Clin Rheumatol (2009) 28:793–799
DOI 10.1007/s10067-009-1150-y

ORIGINAL ARTICLE

Effects of a hand-joint protection programme with an addition of splinting and exercise

One year follow-up

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Received: 8 July 2008 / Revised: 11 February 2009 / Accepted: 25 February 2009 / Published online: 18 March 2009

Abstract Forty-two women with thumb base osteoarthritis referred to a joint protection programme (JP) were distributed into groups: one with only JP (Control group) and one with addition of splints day/night, hot pack/home exercise (SE group). Assessments of pain, stiffness, grip force, disabilities of daily activities were performed before treatment, 1 week and 1 year after treatment. The SE group had a significant decrease in pain, stiffness and an improvement in daily activities directly after the intervention and at 1-year follow-up compared to the Control group. In the SE group pain at night, pain on motion, and stiffness decreased. Grip force increased and daily activities improved. The Control group decreased in pain on motion and showed improvement in daily activities just after the intervention but not at 1-year follow up. This comparative study shows that when splinting and exercise regimen are added to a JP programme it gives a greater improvement of pain, stiffness, grip force and daily activities than the JP programme alone.

Keywords Daily activities · Grip force · CMC-1 OA · Occupational therapy · Pain

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Introduction

Osteoarthritis (OA) is the most prevalent joint disorder in the world and hand OA is the most common, typically involving the inter phalangeal and carpo metacarpal (CMC) joints and affecting 75 % of women aged 60–70 years [1, 2]. Thumb base OA in women older than 75 years [3] has a radiographic prevalence of 40% and is an extremely disabling condition that severely compromises the entire hand, causes pain and loss of hand function and leads to difficulties in performing ordinary, everyday activities [4]. Occupational therapists (OT) are often involved in conservative treatment through special programmes for the treatment of hand OA with a focus on hand function and the ability to perform occupational tasks [5]. Joint protection is a concept routinely employed in all patients with joints affected by arthritis. Originally designed for rheumatoid arthritis (RA) [6], the concept has been expanded to include OA [7]. Successful treatment is based on an understanding of the specific anatomy and the unique functional attributes of the human hand and thumb [8]. Conservative treatment includes splinting, thenar intrinsic strengthening exercise, drugs and injections [9]. Drug treatment recommended for hand OA includes analgesics, non-steroidal anti-inflammatory drugs (NSAIDs) and glucosamine sulphate [10]. However, none of these treatments have been shown to retard cartilage loss and must thus be regarded as purely symptomatic [5]. Studies are lacking in the literature that indicate how and to what extent conservative treatment should be carried-out effectively. CMC-1 OA is a common diagnosis in outpatient care; the majority of patients are women, generally healthy and physically active and who find that the pain and dysfunction at the base of the thumb restricts involvement in activities of daily living. A study concerning the effects of

exercise programmes and joint protection for hand OA patients in outpatient care showed an improvement in grip force but no reduction of pain [11]. Some recent studies show that splinting relieves pain in CMC-1 OA patients [12]. In a study by Carrie [13], 125 patients were retrospectively reviewed to determine the efficacy of splinting. It was found that splinting is a well-tolerated and effective conservative treatment that diminishes, but not completely eliminates, the symptoms of carpometacarpal joint arthritis and inflammation. A comparative study in which 25 patients with grades OA I and II according to Eaton [14] were assigned randomly to use either a prefabricated elastic thumb splint or a custom-made thermoplastic thumb splint showed that both splints decreased pain and improved function, with the patient preferring the elastic prefabricated thumb splint [15]. A 7-year follow-up study showed that, when splinting was continued beyond 3 weeks, in addition to provision of assistive devices by an occupational therapist, a significant 65% reduction in the number of persons in need of surgery could be achieved without the use of steroid injections [16]. Recommendations from EULAR (European League against Rheumatism) for management of thumb base OA are splints, local application of heat, especially prior to exercise [17] the same recommendations as for rheumatoid arthritis (20). The primary outcome of the present study was to examine whether structured splinting and intensified hand exercise added to the joint protection (JP) programme for women with thumb base OA would lead to an improvement in hand function. A secondary outcome was to investigate and examine the effects on daily activities.

Materials and methods

Participants and intervention

Women with hand OA in one or both CMC-1 joints were referred to the JP programme by a physician. Inclusion criteria were women with either clinically and/or X-ray diagnosed hand OA, who had experienced any kind of pain in the CMC-1 joints, not specified to a certain level of pain, and not been in a JP programme group earlier. Exclusion criteria were women with evidence of RA or any rheumatic disease other than OA, and women with carpal tunnel syndrome.

