Effect of custom made splint in first carpo-metacarpal joint Osteoarthritis: A Quincy Experiments

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Abstract— Custom- *made splints are in use of treatment of osteoarthritis but there are very few studies in this regards i.e. effectiveness of use of these custom-made splints. So this present Quincy experiment interventional study was conducted to evaluate the effectiveness of custom-made splints (short dynamic splint) on pain, function, grip strength and key pinch in patients with first carpometacarpal (CMC) joint OA (grade 2nd and 3rd) in comparison to conventional treatment. Sixty patients with CMC joint osteoarthritis were randomly assigned to the splint (group A) or non splint group B) treatment. So 30 CMC joint osteoarthritis patients (grade 2nd and 3rd)were given custom-made splints (short dynamic splint)and 30 CMC joint OA (grade 2nd and 3rd)were given conventional treatment. Both groups were comparable statistically in both the groups (P>0.05) as per age, sex etc. In follow up assessment at 4th & 8th week, the Splint group shows significant improvement in all the outcomes (pain, grip and pinch strength) measures at all follow up except DASH score improvement at 2nd follow up in comparison to non splint group. So it can be concluded that the splint group shows significant improvement in all the outcomes (pain, grip and pinch strength) measures at all follow up except DASH score improvement at 2nd follow up in comparison to non splint group. Result of present study supports that rehabilitation intervention (Short Custom-Made splint) can significantly benefits to individuals with early osteoarthritis and by it we can delay the need for surgical intervention.*

Keywords: CMC joint osteoarthritis, custom-made splints.

I. INTRODUCTION

Osteoarthritis is the most common form of arthritis. It causes pain, swelling, and reduced motion in joints. It can occur in any joint, but it usually affects hand, knee, hip and spine. Hand OA particularly affects the base of the thumb: the carpometacarpal (CMC) joint. the thumb CMC joint is a frequently involved site in patients with OA. The base of the thumb, primarily the trapeziometacarpal (TMC) joint, is the second most common site affected by primary idiopathic arthritis in the hand behind only the distal joints of the fingers.[1]

Symptomatic arthritis in this area can cause a much more significant functional disability due to the broad range of activities that become impaired. Major risk factors for Hand OA are Age over 40 years, Female gender, Positive family history, Occupational usage, Obesity and Joint injury.[2]

Patients with arthritis of the basal joint will typically complain of pain at the base of the thumb particularly with pinch grasp activities such as opening jars or bottles and turning keys. . On physical examination, palpation directly over the thumb base or TMC joint will cause pain. With advanced arthritis, motion of this joint will often elicit crepitance.[3] Physical examination should include the Grind

test and Crank test. Both maneuvers reproduce pain and crepitus in the diseased CMC joint.[4] Differential diagnosis includes dequervain's disease, thumb triggering and metacarpophalangeal arthritis. Roentgenographic features of first carpometacarpal osteoarthritis include joint space narrowing, subchondral sclerosis, osteophyte formation (most frequently on the lateral trapezium), periarticular ossicles, radial subluxation of the metacarpal, and occasionally juxta-articular erosions and cysts.[5]

Hand function is determined both through patient-reported questionnaires and physical measurements. Physical measurements important for CMC joint function are range of motion (ROM), grip & pinch (tripod and key) strength and dexterity.[6]

Conservative treatments for this includes splinting, NSAIDS etc. Goal of splinting the CMC joint is to increase stability at the joint. Splinting applies external support to the joint. During the application of the splint, the CMC joint is positioned as close to a neutral position as possible to increase joint congruity. Splinting the CMC joint also limits the amount of movement at the joint.[7] There is also evidence supporting the association between occupations involving repetitive thumb use (tasks requiring repeated thumb flexion and extension more than once per minute) with an increased risk for CMC OA.[8] Splinting the thumb in the recommended position of thumb palmar abduction, so that the index and thumb can oppose[9], can restrict repetitive thumb movement. Those patients with more advanced arthritic degeneration are more likely to fail conservative treatments. When conservative treatments fail to provide sufficient relief, the choice of surgical procedure depends on the stage of joint degeneration and the physical demands of the patient.[10]

So this present Quincy experiment interventional study was conducted to evaluate the effectiveness of custom-made splints (short dynamic splint) on pain, function, grip strength and key pinch in patients with first CMC joint OA (grade 2nd and 3rd) in comparison to conventional treatment.

