Table SI. Characteristics of included studies

<table>
<thead>
<tr>
<th>Authors/design</th>
<th>Participants</th>
<th>Interventions</th>
<th>Outcome measures</th>
<th>Results/comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCT’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anderson &amp; Maas, 1987 (24)</td>
<td>n=92 patients female, Mean age: 54.47 years, range mid twenties to late seventies (SD 13.83) Disease duration: not stated</td>
<td>4 kinds of working splints used: Dorsal – Sans splint XR Palmar – San-splint® pink Gauntlet – Plastazote® Fabric – Cotton elastic pre-fabricated Splints fitted immediately following group allocation</td>
<td>Joint tenderness: richie scale Grip strength: sphygmomanometer</td>
<td>Comparisons between the 5 groups in terms of age and pain level using ANOVA concluded that if there were any significant differences in grip strength it would be very unlikely to be due to age Splinting does not have an immediate positive effect on grip strength Results failed to support the hypothesis that splints would immediately increase grip strength</td>
</tr>
<tr>
<td>Haskett et al., 2004 (25)</td>
<td>n=45 patients, female=39, male=6 Mean age: 49.1 (SD 13.0) years, range 25–75 years Disease duration: 8.6 (SD 9.2) years, range, 0.5–45 years Diagnosis: RA N=35</td>
<td>4 week period using each of the splints in turn separated by 1 week washouts: Roylan® wrist extensor splint (RWS) Custom made leather wrist splint (LWS) Anatomical technologies ©elastic wrist support (AWS) Advised to use during activities that caused pain or discomfort Wear for a minimum of 10 h per week</td>
<td>Disease activity: Active joint count Perceived fatigue Morning stiffness Wrist pain: 10 cm horizontal visual analogue scale Hand function: Arthritis Hand Function Test (AHFT) Perceptions of function: McMaster-Toronto Arthritis Patient Function Preference questionnaire Splint diary completed daily</td>
<td>There did not appear to be order or carryover effects MANOVA indicated that wrist splints significantly reduced pain (p= 0.007). Custom leather splint was most effective in reducing pain from 4.1 cm –2.8 cm (p=0.001). All splints improved hand strength &amp; CRS provided significantly Stronger grip than the ACS (p=0.04). Splints did not compromise dexterity Improvements were maintained at 6 months. No change in functional ability Cost of custom made versus off the shelf discussed – 2–3 times more expensive</td>
</tr>
<tr>
<td>Kjeken et al., 1995 (26)</td>
<td>n=69 patients: 52 female, 17 male Mean age range: not given, median age – 64 years, range 24–79 years Disease duration: median 3 years, range 1–424 months</td>
<td>Frequency: Rehband ™ elastic wrist orthoses used during the 6 month treatment period when performing painful activities and intermittently in resting position during periods of severe joint pain. Treatment group: Rehband ™ elastic wrist orthosis. Measured at baseline and 6 months with and without orthosis Control group: no use of wrist orthosis</td>
<td>General disease activity: duration of morning stiffness (mins), pain at rest: (100 mm VAS), pain on motion (VAS) and Erythrocyte Sedimentation Rate. General functional capacity: Health Assessment Questionnaire (HAQ) Effects on wrist joint: presence/absence of wrist swelling and/or tenderness, joint circumference (cm), patient’s experience of pain on motion (VAS) and pain during 2 standardised activities Active and passive motion: goniometer Pinch grip: Mannerfelt Intrinsicmeter Grip strength: sphygmomanometer Muscle atrophy: forearm circumference</td>
<td>Changes in wrist joint variables and general disease activity variables were not statistically different between the orthosis group and the control group Patients in the orthosis group had 25% and 12% improvements in grip strength and pinch grip and 50% reduction in pain while using the wrist orthosis Use of wrist orthoses improves function and reduces pain but has no effect after 6 months compared to a control group on measures of local or general disease activity</td>
</tr>
</tbody>
</table>
Pagnotta et al., 2005 (27)
n = 30 patients, 26 female, 4 male
Mean age: 56.7 years, range, 28–76 years
Disease duration: mean time from disease onset 9.2 years, range from recent onset to 31 years
ARA Classification:
Class I – \( n = 0–0\% \)
Class II – \( n = 18–60\% \)
Class III – \( n = 11–37\% \)
Class IV – \( n = 1–3\% \)
Follow up: baseline, 2 further assessment sessions 3–7 days apart but no indication how long after prescription