Design

All out-patients meeting the criteria for inclusion in Gothenburg were referred by physicians to the JP programme for hand OA group sessions during a period of 6 months. No patient meeting the inclusion criteria refused participating. A parallel, controlled, non-randomised trial was conducted to examine the effect of an extended JP programme Splint and Exercise (SE group) compared with the standard JP programme (Control group). Women were distributed into two groups according to the order of admission into different geographic areas either Central clinic or West/South clinic in primary health care (Fig. 1). The study was conducted from September 2003 to February 2004 and a 1-year follow-up, 2004–2005, no patient meeting the including criteria refused participating. Forty-two women enrolled in the JP programme at baseline, two drop-outs (foot accident, flu). Thus, a total of 40 women, 20 women in each group, were included in the interventions. The SE group used splints 24 h/day combined with daily home exercise; the Control group participated only in the JP programme. There were five drop-outs at the 1-year follow-up; two women had had thumb surgery and three declined participation. Per-protocol analyses were used based on the 35 women who completed the 1-year study (Table 1, Fig. 1). The study was approved by the Ethics Committee, Gothenburg University. All participants gave informed consent after verbal and written information.

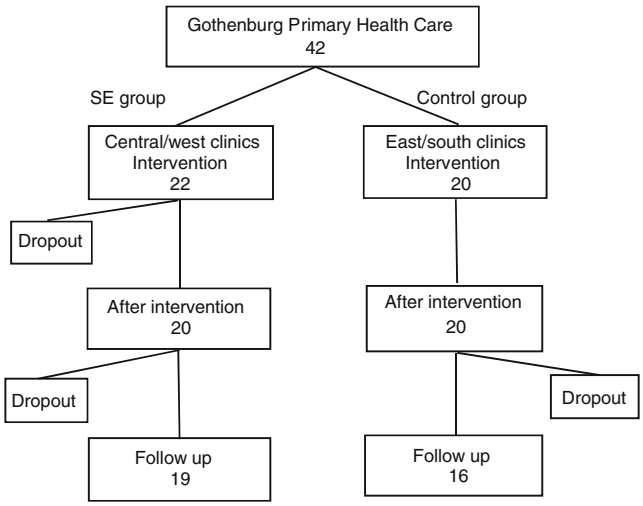

Fig. 1 Distribution of the two groups

JP programme for hand OA treatment

All women participated in the JP programme for hand OA treatment, the same concept for JP programme as for Rheumatoid Arthritis have been used: distinct written course material, small groups of participants, altering theory and practice with revision, dialogue communication—with mutual respect between individuals [18]. Occupational therapists specifically trained in OA group sessions were the care providers. The JP programme included ten group educational–behavioural sessions over a period of 5 weeks [6, 18], with four to eight participants in each group. The

Table 1 Group characteristics in women with CMC-1 OA

	SE group	Control group	Group comparison *p*-value
N (35)	19	16	
CMC 1 diagnosis	4 left, 7 right, 8 left and right	1 left, 5 right, 10 left and right	
Age, md (range)	61 (40-76)	61 (50-76)	0.956
Year of disease, md (range)	2 (1-23)	5 (1-18)	0.312
SYSADOA use	4	3	0.602
Pain killer use	4	5	0.381

CMC Carpo metacarpal, *SYSADOA* symptomatic slow-acting drugs for osteoarthritis, e.g. glucosamine

education concerning joint protection consists of information about hand anatomy, osteoarthritis, and theoretical and practical information about pain and how to cope with it [6]. To introduce alternate working methods to reduce difficulties of daily activities [7] the women tried grip assistive devices and elastic thumb splints during the day both at the clinic and at home. Every session included paraffin wax treatment and hand exercise with paraffin dough following a standard written programme including nine different movements in order to increase range of motion (ROM) of all joints in the hand and to strengthen the structure around the CMC-1 joint to maintain its stability. The exercise regimes in this study focused on ROM and pain free moderate strength of the hand intrinsic and the thumb extrinsic muscles [4, 11, 19]. The women had paraffin wax treatment as follows: both hands were slowly dipped five times into a 47 to 50°C wax bath and then wrapped in paper and fitted in quilt mittens that were kept on for 20 min [20].