II. METHODOLOGY

This interventional study was conducted on patients with clinical symptoms and signs consistent with 1st CMC osteoarthritis from April 2014 to November 2015 in SMS Medical College, Jaipur. After taking approval from Institutional Ethics Committee (IEC) study was conducted under PMR department of institute. For this purpose confirmed cases of CMC OA of grade II and III aged more than 18 years of either sex were recruited. Out of these recruited cases, cases with other deformities of hand and using splint already were excluded from the study. Patients with other chronic diseases and allergic to splint were also excluded with patients who has not given written informed consent for the study. Patients who were unable to do test were also excluded from study.

Physical examination includes the Grind test and Crank test. Radiological confirmation was done by taking Robert's view in which the patient's forearm lies flat and fully rotated internally, with the dorsal surface or carpometacarpal joint against the film. The target-to-film distance is 30 inches with the central ray directed 10 degrees cephalad from the vertical.

Confirmed carpometacarpal osteoarthritis cases who meet the inclusion criteria were randomized by simple random technique through chit box method to either active treatment group (custom made splint with standard medical treatment) or control group (standard medical care only).

Patients in the splint group were instructed to wear custom-made splint made up of LTTPE material for stabilization of first CMC joint. Splint was worn for the whole day (at least for eight hours) except while sleeping & bathing and when working with heat. Outcome variables included pain, Grip strength, pinch strength and DASH score.

Pain was assessed by a 10 cm. visual analogue scale, for which 0 represents no pain and 10 represents unbearable pain. The patient indicated his/her level of pain on the scale using the tip of a pen.

Functions were measured via completion of the disability of the arm, shoulder, and hand (DASH) questionnaire. The DASH consists mainly of a 30-item disability/symptom scale, scored 0 (no disability) to 100, concerning the patient's health status during the preceding week. The items ask about the degree of difficulty in performing different physical activities because of the arm, shoulder, or hand problem (21 items), the severity of each of the symptoms of pain, activity-related pain, tingling, weakness and stiffness (5 items), as well as the problem's impact on social activities, work, sleep, and self-image (4 items). Each item has five response options. The scores for all items are then used to calculate a scale score ranging from 0 (no disability) to 100 (most severe disability). Its score ranges from 0 to 96 with higher scores indicating worse functional capacity.

Grip strength was measured by hand held electronic dynamometer. Three measurements were taken in Kgf, from which the mean result was considered for analysis. Pinch Strength was tested with an indigenous pinch evaluation instrument. Patients positioning was standardized and the average force of five consecutive trials calculated in mm of Hg.

All patients were examined thoroughly at baseline, one month, and finally at 2 months on basis of VAS score, DASH score, grip and pinch strength and comparison between the groups was done at each follow up.

Data thus collected were complied in Microsoft Excel worksheet 2007 in the form of master chart. Variables on ratio and interval scale was summarized as mean and S.D. Variables on ordinal scale were summarized as Median and Inter Quartile. Range (IQR) and variable on nominal scale/categorical scale was summarized as Proportions (%).Significance of difference in means at different interval in the same group was inferred by Paired t-test. Significance of difference in means in the both groups was inferred by unpaired t-test. Significance of difference in proportions at different interval in the same group was inferred by McNemar Test. Significance of difference in proportions in the both groups was inferred by Chi-square test. Ordinal variables (VAS scores and DASH scores) at different interval in the same group were inferred by Wilcoxan Rank Sum test. Ordinal variables (VAS scores and DASH scores) in the both groups were inferred by Mann-Whitney-U test. P-value < 0.05 will be taken as significant. MEDCALC 14.0.0 version software will be applied for statistical analysis

III. RESULTS

Out of 60 patients, 30 patients in splint group and 30 in non-splint group were randomly assigned. Mean age of patients in splint group was 56.4 years and in non-splint group it was 56.8 years, which was well comparable ($p>0.05$). Likewise age, both groups were well comparable without significant ($p>0.05$) difference as per sex distribution and osteoarthritis grade. Other variable studied related to Osteoarthritis were also comparable except pinch score. Mean VAS score and Mean DASH scores were also not having significant ($p>0.05$) difference in both the groups. (Table 1).

