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LOCAL CRYOTHERAPY, COMPARISON OF COLD AIR AND ICE MASSAGE ON PAIN AND HANDGRIP STRENGTH IN PATIENTS WITH RHEUMATOID ARTHRITIS

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SUMMARY

Background: *The main benefits of cryotherapy in rheumatoid arthritis (RA) are in reducing inflammation and swelling and in relieving joint pain. This study aimed to compare the short-term effects of cold air therapy vs. ice massage, on pain and handgrip strength (HGS) in patients with RA.*

Subjects and methods: *The study is a non-randomized clinical trial. Patients were recruited if they had disease activity score (DAS28) ≥ 3.2 with at least 2 swollen joints on the dominant hand and were consecutively divided into two groups of 15 patients. There was no statistically significant difference in DAS28 score between groups. The first group received cold air therapy at -30 °C and the second ice massage of the hands. The pain (visual analogue scale, 0-10), and HGS (kg) were measured immediately prior and after cryotherapy, and 30 and 60 minutes after cryotherapy. Descriptive statistics, Independent Samples T-test, and Paired Samples T-test were used for statistical analysis.*

Results: *Pain intensities for cold air therapy were as follows: 5.33 (±2.44), 3.13 (±2.67), 2.87 (±2.56), 2.80 (±2.73), and for ice massage were: 5.20 (±2.37), 2.87 (±2.42), 2.60 (±2.23), 2.67 (±2.28). In both groups pain was significantly lower immediately after, 30 and 60 minutes after the treatment compared to the baseline (p=0.001). There was no significant difference in pain alleviation between the groups regarding the used method of cryotherapy on all three measured time points. Nonsignificant improvement in HGS occurred after both methods of cryotherapy. There was no significant correlation between pain intensity and HGS.*

Conclusions: *A single application of cold air therapy and ice massage equally provides immediate and significant pain alleviation in patients with active RA, which is maintained for one hour. There is scientific evidence that HGS is influenced greatly by the disease activity. A single application of cryotherapy could not reduce disease activity explaining recorded nonsignificant effect on HGS.*

Key words: *rheumatoid arthritis – cryotherapy – pain - handgrip strength*

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INTRODUCTION

Rheumatoid arthritis (RA) is a systemic autoimmune inflammatory disease characterized with chronic symmetrical arthritis predominantly of small hand and feet joints causing morning stiffness, joint pain and swelling and leading to joint erosions, deformity, and disability (Aletaha & Smolen 2018). Cryotherapy is often used as a nonpharmacological treatment for RA. Local cryotherapy modalities: ice massage, ice packs, cold gel packs and cold air therapy at -30°C when used for a longer period of time can decrease both skin and joint temperature, providing analgesic effect, a decrease of inflammation and muscle spasm, consequently improving physical function and decreasing disease activity (Peres et al. 2017). Local cryotherapy with vapours of nitrogen at -160°C is effective in reducing pain (Jastrząbek et al. 2013). Whole-body cryotherapy is a novel and an extreme method of cryotherapy administered at -110°C for 2 to 3 minutes, which seems to decrease pain more than whole-body cryotherapy at -60°C and local cryotherapy modalities (Hirvonen et al. 2006).

The aim of this study was to compare the short-term effect of single application of cold air therapy at -30 C and ice massage on pain and handgrip strength in patients with active RA.

SUBJECTS AND METHODS

Subjects

The study was conducted from January 2019 to June 2019 at the University Department for Rheumatology and Rehabilitation, University Hospital Centre Zagreb, and was approved by the local Ethics Committee by the number 02/21 AG. Each patient signed an informed consent before being included in the study and their rights as human subjects were protected. The study has been performed following the ethical standards, and it conforms to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000).

The study included 30 patients with RA fulfilling the 2010 ACR/EULAR classification criteria for RA (Aletaha et al. 2010), 26 (86.7%) women and 4 (13.3%) men, average age 63.37±9.7 years. Inclusion criteria were disease activity score 28 (DAS28) ≥ 3.2 (moderate disease activity or higher), with at least 2 swollen joints on the dominant hand. DAS 28 includes number of swollen and number of painful joints out of the 28 evaluated joints, patient's and physician's assessment of general health on a VAS, and erythrocyte sedimentation rate (ESR) or C-reactive protein (CRP) (Prevoo et al. 1995). Exclusion criterion was a history of Raynaud's syndrome. Thirty consecutive patients were divided into two groups of 15 patients. There was no statistically significant difference in the DAS28 score between the groups (Table 1). Group 1 underwent a single cryotherapy with cold air at -30°C (Cryo 6, Zimmer, Neu ulma, Germany). The treatment was applied for 5 minutes on the dorsal and palmar side of each hand, with the distance of 15 cm. Group 2 received a single cryotherapy using hand ice massage. The treatment was applied for 5 min on the dorsal and palmar sides of each hand. Both procedures were applied in an air-conditioned room with a temperature of 22°C.