Splint and exercise group

In addition to the JP programme of hand OA treatment, the SE group received splints (Fig. 2) for every affected joint and home instructions during the 5 weeks, as follows:

- Wearing a custom-made thermoplastic forearm splint at night.
- Wearing a prefabricated elastic thumb splint and/or a custom-made thermoplastic thumb splint at all times during the day.
- Before hand exercise, using a hot pack for 15 min at home (instead of paraffin wax treatment at clinics).
- Carrying out the same hand exercise with paraffin dough as in the JP programme once a day.

The patients received written instructions as to how they should use their splints and perform their home exercise. The home programme with splinting and exercise was discussed at every group session and repeated together with the group participants.

Assessments

Assessments were made on three occasions, at baseline (1 week before the start of the intervention), 1 week after the 5-week JP programme and at follow-up, 1 year after the intervention. The women marked their pain and stiffness during the most recent week on the visual analogue scale (VAS) 0–100-mm [21] with the endpoints no pain/stiffness and pain/stiffness as bad as it can be. Grip force of the hand and pinch bilaterally were measured in newton (N) with the Grippit electronic instrument (AB Detektor, Gothenburg, Sweden) [22]. Grippit measures both peak grip force and average grip force based on 20 registrations over a 10-s period. The examiner first demonstrated the grip procedure and gave verbal instructions. The forearm was placed in the arm support in the neutral position, with the elbow flexed 90° and the wrist in a neutral position. The other arm rested on the table, and the feet were placed firmly on the floor. The women were encouraged to press as firmly as possible for 10 s. The pinch grip force with the thumb and the index finger was then measured, the participants still sitting in the same position and using the same procedure. A self-administrated instrument dealing with disabilities of the

Fig. 2 The two splints

Table 2 Group analysis of pain, stiffness (VAS 0–100 mm), daily activities (DASH score 0–100), grip force, the dominant hand (newton)

	Comparison of the values at the time points									Change scores between groups	
	Before			After			Follow up			Before–after	Before–follow-up
	SE group–Control group		*p*-value	SE group–Control group		*p*-value	SE group–Control group		*p*-value	*p*-value	*p*-value
Pain at night	22 (0–82)	28 (0–82)	0.333	13 (0–94)	28 (0–89)	0.034*	12 (0–94)	26 (0–60)	0.012*	0.028*	0.010*
Pain on motion	51(10–100)	65 (28–100)	0.071	33 (6–100)	51 (28–91)	0.034*	34 (6–100)	53 (10–86)	0.012*	0.006*	0.018*
Stiffness	42 (0–100)	45 (12–80)	0.659	22 (0–100)	39 (0–75)	0.014*	33 (0–100)	48 (12–80)	0.041*	0.014*	0.042*
DASH	37 (9–76)	44 (19–80)	0.076	28 (6–69)	38 (21–76)	0.007*	27 (8–60)	42 (26–81)	0.003*	0.008*	0.003*
Hand grip force	107 (37–342)	87 (35–192)	0.072	140 (38–396)	104 (47–219)	0.321	136 (34–320)	101(21–247)	0.590	0.321	0.590
Pinch grip force	27 (10–42)	23 (6–56)	0.072	27 (9–55)	24 (8–52)	0.457	24 (3–42)	22 (6–44)	0.075	0.316	0.134

VAS (visual analogue scale) and DASH (disabilities of the arm, shoulder and hand) as median (range), Newton as mean (range)

*p-value<0.05

arm, shoulder and hand (DASH), score 0–100 [23, 24], with 30 items was used to investigate difficulties in everyday activities. The items with leisure and work were not used. All patient assessments in the SE group at the start and at the end were made by an independent OT not directly involved in the JP programme, and all interventions were carried-out by the first author (CB). All measurements and interventions in the control group were conducted by registered occupational therapists in each clinic who were specially trained in OA and who had worked in the area for several years.

Statistical analysis

All statistical analyses were made with SPSS for Windows 13.1.

Non-parametrical statistics were used to analyse data on pain, stiffness and disability in daily activities. Groups were compared for differences using Fisher's exact test and Mann–Whitney *U*-test before the intervention, before/after the intervention and before/at the 1-year follow-up. Within-group differences were analysed with Wilcoxon Signed Rank Correlation for differences between before/after the intervention and before/at the 1-year follow-up. Parametric statistical methods were used to analyse grip force in the hand and pinch. The *T*-test was used for independent samples in group comparisons before the intervention, before/after the intervention and before/at the 1-year follow-up. Within-group differences were analysed with *T*-test paired samples for differences between before/after the intervention and before/at the 1 year follow-up, with a p-value<0.05 indicating significance.

