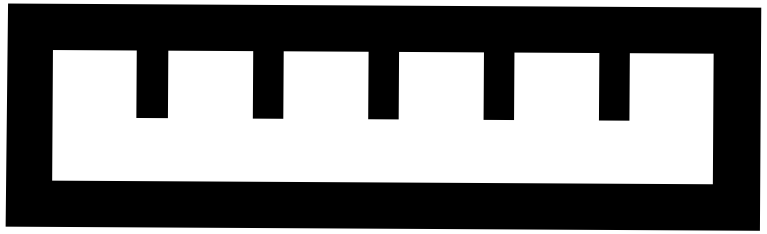
Measuring up to the challenge of CRPS rehabilitation



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McMaster University | School of Rehabilitation Science REACHING FURTHER

CRPS challenges: it's variable!

No clear single mechanism for development

Little agreement on possible sub-types (Type I/ Type II, warm / cold) and time course

Bruehl, 2016; Birklein 2015

CRPS challenges

No gold standard diagnostic test

No widely accepted outcome measures

Rehab is primary treatment, but rehab research is lacking

Bruehl, 2016; Birklein 2015; Packham et al, 2012

COMPACT

Core Outcome Measurement Set for CRPS Clinical Trials (Greive et al, 2018)

COMPACT PRO recommendations (Grieve et al, 2018)

DOMAIN	MEASURE
Pain	SF McGill Neuropathic scale PROMIS 29
Disease severity	CRPS Severity Scale
Participation	PROMIS 29 EQ-5D
Physical function	
Emotional and psychological functioning	PROMIS 29 Single item on suicidal ideation
Self-efficacy	Pain Self-Efficacy Questionnaire
Catastrophizing	Pain Catastrophizing Scale
Self-perception of change	GROC

Can we correctly identify persons with

CRPS vs. nerve injuries vs. post-traumatic inflammation

using skin temperature differences?

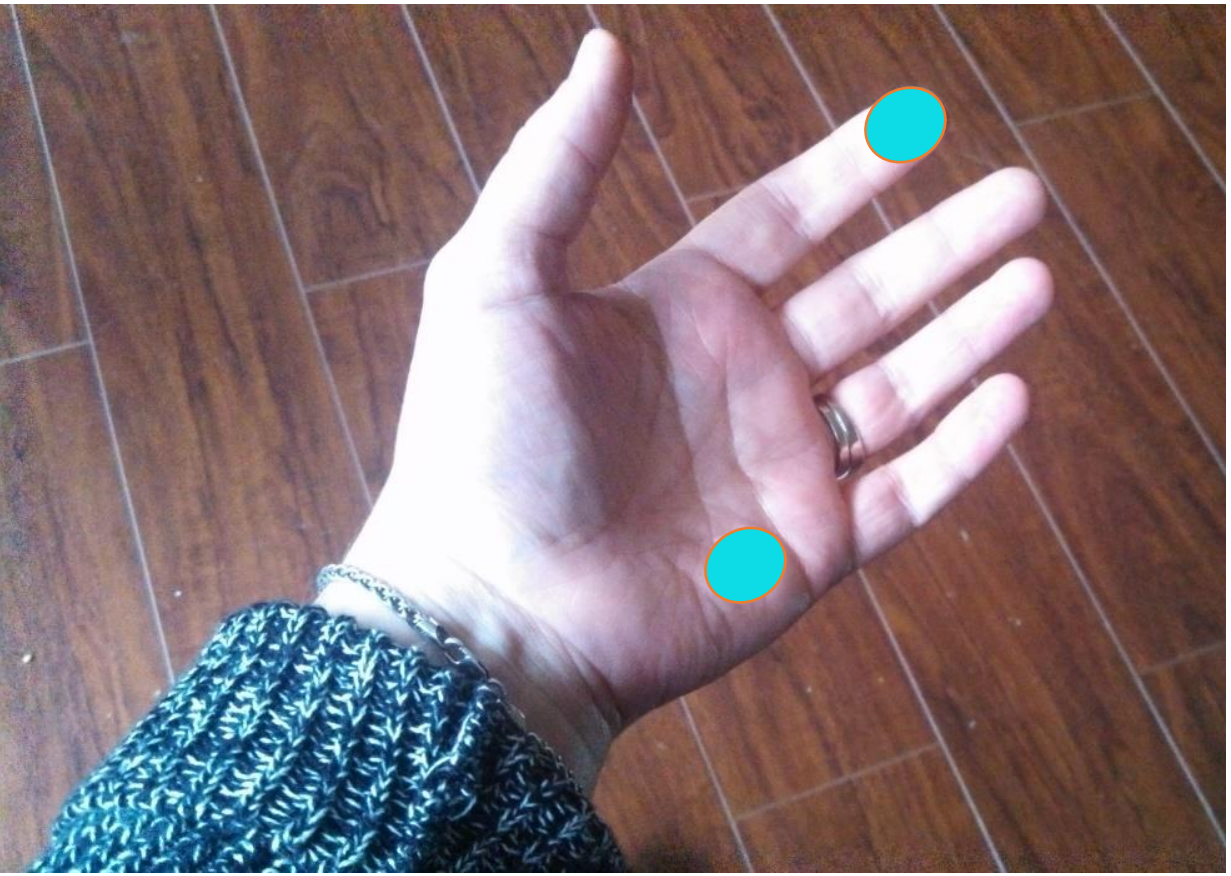
Identification of CRPS using skin temperature asymmetry

Previous studies failed to find this to be useful, &/or used $$$ tools, but:

- Didn't account for innervation patterns
- Didn't account for warm/cold subtypes
- Only compared to healthy volunteers, or other fracture patients

Pilot work demonstrated adding a cold pressor test for a consistent thermoregulatory stressor was safe, and inexpensive IR thermometers were reliable (Packham et al, 2012)

Measurement points used:



Can we correctly identify CRPS vs. nerve injuries vs. post-traumatic inflammation vs. normal differences?