Assessment of pain and handgrip strength

The pain was measured using a visual analogue scale (VAS; score 0-10). VAS was presented as a straight, 10 cm horizontal line, with the left end marked as "no pain" and the higher score indicated a higher level of pain. Handgrip strength (HGS) (kg) was measured using digital dynamometer (Digital Hand Dynamometer, SH5003, Sehan Corp, Masan Korea) on the dominant hand. Each participant's grip strength was measured 3 times on the dominant hand, while seated, with the elbow held in 90° of flexion and hand in neutral position between supination and pronation. The mean value of 3 measurements was considered as maximal grip strength. In both groups, pain and dominant handgrip strength were measured four times: immediately prior and after cryotherapy, and 30 and 60 minutes after cryotherapy.

Statistical analysis

The SPSS Statistics 21 program was used to analyze the data. Descriptive statistics were used to describe continuous and categorical variables. Kolmogorof-Smirfnoff test was run to determine data distribution normality. Independent Samples T-test was run to determine the difference in pain level and handgrip strength between the groups. Paired samples T-test was run to determine the difference in pain level and handgrip strength before and after each cryotherapy method.

RESULTS

There was no significant difference in pain alleviation between the groups regarding the used method of cryotherapy on all three measured time points (Table 2).

Pain was significantly lower immediately after, 30 and 60 minutes after the both cold air treatment and hand ice massage compared to the baseline (p=0.001 and p=0.001 respectively on all three measured *time points*). In general, pain was significantly lower 60 minutes after cryotherapy in all patients (M=2.53, SD=1.94, t(29)=7.142, p=0.001). The 95% confidence interval for the effect of cryotherapy on mean VAS pain level in all patients is between 1.808 and 3.259.

There was no significant difference in HGS between the groups regarding the used method of cryotherapy on all three measured time points (Table 3).

Allthough there was improvement in HGS 60 minutes after cold air treatment and hand ice massage compared to the baseline, the differences were not statistically significant (p=0.275 and p=0.145 respectively). In the whole sample of patients HGS improved

Table 1. Patient's characteristics

	Group 1 (cold air, N=15)	Group 2 (ice massage, N=15)	p-value
Sex (female:male)	12:3	14:1	/
Age (years)	63.73±9.95	63.00±9.81	0.840
DAS28	5.01±1.79	4.25±1.05	0.174

DAS28 – Disease Activity Score 28

Table 2. Hand pain intensities in RA patients before and after cryotherapy

Pain - VAS	Group 1 (cold air, N=15)	Group 2 (ice massage, N=15)	p-value
Immediately prior cryotherapy	5.33 (±2.44)	5.20 (±2.37)	0.880
Immediately after cryotherapy	3.13 (±2.67)	2.87 (±2.42)	0.776
30 minutes after cryotherapy	2.87 (±2.56)	2.60 (±2.23)	0.763
60 minutes after cryotherapy	2.80 (±2.73)	2.67 (±2.28)	0.886

VAS – visual analogue scale

Table 3. Dominant handgrip strength in RA patients before and after cryotherapy

Handgrip strength (kg)	Group 1 (cold air, N=15)	Group 2 (ice massage, N=15)	p-value
Immediately prior cryotherapy	12.98 (±9.98)	13.37 (±6.64)	0.901
Immediately after cryotherapy	15.61 (±11.44)	15.37 (±7.33)	0.947
30 minutes after cryotherapy	14.88 (±10.61)	15.80 (±8.89)	0.799
60 minutes after cryotherapy	13.75 (±10.21)	14.74 (±8.04)	0.771

immediately after cryotherapy and improvement persisted 60 minutes after cryotherapy. The general improvement in HGS almost met the level of statistical significance (M=1.073, SD=3.027, t*(29)*=-1,942, p=0.062). The 95% confidence interval for the effect of cryotherapy on mean hand grip strength in the whole patient sample is between -2.2039 and 0.0572.

There was no significant correlation between pain intensity and HGS between the groups at any point of time. Both methodes of cryotherapy were safe for the patients.

