Key words: knee osteoarthritis, laser therapy, High Intensity Laser Therapy, HILT

"High intensity laser therapy in knee osteoarthritis: comparison between two different pulsed-laser treatment protocols".

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ABSTRACT

High Intensity Laser Therapy seems to be very effective in pain and function control in patients with KO, due to its high intensity and to the depth reached by the laser ray, but the optimal dose is not known yet.

A previous research found a comparable efficacy to viscosupplementation in knee osteoarthritis II –III Kellgren stage, using the antalgic –antiphlogistic protocol (10 treatment sessions of pulsed high power laser, Nd:YAG).

The aim of this study was to compare the efficacy of two different HILT protocols to viscosupplementation in patients with symptomatic KO.

58 out-patients with symptomatic KO (II-III Kellgren-Lowrence Scale stage) were enrolled and evaluated by WOMAC Scales, before treatment (t0), after treatment (t1) and after 4 months (t2). After randomization, the treatment consisted in viscosupplementation (4 Hyaluronic acid infiltrations 1/week) for Group A, HILT antalgic treatment (10 sessions, three times a week for Group B, 5 sessions three times a week for Group C).

All the three groups showed a highly statistically significant improvement between t0 and t1 in WOMAC Scales, which was maintained at follow-up (t2). No side effect was found, neither in Group A nor in Group B, nor in Group C.

HILT treatment showed analogous results to viscosupplementation . HILT seems a good medical instrument for pain control and for the improvement of patient's quality of life, with dose-related effects.

INTRODUCTION

In last ten years HILT has been widely used in several painful conditions, especially in sports lesions (contusions, tendon injuries, muscular sprains, ect.) and other acute osteomuscular diseases (tendonitis, bursitis, etc) [1,2].

More recently interesting results about degenerative diseases, such as osteoarthtritis and low back pain have been reported too [3,4].

Available scientific literature is not wide nor definitive about HILT, for many reasons, i. e. scarceness of related studies, scarceness of shared and approved therapeutic protocols, absence of evidence about laser's efficacy in KO therapy.

So, it would be necessary to approach HILT with rigorous and rationale protocols, both in biological and clinical research, to find experimental evidences and the best way to cure patients.

From this point of view, in our Rehabilitation Service we are studying the effects of HILT in patients with degenerative diseases, such as osteoarthritis, which are characterized by pain and functional limitations. These chronic conditions affect the quality of life of the majority of patients, especially the elderly. [5,6]

KO could be considered as a "social disease", considering its prevalence (very important, though underestimated), its relationship with the disability (in fact, disability is directly correlated with pain level), and the necessity of long-lasting and integrated treatments, which include a pharmacological (drugs, hyaluronic acid) and a non-pharmacological aspect (exercise, FKT, physical therapy).

In relation to this we should consider important side effects of pharmacotherapy [7], and the not negligible weight of direct and indirect costs of the management of patients like that.

For the right and correct care of these patients physicians should follow international guidelines in association with an EBM approach, to conceive an individualised and adapted management plan, which considers patient's characteristics and needs.

International guidelines [8] for the treatment of KO provide a patient-centred care, a holistic approach to the disease, and a balanced combination of pharmacological and non-pharmacological treatment modalities. The main tasks of the integrated treatment in KO are pain

relief and disability reduction; between non-pharmacological means guidelines recommend also the physical therapy, and more precisely electrotherapy (TENS) and thermotherapy. Physical therapy may be useful for its local effects against pain.

EBM literature about HILT is not available yet; anyway some good researches are producing interesting results in experimental and clinical domains. HILT effects are due to photothermical, photochemical and photomechanical actions [9,10], which lead to pain and flogosis reduction and seem to stimulate reactivation in connective tissues. Nevertheless in clinical researches different HILT protocols are proposed, in relation to session's duration and timing. It is not completely clear which could be the optimal HILT doses to obtain the best results.