Allowed a brief practice of each task prior to the testing situation
Two sessions 3–7 days apart
Five work performance tasks and 2 endurance tasks carried out with and without the splint
Activities and whether splint or not first randomised
Futuro ™, Roylan® D, Medical Specialties
Pain: 10 cm VAS
Work: Baltimore Therapeutic Equipment Company work simulator
Endurance: Baltimore Therapeutic Equipment Company work simulator
Perceived difficulty of task: 10 cm VAS
Perceived splint benefit: 10 cm VAS

With the splint on pain was significantly lower in 5 tasks as was perceived difficulty in task performance. Work performance did not differ significantly with the splint on versus off. While mean endurance scores were always better with the splint on, differences reached significance on only one task. The task with greatest overall perceived benefit was chopping with a knife.
For most tasks splint use improved or did not change pain levels, did not interfere with work performance, increased or maintained endurance and did not increase perceived task difficulty
Brief test allowed before!! With/without?
3 different types of splints no reference to this!

Stern et al., 1996 (22)
n = 2 patients, 22 female, 20 male
Mean age: 56.50 years
Disease duration: mean of 11.05 years since diagnosis
Follow up: baseline and following one week of use

One week use of each of 3 designs of wrist orthoses (Smith & Nephew, Roylan® D-Ring & Kendall-Futuro ™ #33) preceded and followed by a one week wash out period
Subjects directed to use their orthosis intermittently during functional tasks for a minimum of 4 h per day across 5 of the 7 days

Finger dexterity: The Purdue Test
Hand function: The Jebsen-Taylor Test

Both finger dexterity and hand functions were reduced by splinting: men and women were affected similarly. There was no difference in finger dexterity or hand function afforded by the 3 orthoses. Results on both the Purdue and Jebsen-Taylor tests showed a significant learning effect across time

Stern et al., 1996 (23)
n = 36 patients, 18 female, 18 male
Mean age: women 49.44 years, men 62.67 years
Disease duration: mean years since RA diagnosis; women, 12 years, Men 12.33 years
Follow up: baseline and following one week of use

One week use of each of 3 designs of wrist orthoses on the dominant hand (Smith & Nephew, Roylan® D-Ring & Kendall-Futuro ™ #33) preceded and followed by a one-week wash out period
Subjects directed to use their orthosis intermittently during functional tasks for a minimum of 4 h per day across 5 of the 7 days

Grip strength: Calibrated hydraulic Jamar dynamometer
Effect of orthosis on daily tasks: written questionnaire

Immediate effect of splinting with commercial wrist orthoses is reduced grip
After a 1 week adjustment period the Smith & Nephew Roylan D-Ring® afforded splinted grip to that of the non-splinted grip strength. The other 2 orthoses continued to reduce grip significantly below that of the Roylan®. Roylan® deemed comfortable by more subjects than other orthoses and helpful in some housework, farm chores and meal preparation. Hindered some self-care tasks, writing and typing
Both styles of splints significantly reduced pain (effect size leather splint 0.79, fabric splint 0.43), improved hand function, and increased grip strength compared to baseline (\( p < 0.5 \)) with no increase in wrist stiffness

Thiele et al., 2009 (28)
n = 25 patients, 13 female, 12 male
Mean age: 54 years, range 18–82 years
Diagnosis: OA \( n = 6 (24\%) \), RA 17 (68%), other inflammatory \( n = 2 (8\%) \)
Disease duration: 15 years, range 1–58 years
Follow-Up: baseline and end of each 2 week splint phase

Two phase crossover trial comparing a custom made leather splint with a commercial fabric splint (Futuro ™)
Splints were worn for 2 weeks separated by a one week wash out period
Total duration of trial 5 weeks
Advised on appropriate use and care of splint – no specification of how long to wear

Power grip strength: Calibrated Jamar dynamometer
General hand function: Australian Canadian osteoarthritis Hand Index VA 3.0 (AUSCAN) – general hand function, pain and stiffness
Self perceived occupational performance: Canadian Occupational Performance Measure