Table 1
Comparison of Baseline characteristics of patients in both Groups

Baseline characteristics	Splint Group (N=30)	Non-splint Group (N=30)	P Value LS
Age (in years) Mean±S.D.	56.4±11.71	56.8±9.68	0.886 NS
Gender (Male/female)	13/17	15/15	0.796 NS
Side affected (Rt/Lt)	15/15	14/16	0.999 NS
Osteoarthritis grade (2^{nd}/3rd)	9/21	17/13	0.068 NS
Duration of symptoms (months) Mean±S.D.	18.1±25.38	17.05±26.19	0.875 NS
Tenderness Positive	26	28	0.667 NS
Grip strength(kgf)	17.1±4.46	18.27±5.11	0.349 NS
Pinch score(mmHg.)	86.63±12.02	103.4±15.25	<0.001 S
Grind test Positive	28	27	0.999 NS
VAS Score (for pain)	6.7±0.88	6.37±1.16	0.219 NS
DASH Score	69.3±7.36	69.36±5.43	0.971 NS

When mean change in grip strength of both the groups i.e. splint group and non-splint group was compared from baseline to at different intervals, it was observed that mean change in grip strength was significantly more in splint group than non splint group from baseline to 1st follow up ($p<0.001$), 1st follow up to 2nd follow up (($p<0.001$) and as well as from baseline to 2nd follow up ($p<0.001$). (Table 2)

Likewise when mean change in Pinch scores of both the groups i.e. splint group and non-splint group was compared from baseline to at different intervals, it was observed that mean change in Pinch scores was also significantly more in splint group than non splint group at various intervals i.e. from baseline to 1st follow up ($p<0.001$), from 1st follow up to 2nd follow up (($p<0.001$) and from baseline to 2nd follow ($p<0.001$). (Table 2)

When mean change in VAS pain in both groups was compared from baseline to at different intervals, it was observed that mean change in VAS scores was significantly ($p<0.05$) more in splint group than non splint group from baseline to 1st follow up ($p=0.005$) and 1st follow up to 2^{nd} follow up at two months (($p=0.002$) and baseline to 2nd follow up ($p<0.001$). (Table 2)

Likewise when mean change in DASH scores of both the groups i.e. splint group and non-splint group was compared from baseline to at different intervals, it was also observed significantly more mean change in DASH scores in splint group than non splint group at every follow up groups i.e. from baseline to 1st follow up ($p<0.001$) and 1st follow up to 2nd follow up (($p<0.001$). (Table 2)

Table 2
Comparison of Mean Change in clinical variables on follow ups after treatment within and between two groups

Variables	Baseline-1st follow up	1st follow up-2nd follow up	Baseline-2nd follow up
Grip			
Splint group	**2.823**±10.61	**0.96**±0.60	**3.783**±0.93
Non-splint group	0.767±0.63	0.54±0.34	1.309±0.84
$P^{groupA-B}$	<0.05	<0.05	<0.05
Pinch			
Splint group	**19.87**±5.88	**9.367**±3.16	**29.23**±6.76
Non-splint group	4.6±1.85	3.5±2.58	8.1±3.61
$P^{groupA-B}$	<0.05	<0.05	<0.05
VAS pain			
Splint group	**2.7**±1.23	**1.933**±1.081	**4.633**±0.96
Non-splint group	1.767±0.81	1.033±0.76	2.8±1.126
$P^{groupA-B}$	<0.05	<0.05	<0.05
DASH pain			
Splint group	**5.936**±1.87	**4.38**±1.95	**10.32**±2.82
Non-splint group	3.104±1.305	2.27±0.90	5.38±1.42
$P^{groupA-B}$	<0.05	<0.05	<0.05

$P^{groupA-B}$; Comparison of values between the group A and group B
Data are expressed as mean change± S.D.
P value <0.05 was taken as significant

IV. DISCUSSION

Purpose of present study was to assess the effectiveness of custom made splint in patients with osteoarthritis of the 1st carpometacarpal (CMC) joint in terms of reducing pain, increasing Grip & Pinch and improving hand functions.

Around 50% of persons in presents study were in the age group of 51 to 66 years with mean age of 56.4 years in study group and 56.73 years in control group suggesting OA was the disease of old age. Cooper[11] et al stated mean age as 65 years and Swigart[12] et al found the mean age was 54 years like these cases. Bani MA[13] was found the mean age was 56.6 years in their study of these cases. Female to male ratio in present study was 1:1 in both the groups which was different from the previous studies. Zhang et al[1] found symptomatic hand OA in 3% of men and 5.8% of women. Richard Dias[14] et al stated female and male ratio as 6:1. Here both group were comparable.

All the patient reported pain as a chief complaint and difficulty in doing house hold activities as major complaint in present study. These findings are in line with all previous studies. Anne Wajon et al[15] also

suggested pain, stiffness and weakness at the base of thumb as clinical symptoms. According to Judy Colditz[16] the symptoms of OA were joint pain, tenderness, stiffness or instability.

