



Can we reduce the incidence of complex regional pain syndrome type I in distal radius fractures? The Liverpool experience

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Abstract

Introduction: Complex regional pain syndrome is a multifaceted condition, which is relatively common after distal radius fracture.

Method: A series of audits and service evaluations were conducted from 2004 to 2013 to investigate the incidence of complex regional pain syndrome type I and any correlation to tight, restrictive, over-flexed casts. Simple subsequent clinical and patient management changes were implemented and impact re-evaluated.

Results: These audits have contributed to organisational learning and a subsequent reduction in the incidence of complex regional pain syndrome type I in non-operatively managed distal radius fracture from 25%, in keeping with expected incidence in the relevant literature, to a rare event (<1%).

Conclusion: The authors suggest that careful attention to the prevention of complex regional pain syndrome through staff and patient awareness, vigilance for warning signs and minor modifications to the traditional management of distal radius fractures can significantly reduce the incidence of complex regional pain syndrome type I after distal radius fracture.

Keywords

CRPS, prevention, wrist, distal radius, fracture

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Introduction

Complex regional pain syndrome (CRPS) is a common complication of distal radius fractures (DRFs) reported in prospective studies as occurring in up to 25% of cases.^{1–3} It has the potential to turn a usually benign injury into a chronic, painful and debilitating condition.³ The longevity of the effects of CRPS results in approximately 15% of sufferers experiencing persistent pain and impairment two years after onset.⁴ Ongoing symptoms and a lengthy patient management period often result in high therapeutic and medical costs.^{5,6} As there is no proven cure for CRPS,⁷ at a time when efficiency and throughput are high on the healthcare agenda, early preventative patient management is desirable.

DRFs are one of the most common bony injuries estimated as numbering 71,000 per year in the UK and accounting for 17.5% of all fractures annually, with increasing incidence in an ageing population.^{8,9}

Immobilisation is a universally accepted, effective, simple intervention for the treatment of closed DRF without significant displacement with an acceptable outcome for the majority of patients. However, immobilisation has also been implicated as a risk factor for CRPS, with this hypothesis supported by the fact that immobilisation of healthy limbs can induce features of CRPS such as temperature change, mechanosensitivity and thermosensitivity.^{10,11} Problems such as swelling, tight or restrictive plasters (casts) and hypoxia are associated with greater complication rates, most specifically

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the incidence of CRPS.^{2,12,13} Excessive tightness of casts has long been associated with significant morbidity due to compartment syndromes, plaster sores, joint stiffness and incidence of CRPS. The importance of avoiding this and the benefits of early motion following injury are commonly accepted in clinical practice.

While a degree of flexion at the wrist is sometimes required to maintain position for some unstable DRFs, restrictive and excessively flexed casts (Figure 1) that obstruct finger flexion particularly at the metacarpophalangeal joints (MCPJs) of the hand can exacerbate pain. Full range of movement in these joints, while the wrist is immobilised in a cast (Figure 2) has been shown to be important to maintain range of movement and limit oedema if optimal hand function and full recovery are to be achieved.¹⁴

Recent research suggests rapid changes in limb representation in the sensory and motor cortex with disuse of a limb.¹⁵ Additionally, there is evidence that central sensitisation occurs in CRPS, and somatosensory conflicts have been demonstrated in CRPS patients.^{16,17} The intact sensory motor loop enables the performance of accurate and smooth movements. It is recognised that 'the knowledge of the position of one's limbs plays an essential role within the motor system'.¹⁸ These complex interactions are an essential factor for



Figure 1. Excessively flexed plaster/cast.



Figure 2. Full movement of unaffected joints in plaster/cast.

normal daily functional activity. In CRPS, these interactions are disrupted; however, modifying sensory-motor processing has been shown to improve symptoms in CRPS.¹⁹⁻²¹

The concept presented is that CRPS type I incidence in DRF could be reduced by maintaining a normal body schema in the motor and sensory cortex through normal movement and light function, while in a well-fitting non-restrictive cast.