63 persons measured bilaterally in **3 nerve distributions** in the hand (median, ulnar, radial) before and after a cold pressor test (foot in ice water for 30 seconds), for a total of 378 measurements.

16 met the Budapest criteria for CRPS
10 peripheral nerve injuries
8 with recent hand fracture
29 healthy volunteers.

(Packham et al, 2018)

Are there meaningful differences in hand temperatures between sides?

Regression modelling of SkTA measures (n=378)

- diagnosis
- post cold pressor test
- nerve distribution

Were significant predictors ($p<0.001$) explaining 94% of the variance between sides.

ANOVA accounting for nested factors differentiated between diagnostic groups for the magnitude of SkTA $p<0.0001$

(Packham et al, 2018)

Does it give us useful information to inform a diagnosis?

Sensitivity [for a >1.0 ºC SkTA]

Pre CPT = 85.1% Post CPT = 76.6% **Rule in**

Specificity [for a >1.0 ºC SkTA]

Pre CPT = 43.8% Post CPT = 68.8% **Rule out**

(Packham et al, 2018)

What do persons with CRPS think is important:

a) to represent recovery?

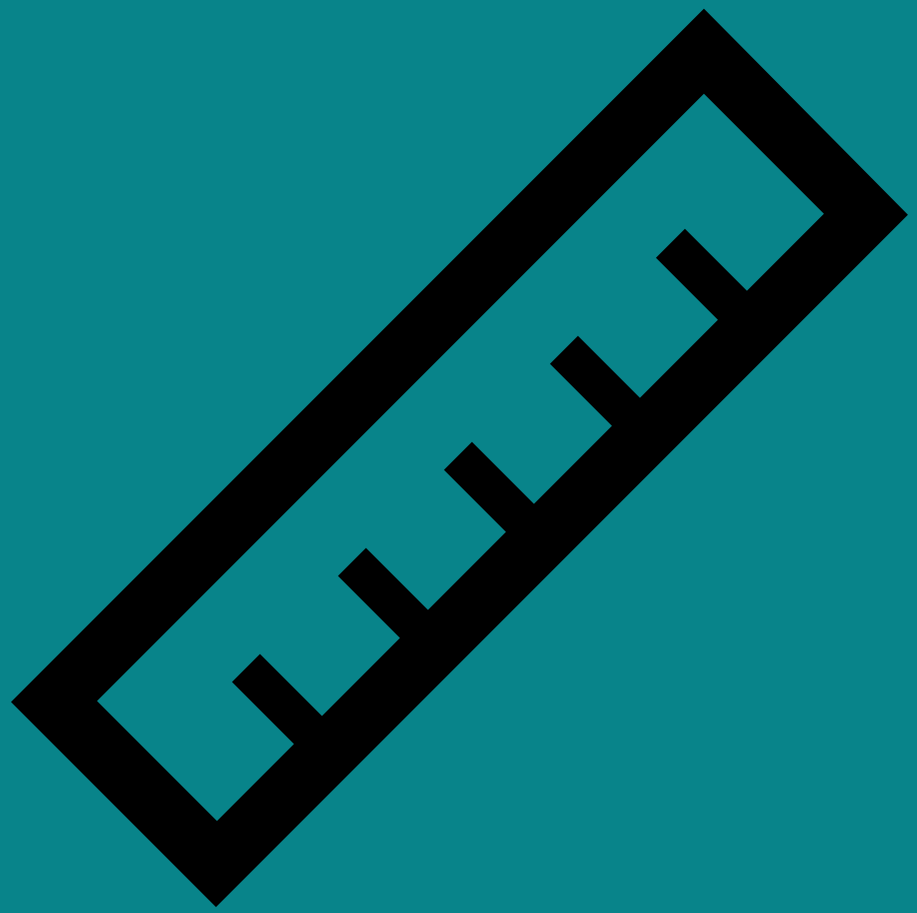
b) for their HCP to know?

CRPS recovery study (Llewellyn et al, 2018)

How will you know you are better?