In present study 75% of patient had their symptoms of less than 1 year duration in both the groups that was 2.99 years in the Sillem et al[17] study and 6.3 years in a study done by Carreira ACG et al.[18]

The VAS scores improved in both the splint and control group was 2.7 and 1.767 at the end of one month and 4.633 and 2.8 at the end of two months respectively, however, this improvement over baseline was statistically significant ($p<0.05$) for the 1st follow up at one month as well as at 2nd follow up ($p=<0.05$) in splint group and non-splint group. Overall, after wearing the splint patients had earlier and sustained improvement.

Participants who had worn splint reported significantly greater reduction in pain symptoms than those not using the splint. Although pain was also improved in non-splint group and it may be due to effect of analgesic medicine and exercises. Present results were similar to previous studies in regard to the effect of thumb splinting on pain. Pain was significantly reduced with both splints in comparative trials by Weiss et al.[19] in 2004. Bani MA[13] et al in 2013 demonstrate the pain reduction with custom made splint after 30 days and further reduction upto 90 days. This pain reduction could be due to the corrected position of the osseous and ligamentous structure with the splint application. The pain reduction was also occurred due to immobilization of the encapsulated joint and decreased inflammation in splinting.

The primary outcome of function was selected to focus on disability and the real-life impact of CMC OA on everyday activities rather than pain alone. Three measures of function were chosen, including the self-report DASH questionnaire as well as grip and pinch strength measurements. The duration for which splint was worn was set at 4 weeks, assuming that this would be ample time to become accustomed to the splints as suggested by the earlier studies. Nevertheless, it may take even longer to achieve the full effect of splints on function, given the continued improvement noted at the 2 month follow-up.

When mean change in DASH score were compared using Mann-Whitney rank sum test at various follow up for splint and nonsplint group there was statistically significant difference (P value <0.001) at one month follow up from baseline and between 1st and 2nd follow up. Although the change was not significant when compared at 2month follow up from baseline. Overall, after wearing the splint patients had earlier and better improvement although exercise protocol also results in improvement in hand functions. M A bani[13] et al in 2013 also reported improvement in the mean DASH score in 18 patients throughout the studied period with use of custom made splint at every follow up at one, two and three months similar to present study. Leana Tank[20] at Grand Valley State University in his thesis (2009) significant improvement in function as measured by a decrease in mean Quick DASH scores on the second session as compared to the first.

Present study shows that mean score on Grip strength was 17.1 at baseline. It changed to 19.92 at one month, and 20.88 at the end of two months follow up in the splint group. In the non-splint group Mean score on Grip strength was 18.27 at baseline and Its changed to 19.04 at one month, and 19.58 at the end of two months follow up. On application of Unpaired 't' test between Splint and Non-splint group, when comparison is done between Mean change in Grip strength there was statistically significant difference (P value <0.001) at one month follow up and when change was compared between 1st and 2nd follow up (P value <0.001). The change was also significant when compared at 2month follow up (P value <0.001).

In this study mean score on Pinch Score was 86.63 at baseline and It changed to 106.5 at 1 month & 115.8 at 2 month follow up in the splint group. Mean score on Pinch Score was 103.4 at baseline, 108 at 1 month and 111.6 at 2 month follow up in non-splint group. On application of Mann-Whitney rank sum test between Splint and Non-splint group, when comparison is done between Mean change in Pinch strength there was statistically significant difference (P value <0.001) at one month and 2 month follow up and when change was compared between 1st and 2nd follow up (P value <0.001).

Both grip and pinch strength improved significantly, after wearing the splints for 4 weeks and 8 weeks and when it was compared with change in non-splint group , there was statistically significant difference at both one and two month follow up and between 1st and 2nd follow up. The mean improvement in grip strength in present study after wearing the splint for 4 weeks was 2.82 kg which was a meaningful clinical improvement as shown in 2002 by Rahman et al[21]. Wajon and Ada[15] in 2005 found an increase of 0.6 Kg in tip to tip pinch after 2 weeks of splinting. McKee et al[22] in 2006 reported a significant improvement in pinch from baseline to follow-up with and without the splints. However, when comparing the amount of pinch force generated with the splints on it was still less than follow-up scores without the splint on. This suggests that splints actually hinder pinch but not in this study because short Dyanamic Custom-made splint allow full mobility of surrounding joints.

V. CONCLUSION

When analyzing for treatment order effect, THE SPLINT GROUP shows significant improvement in all the outcomes (pain, grip and pinch strength) measures at all follow up except DASH score improvement at 2nd follow up in comparison to NON SPLINT GROUP.

The result of present study supports that rehabilitation intervention (Short Custom-Made splint) can significantly benefits to individuals with early osteoarthritis and by it we can delay the need for surgical intervention

CONFLICT

None declared till date.

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