There was a consistent trend for the leather splint to be superior to the fabric but this was only statistically significant for patient perceived occupational performance (\( p = 0.008 \)) and satisfaction (\( p = 0.015 \)).
72% of patients preferred the leather splint to the fabric
Tijhuis et al., 1998 (29)  
\[ n = 10 \text{ patients, 8 female, 2 male.} \]  
Mean age: 47.3 years, range 28–71 years  
Disease duration: not stated  
Follow up: before and after each of the two orthoses were worn for 2 weeks with 1 week separating  
Randomised cross-over comparing the synthetic Thermolyn® wrist orthosis and the Futuro™ wrist orthosis  
Splints were worn for 2 weeks separated by one week without treatment. Patients were asked to wear the orthosis as much as possible during both day and night  
Effect of wrist orthoses on pain: questionnaire, VAS  
Tender joint count: Ritchie scale  
Wrist Range of Motion: passively measured using method described by Gerhardt & Rippstein  
Grip strength: Martin Vigorimeter

Veehof et al., 2008 (30)  
\[ n = 33 \text{ patients, majority were female with 71\% female (}n = 12\text{) in splinting group (}n = 17\text{ total) and 69\% female (}n = 11\text{) in control group (}n = 16\text{ total).} \]  
Mean age (SD): 60.3 (SD 10.8) years in splinting group, 55.1 (SD 12.8) years in control group  
Disease duration: 8.2 (SD 6.8) years in splinting group and 5.0 (SD 4.6) years in control group  
Follow up: baseline and after 4 weeks  
Splinting group: Prefabricated wrist splint to be used as much as possible during the day for 4 weeks. Choice of 4 splints: Roylan® D-Ring, GM005H, GM008 or GM009 (General Medical Bracing)  
Control group: Usual care and offered a splint after the study  
Daily diary: record of number of hours splint worn  
Disease activity: Disease activity score in 28 joints  
Wrist pain: 100 mm VAS  
Grip strength: Martin Vigorimeter  
Functional ability: Disabilities of the Arm Shoulder & Hand (DASH) questionnaire and short version, Sequential Occupational Dexterity Assessment (SODA-S)  
Dexterity/function: measured by two activities – pouring water and lifting groceries. Dexterity/function: measured by two activities – writing and manipulating coins  
Duration of splint use: diary sheet  
Grip, tip pinch and tripod pinch strength: Martin Vigorimeter  
Applied strength: measured by two activities-pouring water and lifting groceries  
Statistically significant differences were found when hinged \((p < 0.001)\) and spiral splints \((p = 0.02)\) were worn. Grip strength decreased with hinged splints. Two point pinch increased and dexterity improved on the nine hole peg test with the spiral splint  
No significant EMG differences were found during different splint conditions  
There is a demonstrable improvement in hand function as measured by grip and pinch strength with use of the splint. The splint improved the ability to lift and pour, hindered the speed of writing and had a limited impact on coin manipulation

Backman & Deitz, 1988 (31)  
\[ n = 3 \text{ patients, female.} \]  
Aged: 66, 69 and 67 years  
Disease duration: 1, 1 and 5 years  
Follow up: baseline phase with repeated measures of the dependant variables (6 or 7 sessions), followed by intervention and an eight-data-point phase ranging from 10–15 days  
Single subject, alternating treatment design with and without a custom-made polyethylene gauntlet wrist splint. Splint and no splint conditions alternated repeatedly and counter balanced over a period of 4 months  
Duration of splint use: diary sheet  
Grip, tip pinch and tripod pinch strength: Martin Vigorimeter  
Muscle activation: surface EMGs recorded muscle activity of 8 muscles in the dominant upper extremity involved with reach and grasp  
Grip and Pinch strength: Jamar dynamometer and pinch meter, respectively  
Manual Dexterity: nine-hole peg test  
Statistically significant differences were found when hinged \((p < 0.001)\) and spiral splints \((p = 0.02)\) were worn. Grip strength decreased with hinged splints. Two point pinch increased and dexterity improved on the nine hole peg test with the spiral splint  
No significant EMG differences were found during different splint conditions