DISCUSSION

Results of our study showed that a single application of cold air, as well as hand ice massage on rheumatoid hand in patients with active RA, provides immediate and significant pain alleviation which is maintained at least one hour after the treatment. Cryotherapy causes vasoconstriction and tissue hypothermia. Studies on the physiological effects of cold therapy show that skin temperature decreases abruptly during cold treatment and does not predict temperature decrease in deeper tissues such as muscles and joints. Cooling time is the strongest single predictor of temperature decrease in the deeper tissues, stronger than subcutaneous adipose tissue thickness. Skin temperature rises rapidly several minutes after cryotherapy, while the temperature rise in deeper tissue is slow and postponed (Jutte et al. 2001, Kim et al. 2002). In patients with RA localy applied cold air therapy induces significant decrease in surface skin temperature of the cooled hand (Korman et al. 2012). After the cessation of the cold treatment, a rapid rewarming occurres and hand reaches the baseline temperature in 15 minutes. Given that different reports suggest that cooling with cold air of -30 °C or using ice packs reduces the temperature in the knee joint (as a large joint), we believe that these modalities can reduce temperature in the small hand joints in patients with RA as well (Kim et al. 2002, Korman et al. 2012, Oosterveld & Rasker 1994). The knee joint temperatures obtained in healthy subjects ranges from 31°C to 33°C, while in patients with RA, the knee joint temperature correlates with the knee joint arthritis activity, ranking from 32°C in inactive arthritis to 37°C in severe arthritis (Harris & McCroskery 1974). Moreover, there is evidence that higher joint temperatures increase the breakdown of articular cartilage. Reports linking raised synovial fluid levels of lysosomal enzymes (i.e. protease, lipase, peroxidase, aminotripeptidase, allkaline phosphatase, ß glucuronidase an important lysosomal enzyme involved in the degradation of glucuronate-containing glycosaminoglycan) and other intracellular enzymes with inflammation activity in RA have been long published (Jacox & Feldmahn 1955, Jasani et al. 1969). Lysosomal enzymes are involved in the pathogenesis of RA, in particular by inducing damage to the articular cartilage (Muirden et al. 1972, McInnes & Schett 2011). In the pathogenesis of RA, proinflammatory citokine tumor necrosis factor – alpha (TNF-α) has an important role. The whole body cryotherapy of -160°C for patients with RA causes significant decrease in TNF-α systemic levels, reduces pain, morning stiffnes and improves function measured with Health Assesment Questionnaire (HAQ) (Jastrząbek et al. 2013). Therefore, important goal of physical therapy in RA should be to decrease intraarticular temperature by applying cryotherapy on active joints, in order to reduce pain, inflammation and joint destruction while promoting better function. Cryotherapy can reduce joint pain in patients with RA in two ways. Indirectly, as a consequence of reduced inflammation and directly, through gradual reduction of the transmission of impulses in the sensory nerves, by increasing the activation threshold of tissue nociceptors and by decreasing the conduction velocity of pain nerve signals (Nadler et al. 2004). In our study we believe that the latter mechanism was the predominant one.

In our study, both methodes of local cryotherapy were also shown to slightly improve the HGS, but this effect was not statistically significant. Based on the current knowledge, HGS correlates significantly with disability and disease activity in patients with RA (Palamar et al. 2017). Moreover, studies show that there is no correlation between the radiological scores (i.e. structural damage) and function in RA, thus hand function seems to be affected prominently from the disease activity (Regan-Smith et al. 1989, Birtane et al. 2008). Active inflamation presents negative influence on muscle strenght in RA (Stucki et al. 1994). Rheumatoid cachexia referres to low muscle mass in patients with RA without weight loss. A proinflammatory cytokine TNF-α is associated with the decrease of muscle mass in women with RA, as well as with the increased protein catabolism and physical inactivity. (Summers et al. 2008, Walsmith et al. 2004). Both pain and joint effusion lead to muscle dysfunction. It is believed that increased fluid in joint distends the joint

capsule and produces surrounding muscle inhibition, leading to weakness and atrophy (Palmieri-Smith et al. 2013, Torry et al. 2005). Therefore, control of the disease activity is essential for the preservation of muscle mass and muscle strength in RA. It is reasonable to assume that a single application of cryotherapy can not reduce disease activity which could explain a nonsignificant effect of cryotherapy on HGS improvement in our study.

The main limitation of the study is the relatively small sample size. Moreover, further research with more cryotherapy sessions and with longer follow-up period is needed in order to investigate the possible influence of local cryotherapy on disease activity and HGS in patients with RA.

CONCLUSIONS

Our results showed that a single application of both methods of local cryotherapy (ice massage and cold air therapy at -30°C) equally provide immediate and significant pain alleviation in patients with active RA, which is maintained at least one hour after the treatment. Both methodes were also shown to slightly improve the HGS, but this effect was not statistically significant. There was no significant correlation between pain intensity and HGS. Moreover, pain did not influence the HGS regardless of the applied cryotherapy method. Since hand ice massage and cold air therapy at -30°C are equally effective in pain alleviation, hand ice massage should be advised to patients as a cost-free method which can be applied in home settings as well.

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Contribution of individual authors:

Nadica Laktašić Žerjavić, Emina Hrkić & Porin Perić: study design, data collection, statistical analysis, literature searches, and analyses, first draft, approval of the final version.

Valentina Delimar: data collection, statistical analysis, literature searches, and analyses, first draft, approval of the final version.

Iva Žagar, Kristina Kovač Durmiš, Sanda Špoljarić Carević, Andreja Matijević & Nikolino Žura: data collection, literature searches, and analyses, first draft, approval of the final version.

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