In a previous research [11] we found a high efficacy of HILT in treating knee osteoarthritis patients, achieving long-lasting symptomatic and functional improvement, using an antalgic – antiflogistic protocol. In this study the effects of HILT were comparable to the effects of viscosupplementation [a well known and accepted modality to improve pain and perhaps the osteoarthritis evolution 12,13], at least for clinical aspects. HILT results were rapid, long-lasting and no side effects were observed. The patients were all compliant to the treatment. The protocol of that study provided 10 HILT sessions, but in our experience we saw the patients rapidly improving after the initial sessions, reaching a plateau in the latter ones.

It is possible that the immediate effect was due to the direct analgesic laser properties, while antiflogistic effect is responsible for slower and more lasting response. Our purpose was to evaluate the efficacy of a shorter HILT protocol, which could be even easier for patients and at the same time could save physician's time too (in fact, the physician is directly engaged in performing the manual lasertherapy program). The patients treated with viscosupplementation were chosen as control group because viscosupplementation is a local intervention supported by EBM in KO [14].

The present study was a prospectic, three arm, open-label, randomized clinical trial.

The aim was to evaluate the clinical and functional efficacy of a short HILT treatment, compared with a longer (standard) protocol and with viscosupplementation, in patients affected by symptomatic knee osteoarthritis.

MATERIALS AND METHODS

Patients. Patients suffering for symptomatic KO were recruited for this trial from outpatients of the Recovery and Rehabilitation Agency (AOU Careggi, Firenze). A total of 58 patients with symptomatic KO (pain and functional limitation), aged 52-80 years, were included. Informed consensus was obtained. Inclusion criteria required the presence of symptomatic KO (following ACR criteria [15] II-III stade of Kellgren-Lawrence Scale [16] on the radiological evaluation. Exclusion criteria were: therapy with oral anticoagulants, non compliant patients (cognitive impairment or psychiatric disorder), neoplastic pathology, presence of deep vein thrombosis. The patients' evaluation included history and clinical examination.

Initial assessment (t0), before treatment (t1), and follow-up (t2) included WOMAC Scale [17]

The patients were randomized for treatment in three groups, following the method of random number table.

Treatment. After randomization the patients underwent three different treatment protocols: Group A (18 patients) was treated with hyaluronic acid intraarticular infiltrations (4 infiltrations, 1 session/ week, mw 500-1000 kD), Group B (19 patients) was treated with High Intensity Laser Therapy (ten sessions, on alternate days), and Group C (21 patients) was treated with High Intensity Laser Therapy (five sessions, on alternate days) see Table I. The only difference between the two HILT protocols was the number of sessions (10 vs. 5 sessions).

The patients were reassessed at the end of the treatment (t1) and after 4 months (t2).

Data analysis. Data of patients were compared by Student t-test and Wilcoxon test.

RESULTS

A total of 58 patients were recruited and included in the analysis. 18, 19 and 21 patients respectively were randomized to Hyaluronic acid treatment (Group A) and HILT-ten sessions- (Group B), and to HILT -five sessions- (Group C). All the patient but one (Group A) finished the study. Baseline data of the three Groups are explained in table II. Although this was a randomized comparative study, the small number of patients did not guarantee against differences between treatment groups' baseline characteristics. The experimental groups resulted not exactly balanced for all the variables collected at baseline. Nevertheless the three groups resulted comparable and the resultant variables were not related to the initial differences. Total median age was 74,4 years (range:53-84); 71,0 years (range:54-81) and 70,5 (range: 52-79) and 69,6 (range 51-72) for Group A, Group B and Group C respectively, while the proportion of male (M) and female(F) patients was analogous. WOMAC Scale values at t0 were 41,6 ±10,1 (Group A), 42,9 ± 7.3 (Group B) and 42, 3 ± 10, 5.