Burnier et al., 2003 (32)  
\[ n = 5 \text{ patients, 4 female, 1 male.} \]  
Mean age: 48.4 years, range 42–56 years  
Disease duration: 16.2 years, range 7–23 years  
Follow up: immediate effects  
4 splint conditions: no splint and 3 splint types: Static positioning splint – Liberty™ D-Ring wrist brace long  
Dynamic splint – hinged wrist resist  
Dynamic splint – spiral custom made wrist hand splint  
Statistically significant differences were found when hinged \((p < 0.001)\) and spiral splints \((p = 0.02)\) were worn. Grip strength decreased with hinged splints. Two point pinch increased and dexterity improved on the nine hole peg test with the spiral splint  
No significant EMG differences were found during different splint conditions
Nordenskiold, 1990 (33)
$n=104$, 22 female patients with RA and 82 females without RA
Mean age: 53 years, range 30–65 years (RA), 40 years, range 23–65 years (non RA)
Disease duration: mean 11 years, range 1–33 years
Follow up: immediately before and after application of splint on RA group; 2 types of soft volar wrist splint, Camp and Rehband™
Control group: 2 types of soft volar wrist splint, Camp and Rehband™
Nb: unclear as to whether all subjects used one or other or both splints
Pain: 100 mm VAS
Pain on performance of ADL tasks: VAS following setting a breakfast table for 2 people, filling a glass with milk from a full carton and vacuuming a floor without a rug for 3 mins
Grip force: GRIPPIT
Effectiveness of splint: interview with standardised questions
Pain was decreased by 39%, 42% and 52% when using an orthosis in the 3 ADL situations
Anecdotally, the women noted that the splints provided support and decreased pain both at home, in work and during leisure activities
Orthoses improved grip force at onset of pain by 26%, 22% and 29%
All subjects showed reduced grip strength (20–25%) when compared to grip strength in a group of women without RA

Pagnotta et al., 1998 (34)
$n=40$, 33 female, 7 male
Mean age: 52.4 years, range 25–81 years
Disease duration: 9.2 years (SD 12.3)
Follow up: following one week of splint wear
Two period crossover design
Futuro™ Kendall #33 splint fitted and worn on a daily basis for one week while receiving inpatient services to become accustomed to the splint. Outcome measurements then carried out with and without the splint on 2 separate days
Disease activity: tenderness, swelling – Joint Examination Appendix (American Rheumatism Association), crepitus, 1 standard radiograph of the wrist and hand
Range of motion: Treuhaft assessment
Work performance: The Baltimore Therapeutic Equipment Company
Dexterity: The Jebsen Hand Function Test
Pain: 10 cm VAS
BTE screwdriver test, work performance was less with the orthosis ($p=0.0002$).
On the BTE shears tests there was no significant difference in work performance with & without the splint
Mean pain was significantly less with the orthosis on.
Mean time to complete all 7 Jebsen Hand Function Test components was longer with the splint on (62 vs 57.6 seconds’ $p=0.0086$)

OBSERVATIONAL
Cytowicz-Karpilowski et al., 1999 (35)
$n=60$, female patients
Mean age: 60 (SD 9.4) years, 45.7 (SD 11.1) years
Disease duration: 6.4 (SD 4.3) years, 6.1 (SD 3.9) years (unclear as to why these differ for the two tests)
Follow up: immediate effects
Study 1: Measured with and without a leather band to strengthen the carpometacarpal joint.
Study 2: Measured with and without a felt pad under the capitulum of the third and fourth metacarpals to correct the flattened transverse arch.
Length of wear: patient report
Support: patient report
Interference with activity: patient report
Comfort: patient report
Putting on/taking off: patient report
There are statistically significant differences between the mean maximal forces, especially those exerted by the distal phalanges for both the band and pad ($p<0.001$).
After bandage application forces exerted by the distal phalanges were 10–45% stronger
The largest increase was found in the distal phalanges after the bandage application
After application of the felt pad the forces exerted by the distal phalanges increased by 17–41%
For support both splints were equal (11/14 found Futuro™ gave adequate support, 12/16 for Spencer)
Both splints interfered almost equally with some normal activities, the balance being marginally in favour of Futuro™.
Both were comfortable to use (Futuro™ 10/14, Spencer 8/12).
Equal rating – don/doffing
29/36 reported wearing their splint
7/16 patients fitted unilaterally and 5/13 fitted bilaterally
There was no patient who found the material had an unpleasant odour
Therapists were unhappy with the odour and stickiness of the material

Gumpel & Cannon, 1981 (36)
$n=16$, sex not stated
Age: not stated
Disease duration: not stated
Follow up: not clear
Intra-patient comparison of Futuro™ and Spencer wrist splints. Given one splint to use then the other at the following outpatient clinic appointment
Lightcast II fiberglass splints were moulded on patients and worn for 9 to 12 months. Patients were seen at irregular intervals and for a final evaluation after approximately 9 months.