This paper presents a series of audits and service improvements designed to develop a culture of attention to detail during the casting phase together with a pro-active maintenance of sensorimotor function, which may in turn prevent the development of CRPS.

Methods

A series of service evaluation and audits were undertaken in patients with non-operatively managed DRF between 2004 and 2013, at the Royal Liverpool University Hospital (RLBUHT). Each audit informed the subsequent ones. Patients included in these audits had non-operatively managed closed DRFs, with or without manipulation in adults at RLBUHT, were aged 16 or over. Patients managed operatively or who had open DRFs or who had CRPS type II were excluded.

The first audit was carried out to identify the incidence of CRPS type I after non-operatively managed DRF. This was repeated following the implementation of recommendations (audit 2). An additional audit was triggered by a perceived unexpected rise in CRPS incidence in 2010 (audit 3). Finally, a service evaluation was undertaken to determine the prevalence of CRPS in patients with DRF treated within a 12-month period following implementation of all recommendations in 2013. The studies and recommendations implemented are summarised in Table 1. This work was approved by the audit department of the RLBUHT, complying with trust information governance requirements. Ethical approval was not required.

Audit 1: Incidence of CRPS type I in DRF population on treatment at RLBUHT during a one-month period in January 2004

All patients with a diagnosis of DRF, meeting the inclusion criteria and attending fracture clinic or hand therapy during a one-month period of January, were assessed using a single data collection form to record the following fields: signs and symptoms of CRPS using Bruehl's CRPS diagnostic criteria^{22,23}; patient-reported tight or restrictive cast; clinical observation of tight or restrictive cast and patient-reported incidence of poor

Table 1. Summary of audits and recommendations implemented.

Audit	Date		Recommendations implemented
1	2004	Audit of DRF population on treatment at RLBUHT	<ul style="list-style-type: none"> • DRF patient information leaflet expanded to highlight action to take on tight, restrictive, over-flexed casts and encouraging swelling control and light normal functional activities. • A culture of vigilance and attention to detail with cast management was developed. • CRPS diagnostic criteria and care pathway displayed in clinic areas for all staff. • Formal and informal MDT education.
2	2006	Repeated audit of DRF population on treatment at RLBUHT after recommendations implemented	<ul style="list-style-type: none"> • Continuation of recommendations post study 1. • Creation of 'Local Gold Standard of care for patients presenting with DRF at RLBUHT' (Table 5).
3	2010	Audit of patients with CRPS comparing patient pathway to 'Local Gold Standard of care for patients presenting with DRF at RLBUHT'	<ul style="list-style-type: none"> • Review of rolling programme of MDT training packages (presentations, workshops and written guidance). • Static staff intervention to improve support to trainees during periods of high demand. • Use of visual aids in all clinical areas, e.g. plaster room, ED, clinics (posters to reinforce the messages in patient information leaflets).
4	2013	Service evaluation to identify incidence of CRPS in patients sustaining a DRF with initial attendance at RLBUHT	<ul style="list-style-type: none"> • Clinical specialist physiotherapist/clinical specialist occupational therapist/extended scope physiotherapists in trauma management to act as 'CRPS champions' in trauma clinics to maintain vigilance for CRPS and promote continual awareness and support for MDT.

MDT: multidisciplinary team; CRPS: complex regional pain syndrome; RLBUHT: Royal Liverpool University Hospital; DRF: distal radius fracture; ED: emergency department.

pain control. The incidence of CRPS was determined and correlated with other recorded fields.

Tight casts included those where patient reported tightness, clinicians noted tightness and when casts were changed as a result of a perception of tightness or when patients stated they 'felt claustrophobic in cast'.

Restrictive casts included those where patients reported they could not move their fingers fully; clinicians noted that plasters were obstructing full MCPJ motion and where casts were changed as a result of the perception of restriction of motion in fingers.