At t1 the three groups showed improvement in the scales points: Group A changed WOMAC values from 41,6 ± 10,1 to 22,5 ± 12 ($p< 0.001$). WOMAC values of Group B varied from 42,9 ± 7,3 to 21,4 ± 4 ($p<0.001$), and Group C varied its values from 42, 3 ± 10, 5 to 24, 8 ± 11 ($p< 0,001$), see Table III and Figure 1a-b. At follow-up (4 months) both the groups A and B maintained the improvement, while Group C showed a little regression of WOMAC values to 28,05 ± 15 points, which anyway was not statistically relevant. Focusing the attention on Group C (21 patients) we can affirm that at time t1 improved patients were 20 (95,3 %), and unchanged patients were 1 (4,7 %); at time t2 (4-months follow up) the same group (20 patients – 1 drop-out) showed that the improvement was stable in 19 patients (85 %), while a regression could be observed in 3 patients (15 %), see Table IV and figure 2.

No side effects were observed in any of the 3 examinated groups.

Hyaluronic acid infiltrations protocol (Group A): 4 sessions of Hyaluronic acid infiltrations, molecular weight 500 -1000 kD, once a week. Infiltration is performed by anterior access with supine patient and flexed knee.
HILT treatment protocol 1 (Group B): pulsed high power laser, Nd:YAG, λ1064nm, 10 sessions, on alternate days, analgesic program, in manual scansion. This program is articulated in three phases (initial, intermediate and final phase). Every phase is articulated in sub-phases in which increasing fluency (510-710 J/cm^2) and decreasing frequency (15-10 Hz) are administered, total energy 2000-3000 J. The total session duration is 15-20 minutes.
HILT treatment protocol 2 (Group C): same program as above, 5 sessions instead of 10

Table I: Treatment protocol of the three groups

	Pats. number	Median age	sex	WOMAC Scale
GROUP A	18	71,0	4 M, 14 F	41,6 ±10,1
GROUP B	19	70,5	4 M, 15 F	42,9 ± 7,3
GROUP C	21	69,6	3 M, 18 F	42,3 ± 10,5

Table II: Groups baseline characteristics

	WOMAC Scale t0	WOMAC Scale t1	WOMAC Scale t2
GROUP A	41,6 ±10,1	22,5 ± 12 (p< 0.001)	20,9 ± 8 (p:ns)
GROUP B	42,9 ± 7,3	21,4 ± 4 (p<0.001)	23,4 ± 10 (p:ns)
GROUP C	42,3 ± 10,5	24,8 ± 11 (p<0,001)	28,05 ± 15 (p: ns)

Table III: WOMAC Scales Values at t0, t1 and at the follow-up (t2) of the three Groups

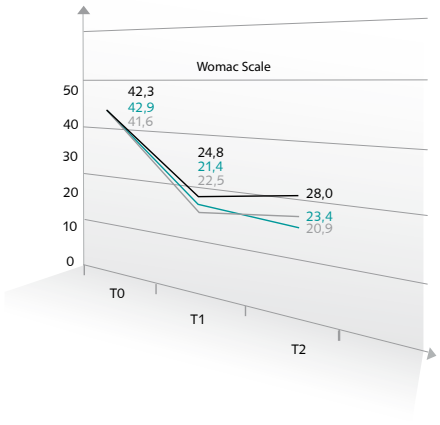

Figure 1a WOMAC Values before treatment (t0), at the end of treatment (t1) and after 4 months

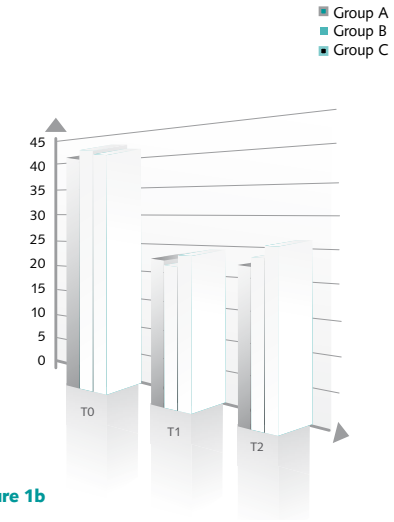

Figure 1b

t2 (20 pts., 1 drop-out)	Improvement maintained	21,4 ± 4 (p<0.001)	23,4 ± 10 (p:ns)
Improvement regression	19	24,8 ± 11 (p<0,001)	28,05 ± 15 (p: ns)