Nicholas et al., 1982 II (37)
$n=36$ available for re-evaluation, 25 females, 11 male.
Age: not stated
Disease duration: taken but not stated
Follow up: irregularly seen at routine clinic visits or when repairs required for splints
29/36 reported wearing their splint
15/29 liked the material
5/29 disliked the appearance
1/29 found it too rough
1/29 thought it did not breathe properly
1/29 found it stretched when wet
2/29 found it broke easily
7/16 patients fitted unilaterally and 5/13 fitted bilaterally
No patient found the material had an unpleasant odour
Therapists were unhappy with the odour and stickiness of the material
Two consecutive surveys of patient compliance with wearing wrist splints were carried out to identify factors contributing to compliance. Custom made thermosplastic and custom made 2-way stretch elastic fabric splints were used. Study 1: Perceived benefits of splinting and discomfort in wearing splints were identified as the major determining factors in compliance which was found to be about 75%. Appearance of splints was a minor issue. Study 2: After 1 year compliance remained the same and perceived benefits from splinting was again the major factor determining compliance. Discomfort in wearing the splint was negligible in the study.
Patients $n=88$, 60 female, 28 male
Mean age: 58 years, range 15–83 years
Disease duration: Mean, 176 months, range 5–45 years
Follow up: N/A

RA patients from 3 major hospitals who had been wearing 1 of 4 wrist-splint types for at least 2 weeks:
- Elastic
- Leather
- Dorsal thermoplastic
- Palmar thermoplastic

Questionnaire to RA patients to gain information regarding wearer and prescriber perceptions of splint suitability:
- Information regarding personal details, splint usage, perceived effectiveness of the splint during 24 daily activities and 12 items related to splint design and quality collected

The 4 splint groups differed significantly on two discriminant functions based on the 24 selected variables Sex, use of a walking stick and being a homemaker contributed most to the first discriminant function.

Significant differences were found between the 4 when comparing the wearers' indicated use of splints for dressing, hanging clothes, sweeping, dusting and reading. Results support view that certain splints are better suited to specific patient characteristics and daily tasks.

---

Stern et al., 1997 (44)
$n=42$, 22 female, 20 male
Mean age: 56.50 years (SD 13.60: range 30–76 years)
Disease duration: Mean 11.05 years (SD 11.03: range 0.3–51 years)
Follow up: N/A

Cross-over design using 3 commercial orthoses for 1 week with a 1-week washout between each

Patients' functional uses of 3 commercial wrist orthoses
Describe patients' preference patterns for the orthoses
Clarify orthotic attributes that are viewed positively and negatively
Private semi-structured interview

Three splints reduced pain similarly, but comfort and sense of security during functional tasks only found is orthoses were comfortable and well fitting. Most preferred the padded short forearm orthosis. Common complaints about the 2 elastic orthoses included chafing at the thumb web space and proximal closures. Longer forearm often perceived as providing unnecessarily high levels of wrist support

---

Veehof et al., 2008 (43)
$n=18$, 78% female ($n=14$), 22% male ($n=4$)
Mean age: 56.3 (SD 16.4) years
Mean (SD) time interval between splint prescription and interview: 6.0 (SD 3.5) months
Follow up: N/A

A qualitative descriptive study to gain insight into the determinants of the use of wrist working splints among patients with RA.

Patients who had received a fabric (commercially available) wrist working splint from their rheumatologist

Description of the prescription and knowledge, splint use, advantages and disadvantages of splint wearing, appearance, comfort and fit of the splint and social environment: experiences, knowledge and opinions of patients with regards to the use of their splints
In depth semi-structured interviews

Majority of patients indicated their splint use was dependent on the seriousness of symptoms (pain swelling or tingling). Important reasons to wear splints were reduction of these symptoms, wrist support and immobilisation of the wrist. Important reasons to stop wearing the splint were reduced functional abilities while using the splint and the performance of dirty or wet activities

BTE: Baltimore Therapeutic Equipment; V AS: visual analogue scale; SD standard deviation; ANOVA: analysis of variance; MANOVA: multivariate analysis of variance; RA: rheumatoid arthritis; ADL: activities of daily living.