Results

A total of 48 patients met the inclusion criteria. Twelve met the Bruehl's diagnostic criteria for CRPS. There was a 25% incidence of CRPS post-DRF in this unit using Bruehl's CRPS diagnostic criteria,^{22,23} which is in keeping with the upper range of incidence quoted in previous studies.¹⁻³ The Fischer exact test²⁴ was used which is indicated for smaller samples and examines the significance of association.

There was a statistically significant, strong correlation between patient reported and clinically observed tight and/or over-flexed casts and the development of CRPS ($P = 0.0001$).

There was a weak correlation between patient-reported and clinically restrictive casts, and the development of CRPS which was not statistically significant

($P = 0.1392$). There was no significant reported difference between those who reported poor or good pain control and CRPS (see Table 2).

Recommendations

The DRF patient information leaflet was expanded to highlight the action to take on tight, restrictive, over-flexed casts and encouraging swelling control and the importance of light normal functional activities. A multidisciplinary culture of vigilance and attention to detail with cast management was developed within the fracture clinic, plaster room and Emergency Department (ED). The recognised CRPS diagnostic criteria and the Trusts care pathway were displayed in all clinic areas to encourage all staff to comply. A rolling programme of formal and informal multidisciplinary team (MDT) education was established.

Audit 2: Repeat audit of DRF population on treatment at RLBUHT after recommendations implemented during a one-month period in January 2006

Following interventions as a result of audit 1 a further audit, utilising the same criteria and method as audit 1 was conducted.

Table 2. Audit of DRF population on treatment at RLBUHT during a one-month period in January 2004.

	CRPS	No CRPS	Significance using Fisher's exact test
Well-fitting cast	1	28	P = 0.0001
Tight/over-flexed cast	11	8	
Total	12	36	
Unrestrictive cast	6	28	P = 0.1392
Restrictive cast	6	8	
Total	12	36	
Good pain control	11	32	P = 0.6330
Poor pain control	1	4	
Total	12	33	

CRPS: Complex regional pain syndrome.

Results

A total of 44 patients met the inclusion criteria. Four met the Bruehl's diagnostic criteria for CRPS. There was a 10% incidence of CRPS post-DRF in this unit using Bruehl's CRPS diagnostic criteria^{22,23} at this time in keeping with the lower range of incidence reported in previous studies.¹⁻³ Only patients with tight or restrictive casts developed CRPS. There was a highly statistically significant correlation between patient reported and clinically observed tight and/or over-flexed casts ($P=0.0001$) and a statistically significant correlation with restrictive casts ($P=0.04$) and the development of CRPS. There was no significant association between those who reported poor or good pain control and CRPS (see Table 3).

Between audits 1 and 2, a number of recommendations were implemented. There was a consequent reduction in the incidence of CRPS from 25% to 10% (see Table 4), which was statistically significant when Fisher's exact test was applied ($P=0.04$).²⁴

Recommendations

Continue as per audit 1 plus development of Local Gold Standard of care for staff guidance (Table 5).

Audit 3: Comparison of patients diagnosed with CRPS after sustaining DRF in January 2010 to 'Local gold standard of care for patients presenting with DRF at RLBUHT'

An individual case note audit was undertaken of patients meeting the inclusion criteria and attending hand therapy

Table 3. Repeat audit of DRF population on treatment at RLBUHT after recommendations implemented during a one-month period in January 2006.

	CRPS	No CRPS	Significance using Fisher's exact test
Well-fitting cast	0	40	$P \leq 0.0001$
Tight/over-flexed cast	4	0	
Total	4	40	
Unrestrictive cast	2	38	P = 0.0357
Restrictive cast	2	2	
Total	4	40	
Good pain control	3	37	P = 0.3268
Poor pain control	1	3	
Total	4	40	

CRPS: Complex regional pain syndrome.

Table 4. Comparison of audits of DRF population on treatment at RLBUHT during a one-month period in January 2004 and 2006.