- decreased limb pain
- less overall pain and discomfort interfering with daily activities
- better movement & less stiffness
- less medication needed

Some of these are things we don't routinely measure in hand therapy settings



What drove me to start doing research was my search for a common ‘ruler’ I could share with other health professionals to inform care decisions and decision making for persons with CRPS

Hamilton Inventory for CRPS was developed using cognitive debriefing

Patient Reported Hamilton Inventory for CRPS (PR-HI-CRPS)

Condition-specific patient-reported outcome measure
(40 items; rated 0-6)
3 subscales: symptoms, daily activities, coping

(Packham et al, 2018)

Clinician-based HI-CRPS (CB-HI-CRPS)

14 items rated 0-3 (none, mild, moderate, severe)
Addresses sensory, autonomic, trophic and motor signs

(Packham et al, 2012)

Question [concept] list: CB-HI-CRPS

Sensory
- Allodynia
- Cold hyperalgesia
- Guarding
- Skin temperature asymmetry

Autonomic
- Vascular function: mottling
- Sweating (hyperhidrosis or anhydrosis)
- Edema

Trophic
- Hair growth
- Nail quality
- Skin quality

Motor
- Movement expected given initial injury
- Movement expected given time elapsed since injury
- Muscle tone
- Incoordination

Sample question: CB-HI-CRPS

Cold Allodynia / Hyperalgesia [sensory subscale]:

Definition: an exaggerated painful sensation evoked by low-temperature stimulation

Scoring:

0 = **None** - no complaints of pain; may report that tube feels cold.

1 = **Mild** - patient reports discomfort with cold but no physical behaviours evident

2 = **Moderate** - patient reports pain, may show a behavioural response such as flinching, grimacing, or vocalizing discomfort

3 = **Severe** - patient reports pain and has a clear behavioural response; may decline to be tested

Testing: Touch test tube of cold water to skin for 3 seconds. Repeat over 3 different zones within affected area. Rate response as above.

Instructions: I am going to touch you with this test tube of cold water; tell me how it feels to you. (*Allow patient to respond then ask*) Does it hurt?

Sample questions: PR-HI-CRPS

I need to concentrate in order to make my affected limbs move.

Always		Often		Some times		Never
6	**5**	**4**	**3**	**2**	**1**	**0**

Pain prevents me from participating in activities throughout my day.

Always		Often		Some times		Never
6	**5**	**4**	**3**	**2**	**1**	**0**

I still enjoy the things I used to enjoy

Strongly agree	Agree	Slightly agree	Neutral	Slightly disagree	Disagree	Strongly disagree
0	**1**	**2**	**3**	**4**	**5**	**6**

Unpublished findings from a pilot trial gives more insights

Characteristics n=39	Mean	SD	Range
Age	45.9	14.4	15 – 76
Duration of injury or pain (in months)	17.9	38.5	1 -- 168
Grip strength (in kgs)	R=24.4 L=26.6	19.2 16.6	0 – 63.3 0 – 54.7
% of normal grip in affected hand	39.1%	29.7	0 – 90.1%
Total MPQ score (tMPQ / 100)	38.3	26.4	0 – 93
PRWHE /100	58.2	24.8	0 – 94
PCS /52	20.8	14.8	0 – 50
CB-HI-CRPS /42	11.0	6.9	1-25
PR-HI-CRPS /260	122.2	57.1	0-223

Characteristic	Frequency	Percentage
Gender	M=20 F=19	M= 51.3% F= 48.7%
Diagnosis	CRPS = 20 PNI = 11 Fracture = 8	51.3% 28.2% 20.5%
Side of injury	R= 25 L= 14	R= 64.1% L= 35.9%
Catastrophizing present (PCS>30)	Yes = 11 No = 28 CRPS + Yes = 7	Yes = 28.2% No = 71.8%

Internal consistency

Independent rater at baseline

CB-HI-CRPS Cronbach's alpha = 0.80

PR-HI-CRPS α= 0.98 total scale

- Symptoms α= 0.95
- Daily function α= 0.95
- Coping/Social Supports α= 0.92

Reliability

Inter-rater reliability n=30

CB-HI-CRPS $ICC_{2,1}$= 0.90 [95%CI 0.81 to 0.95]

Test-retest reliability

CB-HI [n=21 baseline/1 week same evaluator]

$ICC_{2,1}$ =0.87 [95%CI 0.70 - 0.94]

Test-retest reliability [n=27 baseline/1 week]

PR-HI-CRPS $ICC_{2,1}$ =0.94 [95%CI 0.88 - 0.97]

Validity

Do scores on the CB and PR HI-CRPS differentiate between persons with CRPS and those with other diagnoses?

CB-HI-CRPS **p=0.006**, PR-HI-CRPS **p=0.009**
(*CRPS scores were higher*)

Using a cut-point of >10 / 42 on the CB-HI-CRPS **correctly predicts CRPS 65% of the time**

Positive predictive value = 65% [95%CI 49 - 78]

Sensitivity= 68.4 [95%CI 43 - 87]

Specificity= 61.1 [95%CI 36 - 83]