Results

Group characteristics

Age, number of years with hand problems, use of, e.g. glucosamine and symptomatic slow-acting drugs for osteoarthritis (SYSADOA) and use of a pain killer were similar in the two groups, there were no statistically significant differences (Table 1). All 35 women were right-handed. In total, 21 women worked, 12 women in the SE group and nine women in the control group, and 14 women were retired, seven in each group.

Group analysis

There were no statistically significant differences between the two groups at baseline, before the intervention; in pain at night, pain on motion, stiffness, hand grip force or disabilities in daily activities (Table 2). Comparisons between the two groups on the change scores before/after

Table 3 Grip force peak and average values during 10 s (newton), mean and (range)

	SE group			Control group		
	Before	After	Follow up	Before	After	Follow up
Hand						
Left						
Peak	120 (32–277)	144 (63–286)	144 (43–254)	113 (24–224)	120 (16–263)	110 (23–227)
Average	95 (26–200)	112 (48–202)	109 (18–187)	85 (14–167)	92 (11–183)	86 (14–199)
Right						
Peak	107 (37–342)	140 (38–396)	136 (34–320)	87 (35–192)	104 (47–219)	101 (21–247)
Average	85 (31–260)	109 (48–202)	108 (23–219)	69 (22–149)	82 (26–169)	81 (13–210)
Pinch						
Left						
Peak	25 (10–42)	28 (9–44)	25 (9–44)	24 (5–50)	28 (8–65)	26 (10–46)
Average	21 (5–35)	22 (9–50)	21 (4–36)	18 (5–38)	20 (4–46)	20 (7–40)
Right						
Peak	27 (6–63)	27 (9–55)	24 (3–42)	23 (6–56)	24 (8–52)	22 (6–44)
Average	21 (0–53)	22 (6–44)	21 (6–35)	16 (4–44)	19 (4–46)	17 (5–38)

Mean peak value right hand grip force in healthy women 60-69 (age), 229N (22).

intervention and before/at the follow up showed a significant decrease in pain at night, pain on motion, stiffness and disability in daily activities for the SE group (Table 2). There were no significant differences between the two groups comparing the change scores before/after and before/follow up concerning hand grip force or pinch grip force (Table 2). The SE group showed a statistically significant decrease in both pain at night, pain on motion, stiffness and disability in daily activities over the period before/after the intervention and before/at the follow-up. The only statistically significant decrease in the control group was perceived pain on motion and disability in daily activities over the period before/after the intervention (Table 2). Twenty-six women had pain at night before intervention, 13 in each group. At the 1-year follow-up, 20 women marked pain at night, seven in the SE group and 13 in the control group. All 35 women marked pain on motion at baseline, and all the women marked less pain on motion at the 1-year follow-up. There was a significant difference between the groups at follow up, p-value 0.024, the control group using more pain killer. None of the 35 women became totally free of pain on motion. Thirty-two women experienced stiffness before the intervention, 16 in each group. At the 1-year follow-up, 20 women marked less stiffness, 13 in the SE group and seven in the control group. The SE group showed significant increases between before/after the intervention in all hand grip force values and before/at follow-up in all values except left hand average value. No significant improvement in hand grip force was found in the control group (Table 2). The SE group increased their hand grip force in both peak grip force value and average grip force value by 27% between before the intervention and at the 1-year follow-up and the control group increased (not significantly) average and peak grip force by 17% before the intervention/at the 1-year follow-up (Table 3). There were no changes in pinch grip force over time in either group (Table 3).

Discussion

This study shows that when splinting and exercise regimen are added to a JP programme it gives a greater improvement of pain, stiffness, grip force and daily activities than the JP programme alone. All the symptoms were reduced in the SE group, measured from baseline to the 1-year follow-up. In the control group just after the intervention, pain on motion and difficulties in daily activities were decreased and hand grip force was not significantly but weakly improved.

Improvement

The positive results in the SE group, with a reduction in pain at night, may be explained by the structured use of a forearm splint at night; none of the women in the control group used night splints. Swigart et al. [13] and Wajon and Ada [19] showed that intense use of a splint decreases pain, and Berggren's prospective study [16] also showed that splinting in thumb base OA patients increased hand function. Both groups in our study improved in pain on