	CRPS	No CRPS	Significance using Fisher's exact test
Pre recommendations (audit 1)	12	36	P = 0.0397
Post recommendations (audit 2)	4	40	
Total	16	76	

CRPS: Complex regional pain syndrome.

after sustaining a DRF with a diagnosis of CRPS as per Bruehl's criteria.^{22,23} The management record was compared to the 'Local gold standard of care for patients presenting with DRF at RLBUHT' (Table 5). Analysis was undertaken using the following fields: verbal and written information given to patients; staff group seen at initial presentation and follow-up appointments in fracture clinic (static extended scope therapist, rotational trainee grade doctor or static consultant). Information was verified with individual patients verbally to ensure records reflected their experience.

Results

There were a total of 74 DRF that met the inclusion criteria at RLBUHT in January 2010. Eight cases of CRPS diagnosed using Bruehl's criteria were identified in patients sustaining a DRF in January 2010. This is an incidence of 10.8%. Data analysis identified commonalities: all DRF patients who developed CRPS were assessed and managed

Table 5. 'Local Gold Standard of care for patients presenting with DRF at RLBUHT.

1. Do not immobilise DRF excessively or unnecessarily.
2. Ensure plasters are well-fitting and comfortable avoiding over-flexion, sharp edges and ensuring there is no restriction to MCPJs.
3. Encourage hourly full range composite grip/release exercises to control swelling in elevation.
4. Encourage light function and attention to limb while in plaster.
5. All verbal information given is to be supported with a patient information leaflet.
6. All advice given is to be recorded in patient notes.
7. Patients reporting tight and/or restrictive plasters should **always** have their plaster changed.
8. Patients requesting repeated change of plaster or reporting 'claustrophobia in plaster' to trigger immediate referral to specialist physiotherapist within fracture clinic.

DRF: distal radius fracture; MCPJ: metacarpo-phalangeal joint.

by trainee-grade medics (from foundation through to senior trainees). None of the staff were working in the unit at the time of previous audits.

None of the patients who developed CRPS had direct contact with a permanent member of staff until CRPS was diagnosed. Contrary to local gold standard, there was no recorded evidence of patient information leaflet or verbal advice highlighting action to take on tight, restrictive, over-flexed casts or advice regarding swelling control and maintaining light normal functional activities given to these eight patients. These findings were verbally verified with patients.

The findings demonstrated that patients who developed CRPS had not been reviewed in fracture clinic by static (permanent) or senior staff and the usual care pathways had not been followed (with patient information not being given in verbal or written format).

Recommendations

The rolling programme of MDT training was reviewed with the development of a training package (presentations, workshops and written guidance). Static staff intervention was formalised to ensure improved support to trainees during periods of high demand. Visual aids were designed and utilised in all clinical areas as in audit 1 (posters to reinforce the messages in patient information leaflets).

Audit 4: Incidence of CRPS I in patients sustaining DRF with initial attendance at RLBUHT during 2013

A medical and hand therapy prospective and retrospective case note and clinical coding review were

undertaken for the period January to December 2013 for all patients meeting the inclusion criteria and attending RLBUHT to identify any patients who had sustained a DRF and were diagnosed with CRPS as per Budapest criteria (updated diagnostic criteria replacing Bruehl's).²⁵

Results

In 2013, a total of 324 DRF met the inclusion criteria at the RLBUHT. Only one patient presenting for initial management at RLBUHT developed CRPS. One additional patient presented at RLBUHT one week post-fracture (initial treatment elsewhere) with CRPS features already present. This patient had a tight cast which was changed at presentation to our unit. The incidence of CRPS in DRF in our unit in 2013 was <1% (0.6%), which is significantly lower than the incidence quoted in previous studies and in our own unit.¹⁻³

Recommendations

Static senior therapist staff to act as 'CRPS champions' in trauma clinics to maintain vigilance for CRPS and promote continual awareness and support for MDT.