Validity Hypotheses

Construct validity (structural)

r=0.72 CB-HI and PR-HI Symptoms

r=0.67 CB-HI and PR-HI total

r=0.50 CB-HI and PRWHE Pain

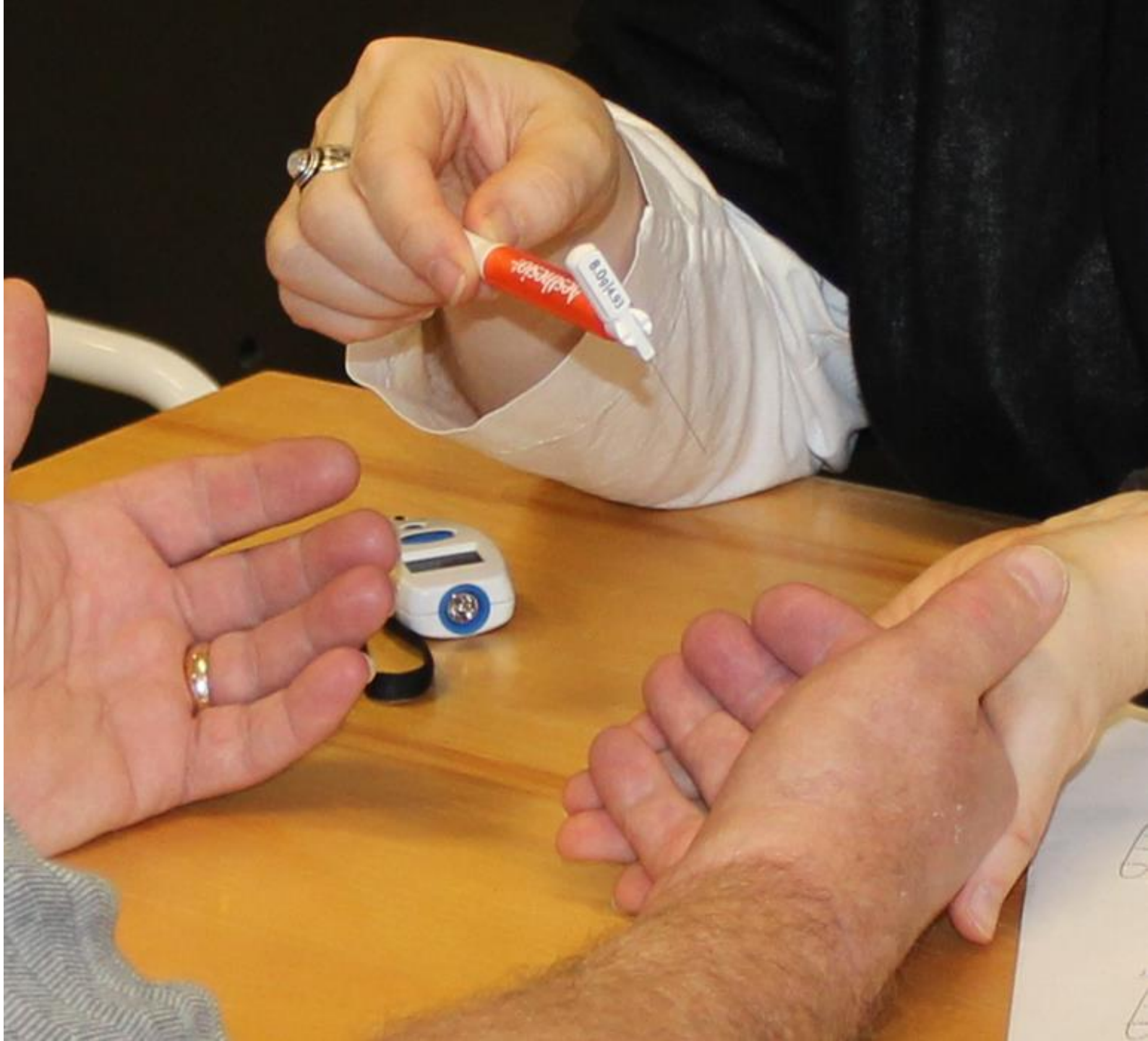
Convergent construct validity

PR-HI-CRPS & PRWHE total scores	r=0.80
PR-HI-CRPS Coping/Social & PCS total score	r=0.73
PR-HI-CRPS Coping/ Social & McGill Pain affective score	r=0.58
PR-HI-CRPS Daily Function and PRWHE disability scores	r=0.67