Table IV: Group C (5 HILT sessions) results

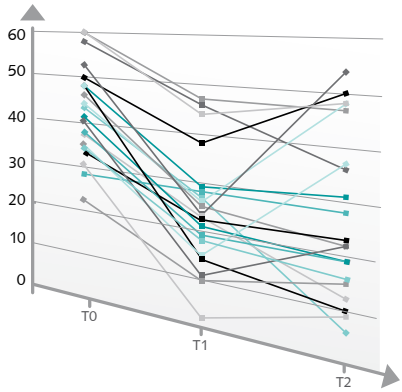

Figure 2 Womac values of single patients (Group C)and after 4 months

DISCUSSION

Scientific interest is growing about HILT, due to demonstrations of its efficacy and sureness. These first results must be considered as preliminary but seem to be consistent. KO is characterized by phlogistic and degenerative aspects at the same time, which lead to the typical semeiological and clinical signs and symptoms, that is acute and painful phases on a degenerative and chronic background. Given that physical therapy is only a part of an integrated approach, techniques nowadays available have no great effects, limited to pain control (such as TENS) or to a superficial antphlogistic action (such as ultrasound, low level laser therapy, etc.), and in any case they generally have a short lasting effect.

HILT effects are different from other forms of physical therapy because of its action mechanisms which comprehend the classical effects of laser therapy on tissues (photochemical, photothermical and photomechanical) but with different intensity and erogation mode.

The specificity of HILT (especially due to the photomechanical effect) is the reason of its almost immediate antalgic effect, probably

followed by an anti-inflammatory action , which starts more slowly but has subsequent lasting effects. Besides, photomechanical effect is responsible, in vitro and animal model [18,19], for several cellular and macromolecular changes and reorganization in connective tissues, which could be driven to a physiological healing.

Regarding hyaluronic's acid effects, our results agree with data found in the literature, because patients improved significantly at the end of the treatment and they maintained this improvement at follow-up, showing a long acting effect of this therapy.

Our study showed, moreover, an optimal efficacy of HILT treatment: in relation to 10-sessions HILT protocol the efficacy is really comparable to viscosupplementation; we achieved a rapid pain relief, even after the very first sessions, and this effect is maintained at the follow-up, 4 months later.

So, our local and limited experience shows a good clinical efficacy for HILT, but till nowadays this method feels the effect of the scarceness of scientific data and related studies.

During these preliminary researches we verified that 10 alternated days sessions are a very good treatment for pain control, but we still don't know which really is the optimal timing of the laser sessions; besides, in this initial experience it seemed to us that patient's improvement begins rapidly in the first sessions, reaching rapidly a plateau all the same. The shorter protocol, which provided 5 alternated day sessions was very effective too, in terms of rapid pain reduction and disability improvement at the end of the treatment. Follow-up results are interesting to discuss because patients which received the shorter treatment (Group C) showed a tendency to regression. So the duration of HILT effects seems to be dose-related. It is difficult to generalise our argumentation, due to the little number of patient examinated.

The results of our study seem to confirm our original hypothesis. Pain shows a very rapid reduction together with a functional improvement (pain is the most important determinant in disability). A long term effect need a longer treatment.

CONCLUSIONS

HILT confirms to be a good non-pharmacological instrument for rapid pain control in KO, with consequent improvement in patient's quality of life. Important effects are achievable with few sessions of HILT treatment too. Clinical comparison between the two different HILT protocols seems to suggest that pain relief is rapidly achievable, as a direct effect, but the indirect effects (based on antiphlogistic action and may be on tissues reorganization) need a longer treatment to obtain lasting results.

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