Discussion

The incidence of CRPS in DRF at RLBUHT in 2004 was 25%, in keeping with the upper range of CRPS incidence after DRF reported in the literature.¹⁻³ Previous research supporting DRF and tight and restrictive casts as risk factors for CRPS was reflected in our findings.^{2,13,26}

After the introduction of comprehensive programme of patient information, staff education, developing a team culture of zero tolerance for tight, restrictive or over-flexed casts and encouraging early light function in cast, the incidence of CRPS post-DRF fell to 10% in keeping with the lower range of CRPS incidence after DRF reported in the literature.¹⁻³ The introduction and dissemination of a local gold standard and introduction of a culture of vigilance for and action on identifying early problems resulted in a further reduction of incidence of CRPS after DRF of <1%, far lower than that reported in the literature.¹⁻³

While a degree of wrist flexion might be desirable to maintain reduction of an unstable DRF, in our clinical practice, flexion is only rarely used in the first two weeks post-fracture and considered excessive if the patient reports discomfort or a change in sensation in the fingers and hand and is unable to fully flex fingers. This is based on expert opinion and

case-based experience rather than hard science. It is not possible from these studies to conclude whether it is a reduction of compression on neurovascular structures or the improved function offered by optimal casting or a combination of all elements of the gold standard that has resulted in a reduction in CRPS. It does, however, suggest some interesting future research areas.

It is possible that changes in limb representation in the sensory and motor cortex may account for some patients being unaware that their cast is too tight or restricting other joints. The authors speculate that maintaining light function, while in a cast may reduce maladaptive changes in limb representation in the sensory and motor cortex. The authors speculate further that this can be facilitated by the maintenance of unrestricted, unaffected joint mobility, avoiding extreme cast positions of flexion and should be supported by written and verbal advice.

This concept in addition to attentive cast management forms the basis of the early intervention and re-education of fracture patients attending RLBUHT as clinically components of the above are often recognised immediately post trauma. They have been recorded within the first week or month of symptom onset within the literature.¹⁸

The trauma orthopaedic and therapies units at RLBUHT have observed that addressing these altered perceptions, positional awareness and feelings towards the limb early in the rehabilitation period (even in a cast) can result in their rapid reversal. The practice knowledge gained from undertaking these audits has resulted in subtle practice refinements within our unit. Picking up verbal and visual clues from the patient earlier, such as overprotection of limb, neglect of limb, reporting feeling 'claustrophobic in cast', and subsequent prompt action have become embedded in everyday clinical practice reinforcing a culture of prevention of CRPS.

Although high pain levels are usually described in CRPS, audits 1 and 2 did not demonstrate a strong correlation between high pain levels and the development of CRPS. However, anecdotally and in clinical practice, a high pain score has for many years initiated early preventative treatment at RLBUHT and continues to be one of the early warning signs to commence immediate intervention. This is supported by recent research where patients with CRPS had significantly more pain in the early stages following their trauma than patients without CRPS.^{11,27} The authors recognise that the way they asked patients about their pain control was a weakness and may have affected the results as patients may not have the same expectations as healthcare professionals of what is adequate pain control in a cast after DRF.

Limitations

The authors did not record male to female ratio of patients, as the purpose of these audits was to evaluate the incidence of CRPS captured at comparative timeframes in a consistent population. However, it is widely recognised that the incidence of both DRF and CRPS is higher in women. The authors recognise that some CRPS patients may have been lost to follow-up through self-discharge or transfer of care to other providers. While these audits were small and limited to a single unit, there was a significant improvement noted after the instigation of a number of simple recommendations. There are limitations to what can be concluded as the findings are based on audit, service evaluation and expert reflection in a single unit. It is not possible to infer cause and effect from individual elements as several interventions were introduced concurrently. The findings and the results of the interventions are, however, interesting and support future multicentre research. Furthermore, they highlight a problem which is poorly recognised and indicate that making simple, realistic, useful and low-cost recommendations may result in potentially high cost savings for the NHS and society.