Assessment techniques

used in

Somatosensory Rehabilitation

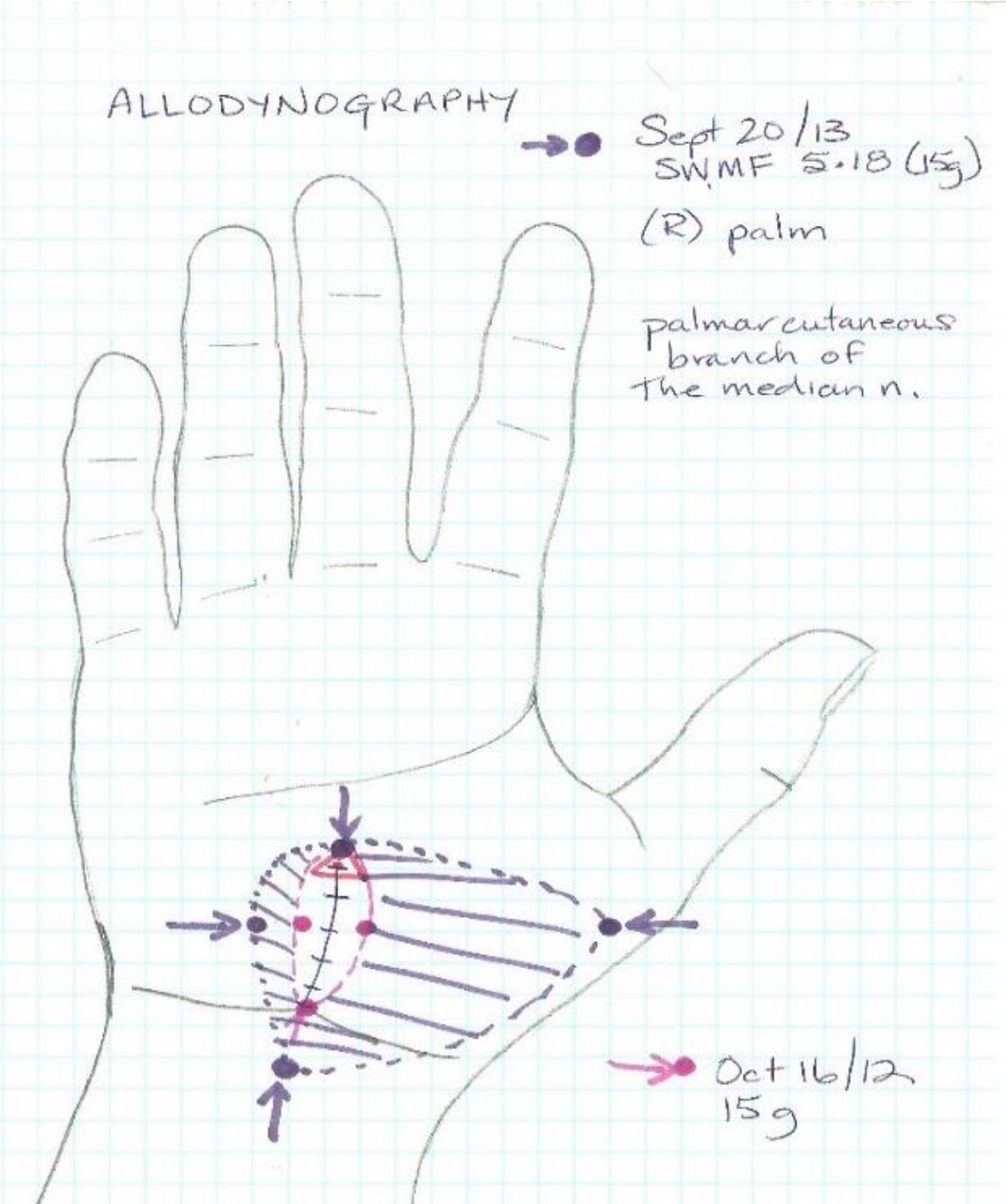


Allodynography

Standardized elements:

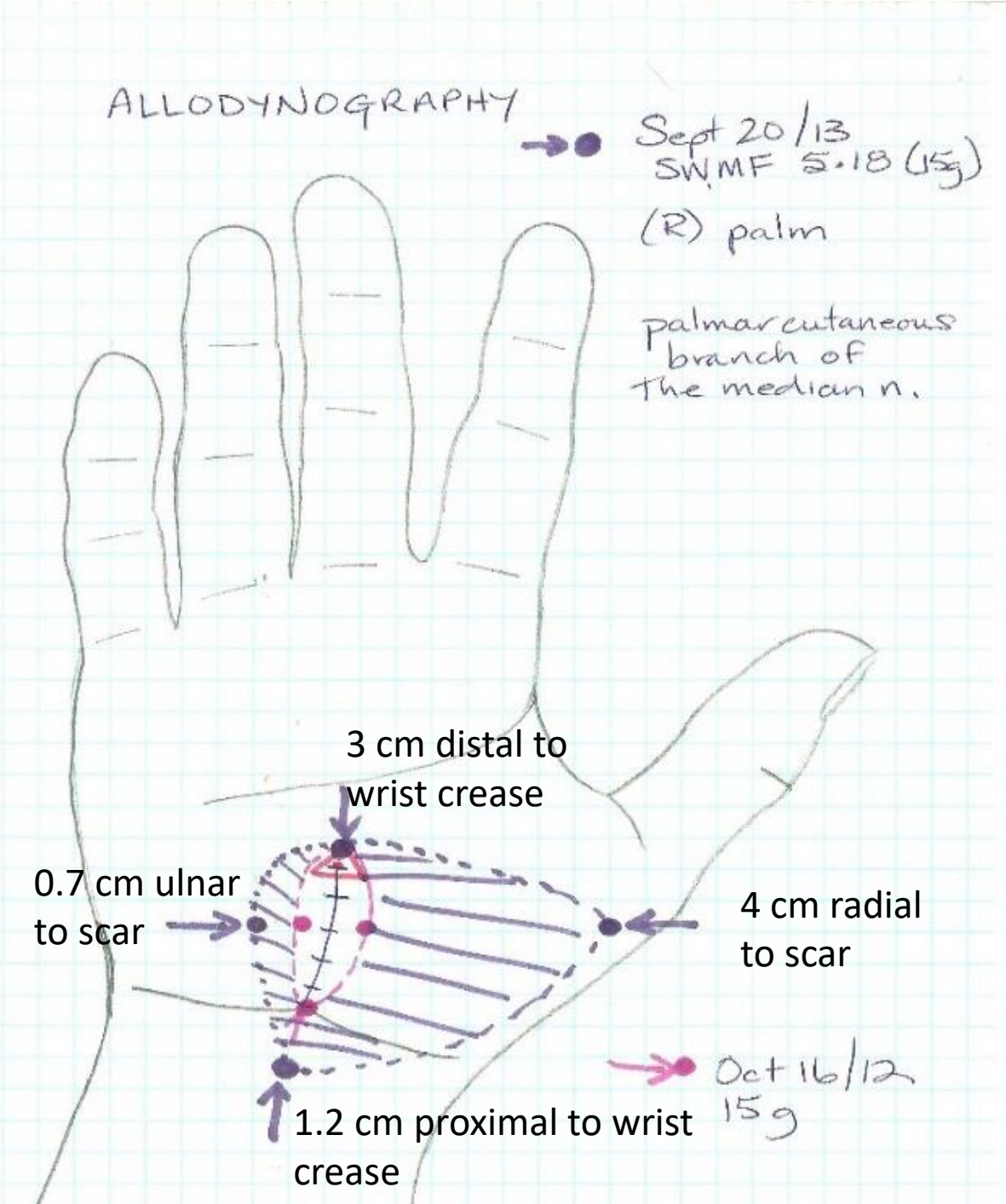
1) map created using 15g (#5.18) monofilament

