well as the elapsed time since the end of the treatment are listed per pathology in the table (**Tab1**).

Results are obtained from the visual analogical scale (VAS) and for the most part from a questionnaire on patient satisfaction regarding the treatments on offer. Prepared in June 2003, the questionnaires were sent by post with a stamped self-addressed envelope for their return.

The graph (**G2**) and the table (**Tab2**) show the ratings by the 333 patients:

- very satisfactory results with full recovery (186 cases = 56%)
- satisfactory results with a sporadic but tolerable symptomatology even during sporting activity (58 cases = 17%)
- insufficient results requiring follow-up treatment (47 cases = 14%)
- disappointing results, often with relapse, requiring interruption of the treatment in favour of other therapies (37 cases = 11%)
- results with aggravation (5 cases = 2%) concerning "sedentary sportsmen" or people on leave due to an accident at work.

Every patient gave an answer regarding his or her return to practicing sporting activities at the same level as before. The percentage of people achieving "a return to identical sport" is detailed in the table. Overall, the rate is 62%.

5- COMMENTS ON THE VARIOUS PATHOLOGIES TREATED.

We do not practice radial shock wave therapy on children or adolescents.

In all cases and as a complement to the treatment, the patient continues his or her sporting activity without "intensive effort" whenever possible. "Interval training" or "fractional training" is only permitted after complete recovery.

Shoulder.

This is the area treated the most during the 15 months. This is due to our recruitment and to the manufacturer's "publicity" concerning the efficacy of shock waves on peri-articular calcifications of the shoulder. Numerous practitioners who had become aware of these new therapies during their continuous local medical training sent us their patients.

Tendinopathy of the cap of the rotator muscles and supraspinous tendinopathy in particular showed good to very good results. However, tenosynovitis of the long biceps requires a greater number of sessions and the treatment does not always lead to the patient being well-satisfied. Our explanation is that this pathology is often linked to an intra-articular pathology of the scapulohumerus. The treatment of this consequence is often insufficient to satisfy the sporting patient.

Calcifications of the sub-deltoid bursa (**Im9**) are amongst the best indications of the simultaneous use of these two therapies. The results are very satisfactory. The cleaning of hydroxyapatite deposits requires particular precautions: antalgics per os are often needed in the hours following the very first sessions.

Elbow.

The results regarding the lateral epicondyle (**Im16**) are mixed. Pure insertion pathologies do not seem to give good results. Pure enthesopathy diagnosis comes from the clinical examination (pain only when the elbow is in extension while contracting against resistance) and from its consistency with ultrasound images. Corporeal tendinopathies on their own or in

association with an enthesopathy show better results. Since the recent use of the more precise "concave head" tip, tolerance of the treatment has increased.

With regard to the medial epicondyle, more rarely diagnosed than the lateral one, we haven't had any pure corporeal tendinopathy.

Wrist.

In autumn 2002, during a meeting with other practitioners who only used radial shock waves, we learned that some of them used this method to treat certain rheumatologic pathologies of the wrist. So we suggested it to 6 patients suffering from De Quervain's tenosynovitis (**Im15**). To our pleasant surprise we observed an undeniable efficacy and rapidity for this pathology. Both crossover bursitis and radial styloiditis cases (anecdotally) also pleasantly surprised us by the very favourable response from top-level sportsmen.

Hand.

Root arthrosis is a rheumatologic diagnosis going beyond sporting injury. This did not concern the cases of competitive sporting patients in our study, however the results were satisfactory. In the case of a top-level climber suffering from a digital pulley bursitis, a good, durable result was quickly achieved.

A patient suffering from an early stage of Dupuytren's disease was also satisfied and was able to play tennis again.

Spine.

Other teams have done it before us. We wanted to offer our therapies for chronic lumbar conditions (**Im11**) which were not suffering a pain crisis but where a constant background pain was present. Some responded very favourably and could resume their sporting activities. Others had to stop the sessions and return to more conventional therapies. No aggravation of their symptomatology was observed.

An idiosyncrasy seems to exist with regard to the use of these two therapies just as it does for other treatments.

We haven't yet gone as far as to offer our services to chronic cervical and dorsal conditions for fear of an aggravation or renewed undesirable effects.

Pelvis.

The results for enthesopathy of the ischio-tibialis are good even though 6 sessions are often necessary before getting conclusive results. Over 80% of patients are satisfied. Nevertheless, enthesitis of the ischio-tibialis is a special case in the body: the cartilaginous plaque between the bone and the common tendon seems to react favourably to the use of these two therapies.

Pubic arthropathy showed excellent results in two cases. We do not have any explanation but it remains to be confirmed in other cases.

Knee.