motion, probably because both groups used thumb splints daytime and were given information about altering working methods, balancing rest and activity, and using assistive devices in the JP programme. This probably explains the result of no group difference. The EULAR report [12], which focuses on evidence-based recommendations for the management of hand OA, still requires a non-splint controlled study, and there is also a need of studies that examine the effects of splints on thumb deformity in lateral angulations and in thumb deformity in flexion. During the intervention, the women in the SE group used splints day and night. Only one woman complained of the thermoplastic material and she was then equipped with a textile cover under the night splint. After the 5-week intervention period, the women were free to use their splints if they still had pain. It is a limitation that no diary was used, but it was routine in every group session to ask about and discuss use of splints and exercise. It seemed that the women in the SE group had good compliance: that they used their splints and did their home exercise as planned. It was high participation in the JP-programme; 92% of all 35 women and nearly 50% attend all ten sessions, no differences between the groups. This intensified exercise combined with splinting in the SE group appears to increase hand grip force—both peak and average values—but not to increase pinch grip force. It has been shown that [11] using standard exercise programmes that impose the same resistance for all participants might produce negative effects in hand joints in persons with low muscle strength. The 35 women in our study had 97 N grip force before intervention, which is only 42% (Table 3) of that of healthy women aged 60–69, who had a peak value of 229 N [22]. Nine women in our study showed the same or a decrease in grip force. The splints and exercises seemed not to change the pinch grip force among the women in this study. The reduction in pinch grip force could not be calculated, as normative values are not yet available for the Grippit instrument. Other studies [20, 25] have shown that paraffin treatment combined with exercise has a good short-term effect on stiffness and grip force, and this was also shown in the present study to be a benefit in the SE group. The DASH score improvements were significant but small, although a ten-point difference in the mean DASH score may be considered a minimal important change [23], and this was the result in the SE group. The study investigates a whole concept: splints, wax baths and exercise added to the JP programme and no conclusions can be drawn about the effectiveness of the different components of the intervention and future research is needed.

Examination

Out-patients with thumb base OA are often referred to an occupational therapist by a physician in primary health care who is not a specialist in rheumatology and therefore has some difficulty classifying Eaton I–IV radiological. It is generally accepted that people with severe degenerative changes (Stage IV) will be less likely to respond to conservative management than those with Stages I–III, but it was difficult to exclude these patients in this study. Patients came from the city of Gothenburg, with a population of 500,000, and the intervention was carried-out over a period of 6 months. The women in each group were recruited from different geographic areas and did not meet in therapy sessions. The assessment of hand function is based on clinical symptoms of thumb base OA, including pain, stiffness and weakness [22]. Assessments of pain and stiffness using VAS and measurements of grip force with the valid and reliable Grippit instrument are common and used clinically in health care. Pinch grip was measured because it is the most frequently used grip in performing daily activities and the most loaded thumb grip. The DASH score is a sensitive instrument but does not identify fine motor activities, and this is a limitation, because the women in the present study complained of difficulties in these activities. Further studies are needed to identify and assess fine motor activities. A study of symptoms in digits 2–5's interphalangeal joints compared with those with symptoms at the base of the thumb showed that both groups perceived the same disability [26]. It is possible that this had an influence on the treatment effect. Splinting is a conservative treatment for thumb base OA, but opinions differ concerning the use of short or long splints. In an earlier study, patients preferred and selected a short splint model [27]. A forearm splint seemed to limit activities of daily living while a thumb splint facilitated these activities. A recent systematic review of splinting for the CMC-1 joint concluded that splinting may help to relieve pain [28]. All women in the SE group were equipped with a forearm night splint and a thumb splint during daytime. From a biomechanical viewpoint, a study has shown the advantage of choosing a thumb splint in order not to restrict the range of motion contributed of a wrist activity splint during daytime [29]. Local application of heat, such as paraffin wax and a hot pack, especially prior to exercise, is a beneficial treatment for hand OA [11]. The exercise programme focused on maintaining stability of the CMC 1-joint and avoiding the deformity of thumb adduction and loss of first web space in the thumb [4]. A main limitation of the study is the lack of blinded controlled randomization and the lack of measurements and assessment of the interphalangeal joints and fine motor activities.

Conclusion

The splinting and exercise regimen added to a JP programme gives a greater improvement of pain, stiffness,

grip force and daily activities than the JP programme alone. This is a small-sized parallel trial; further randomised studies with larger sample are needed that include patients in the different Eaton stages with thumb base OA and assessments of the interphalangeal joints.

Acknowledgements Supported by grants from the Västra Götaland's Research Found VGFOUGSB-6397, VGFOUREG-1857 and Göteborg's Found for Rheumatism (GSFR), The Swedish Research Council (VR K2002-27-VX-14318-01A).

Many thanks go to Birgitta Rosèn, occupational therapist, Associated Professor at Lund University, for fruitful discussions and to statistician Anna Ekman at Göteborg University for helpful analysis.

Disclosures None.

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