2) person identifies stimuli as 3/10 on NRS for pain [*OR pain at rest +1*]**



Allodynography

- Start proximal to painful area
- Apply monofilament for 2 seconds in 10 s intervals at 1 cm increments
- Client indicates ‘STOP’ when stimulus becomes painful; this area is marked on map
- Repeat procedure distally, and at end points of horizontal axis
- Measure area using anatomical reference



Reliability of Allodynography

Completed only in consenting participants demonstrating allodynia as defined by a painful response to a static touch with a 15g monofilament

Inter-rater reliability (n=12)

ICC $_{2,1}$ = 0.97 [95%CI 0.90 - 0.99] **single measures**

Test-retest reliability (n=10)

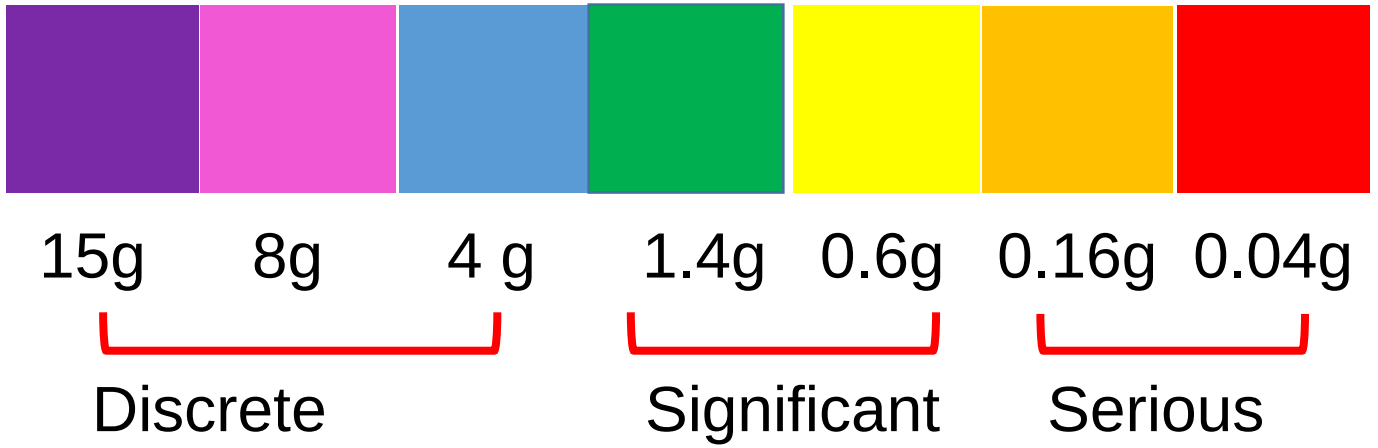
ICC $_{2,1}$ = 0.89 [95%CI=0.59-0.97] **single measures**

**p<0.001 for both

(Packham et al, 2020)