Patellar ligamentitis (**Im13**), often resulting from sporting activities, shows good results provided it is purely corporeal or calcified.

With regard to insertion patellar ligamentitis (high or low) as well as the 2 cases of enthesopathy of the quadriceps, the results are disappointing.

Insertion pathology does not seem to react well to these two therapies. For the time being, we suggest them less and less in such cases. For other knee pathologies the results (anecdotal) are good.

Leg.

Tibial periostosis (**Im12**) does not seem to react well to radial shock waves. However, according to our experience, the single use of hyperbaric gaseous cryotherapy (not described in this document) 3 times a week gives good results over 6 sessions.

In the case of the rarely diagnosed fibular tenosynovitis, we were pleasantly surprised by the very favourable response over 4 sessions.

Calcanei tendinopathy (Achilles Tendon).

Results for Achilles corporeal tendinopathies (**Im14**) (nodular or fusiform, calcified or not) are good in more than 80% of cases (satisfied or very satisfied patients) with a reasonable number of sessions (between 1 and 6, 3 on average). After a period of 8 months, no recurrence was observed and patients resumed their previous level of activity in more than 70% of cases. This is a good indication for the therapy.

However, calcanei enthesopathies are a "catastrophe". There is a bad reaction to the two therapies whether they are used simultaneously or singly.

Plantar Fasciitis.

This condition is probably the best indication for this therapy, showing excellent results (**Im8**). More than 90% of patients resumed sporting activity to its previous level and were satisfied or very satisfied. After about 10 months, the average number of sessions is 3.

We even had a case with 7 years of illness history who recovered fully within 15 days in 4 sessions and without any additional treatment. No sign of fasciitis rupture appeared during the treatment. Orthoses adapted to the plantar morphology of the sporting patient and made under stato-dynamic conditions are often prescribed as a complement in the case of plantar fasciitis.

However, the results in the 4 cases of sequelae of fasciitis rupture were not so good.

Foot.

We got interesting results in a few isolated cases

Muscles.

At first sight, fibrous muscular sequelae (**Im10**) seemed a good indication for the therapy. Therapy results confirmed our initial impression and need to be confirmed over a greater number of cases.

An ultrasound scan often led us to observe the complete disappearance of the intramuscular fibrosis.

Overall, the use of hyperbaric gaseous cryotherapy accompanied by radial shock waves allows the number of RSWT-only treatment sessions to be decreased, yet still giving satisfying results. Is this due to the fact that the immediate undesirable effects of shock waves are greatly reduced? Is it a complementary "chemical" action? Is it a complementary "durable anaesthetic" effect? At the moment we do not have any answers to these questions. We do not have any physiological explanation for the greater efficacy. We can only observe very interesting results which encourage us to continue the combination of both these therapies.

CONCLUSION

The sporting population is demanding and impatient.

Efficient and rapid therapies need to be offered to them.

The simultaneous use of radial shock waves and hyperbaric gaseous cryotherapy meets this need and forms an interesting alternative to other more conventional therapies.

Thanks to a certain innocuousness, a great efficacy and an undeniable rapidity in the results (from 2 to 3 weeks), the combination of these two therapies permits an early resumption of sporting activities under good conditions and at previous levels in about 70% of cases.

Preliminary results over 15 months give us the confidence to pursue this therapy combination which in future will require further publications including a greater number of cases (perhaps

even involving multiple centres) and a longer follow-up to support and confirm these good results.

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IMAGES

Im1 Hyperbaric gaseous cryotherapy with sweeping action on epicondylitis

Im2 EMS from Swiss DolorClast with its 2 pistols

Im3 The Cryotron and its CO₂ bottles

Im4 The hyperbaric gaseous cryotherapy pistol

Im5 The 2 pistols for RSW = convex tip and concave tip

Im6 RSW weak pressure of the convex tip

Im7 RSW strong pressure of the convex tip

Im8 RSW on plantar fasciitis

Im9 RSW on sub-deltoid bursitis

Im10 RSW on IJ muscular fibrous lesion

Im11 RSW on lumbar condition

Im12 RSW on periostitis

Im13 RSW on patellar ligamentitis

Im14 RSW on tendinitis calcanei

Im15 RSW on De Quervain's tenosynovitis

Im16 RSW treatment of an epicondylitis

Im17 RSW use with contact gel

Im18 RSW Pistol = convex tip

Im19 RSW Pistol = concave tip

SCHEMA

Schem1 cooling scale

Schem2 Radial Shock Wave principle

GRAPHS

G1 Distribution of the 333 cases according to their initial sporting activity

G2 Results of RSW + HGC treatment on 333 cases

TABLES

Tab1 Presentation

Tab2 Results