Rainbow Pain Scale

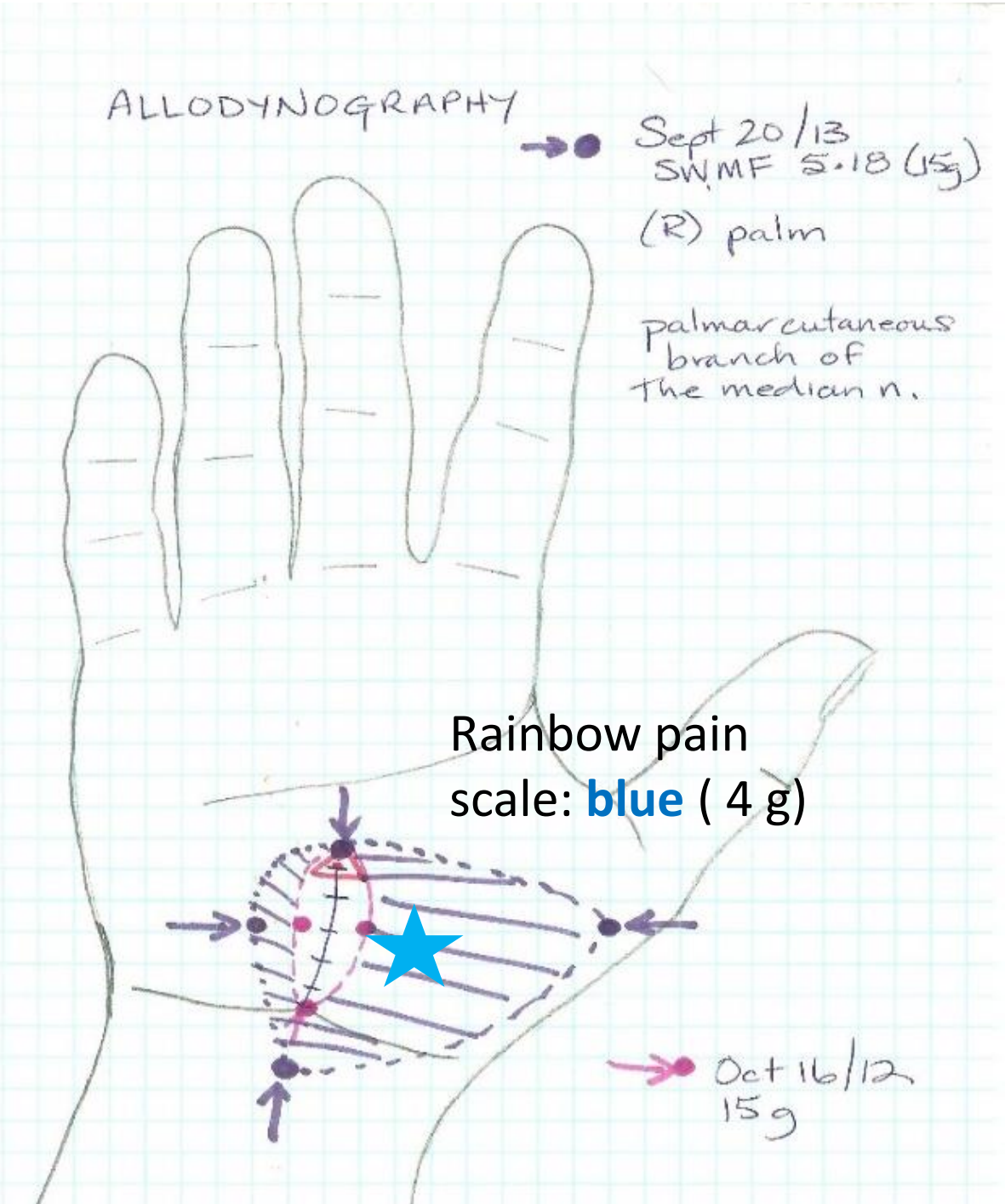
Colours represent the severity of allodynia as represented by the smallest amount of pressure which elicits a painful response *(Spicher et al, 2015; similar to Keizer et al, 2007).*

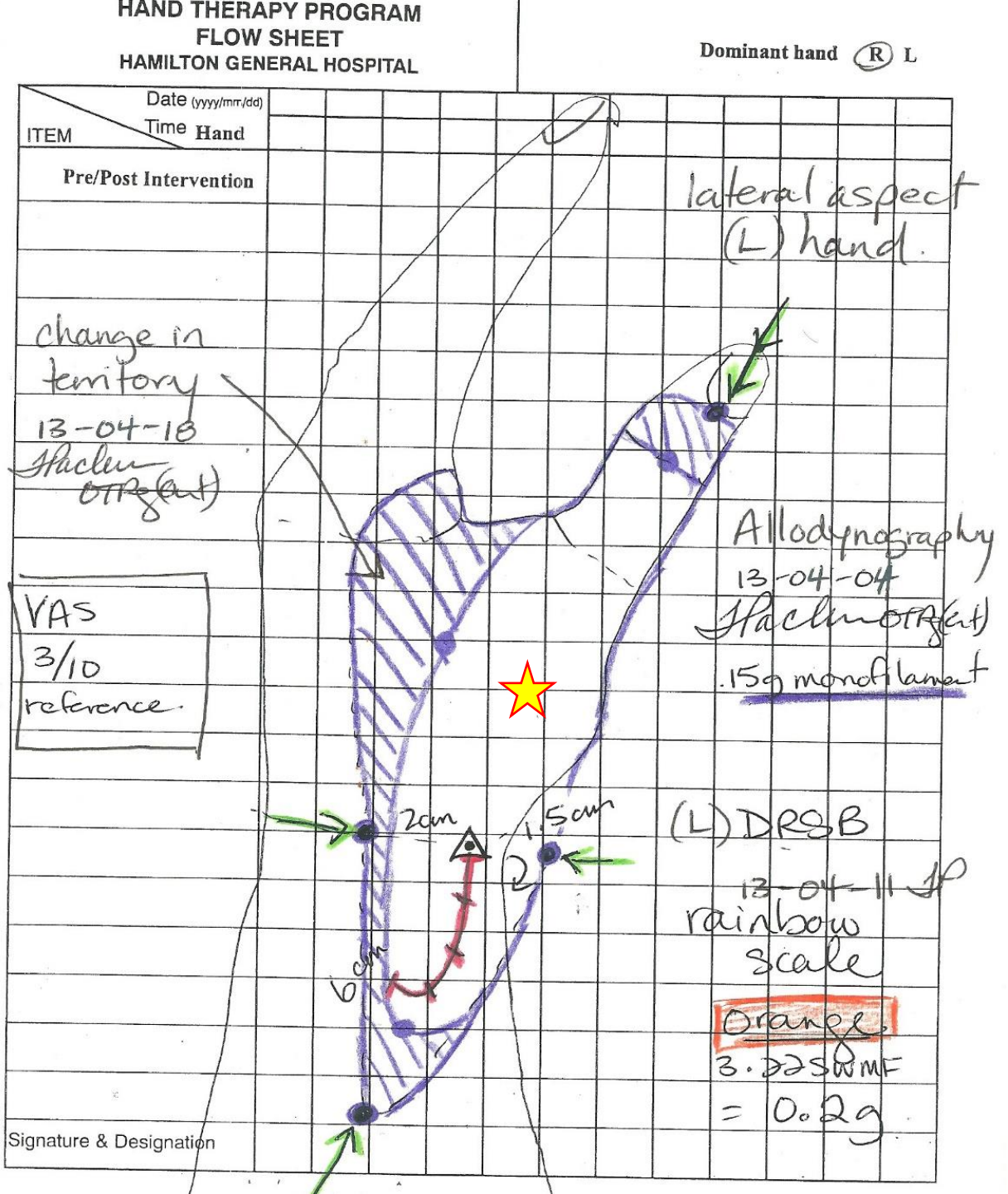


Rainbow Pain Scale

The area tested for the Rainbow pain scale is marked on the allodynography map with a star

‘Colour’ category is also recorded there





Sample allodynography:

Allodynia after thumb CMC arthroplasty for osteoarthritis

Rainbow Pain Scale: reliability

For this evaluation, we also evaluated the reliability of the screening (i.e. identified as having no allodynia)

Inter-rater reliability (n=24)

ICC $_{2,1}$ = 0.79 [95%CI 0.57 - 0.90] **single measures**

Test-retest reliability (n=18)

ICC $_{2,1}$ = 0.82 [95%CI=0.60 - 0.93] **single measures**

$p<0.001$ for all

(Packham et al, 2020)

Other options developed for CRPS

Radboud Evaluation of Sensitivity (RES)

8 items rated on 100mm VAS with anchors of ‘No difference’ to ‘Completely different’ comparing the 2 hands

Combination of patient report and psychophysical testing: 6 items have a standardized sensory stimulus provided

Addresses a need for a simple evaluation of sensation?

Packham TL, MacDermid JC, Michlovitz S, Cup E, Van de Ven Stevens L. **Cross cultural adaptation and refinement of an English version of a Dutch patient-reported questionnaire for hand sensitivity: the Radboud Evaluation of Sensitivity.** *Journal of Hand Therapy 2018; 31(3): 371-380*

Testing in CRPS or hand injuries

Participant demographics RES-E (n=56)

Variable	Mean	SD	Range
Age	44.8	15.5	15 – 76
Time since injury (mos)	27.2	61.5	1 – 294
Grip strength (kgs)	R=28.9 L=26.7	18.4 15.6	0 – 63.3 0 – 60
% of normal grip	44.0	30.2	0 – 100
PRWHE /100	56.3	26.1	0 – 98
RES-E /80	41.8	25.0	1.5 - 80

Key: PRWHE= Patient-Rated Wrist and Hand Evaluation
RES-E= Radboud Evaluation of Sensitivity, English version

Participants had variable presentations

Variable	Frequency	Percentage
Gender	M=27 F=29	M= 48.2 % F= 51.8 %
Diagnosis	Fracture = 19 Tendon = 10 Ligament = 7 Multiple trauma = 6 Nerve = 2 Amputation = 2 Other = 10 **Concurrent CRPS = 25**	33.9 % 17.9 12.5 10.7 3.6 3.6 17.9 **44.6% had CRPS**
Dominance	R= 45 L= 11	R= 80.4 % L= 19.6 %
Side of injury	R= 26 L= 30	R= 46.4 % L= 53.6 %
Hypoesthesia vs. Hyperesthesia	Hypo(Loss)= 30 Hyper(Gain)= 13 Both= 6	Hypo= 61 % Hyper=27 % Both= 12 %

RES-E demonstrated acceptable measurement properties

Test-Retest Reliability (n=36)

$ICC_{(2,1)}$=0.92 [95%CI 0.85 - 0.96]

SEM=7.06 (/80)

Internal consistency: α=0.95

Construct validity: *r*=0.61 RES-E, PRWHE (moderate)

Responsiveness:

Effect size (Cohen's *d)*=0.22 [95%CI -0.67 to 1.09] for RES

ES= -0.35 [95%CI -0.49 to 1.28] for PRWHE

Take-home messages:

No ‘perfect’ solution

Address person-centred priorities

Consider elements that will foster comparisons

Lots of work still to do!

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