Recommendations for clinical practice

The authors recommend a simple gold standard of care for patients with DRF be introduced in all units managing trauma (Table 5).

The use of the International Association for the Study of Pain²⁸ accepted CRPS diagnostic criteria (formally known as Budapest criteria, which replaced Bruhl's diagnostic criteria) as a simple assessment tool visible in clinic areas ensures that diagnosis is consistent (Appendix 1.)

Staff education for the whole MDT is of paramount importance with support for new and rotational staffs including visual reminders of key elements of good care, care pathways for suspected problems and diagnostic criteria for CRPS helping to ensure consistency of care.

Good cast management for DRF is not a passive treatment. This is particularly important when patients do not recognise that their cast is restrictive or tight. Immediate attention to casts that are perceived or observed to be tight is recommended.

It is important to ensure that the patient leaves clinic in a cast with full finger mobility, understanding the importance of maintaining movement, light function and oedema control to prevent complications. It is not enough to tell them to do it. It should be practised and observed.

Equal weighting needs to be given to written, visual and verbal communication and pictures should be used wherever possible supporting patients and all staff

groups by acting as prompts. An example of a patient information leaflet from 2011 can be found in the appendices of the Royal Colleges CRPS guidelines 2012 or more recent leaflets from the corresponding author.¹⁰

Further multicentre research is recommended investigating the impact on neurovascular function of excessive flexion in a cast, fit of the cast and the maintenance of normal sensorimotor input while in a cast and its association with CRPS.

Conclusions

While it is not realistic to prevent all cases of CRPS following DRF, these audits indicate that the incidence can be reduced significantly with simple low-cost measures and attention to detail. This has significant benefits to patients and potential cost savings to a service, the NHS and society.

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Appendix I. RLBUHT diagnostic criteria assessment form using Budapest criteria

- A. The patient has continuing pain which is disproportionate to any inciting event.
- B. The patient has at least one sign at time of evaluation in two or more of the categories.
- C. The patient reports at least one symptom in three or more of the categories.
- D. No other diagnosis can better explain the signs and symptoms.

Hyperalgesia is when a normally painful sensation (e.g. from a pinprick) is more painful than normal.

Hyperesthesia is when the skin is more sensitive to any sensation than normal.

In category 4, the decreased range of motion/motor dysfunction is not due to pain, nerve damage, joint or skin problems. This is a special feature of CRPS and is due to a poorly understood, disturbed communication between the brain and the limb. A helpful question to ask is: 'If I had a magic wand to take your pain away, could you then move your... (e.g. fingers)' many patient will answer 'no' to that question.

Distinction between CRPS 1 (no nerve injury) and CRPS type 2 (major nerve injury) does not affect management pathway but should be noted.

About 10% of patients cannot recall a specific trauma (inciting event) but can be diagnosed appropriately with CRPS.

Additional signs of 'neglect' or 'disconnection' of a limb (similar to those exhibited in CVA patients, e.g. ignoring limb or hiding limb in a glove) and/or feelings of 'dislike' or 'rejection' of a limb may be expressed or may be evident during examination. These are not uncommon with patients with CRPS.

Category		Sign (you can see or feel a problem)	Symptom (the patient reports a problem)
1. 'Sensory'	<i>Allodynia</i> (to light touch and/or temperature sensation and/or deep somatic pressure and/or joint movement) and/or <i>hyperalgesia</i> (to pinprick)	<input type="checkbox"/>	<i>Hyperesthesia</i> does also qualify as a symptom <input type="checkbox"/>
2. 'Vasomotor'	Temperature asymmetry and/or skin colour changes and/or skin colour asymmetry	If you notice temperature asymmetry: must be > 1°C <input type="checkbox"/>	<input type="checkbox"/>
3. 'Sudomotor/oedema'	Oedema and/or sweating changes and/or sweating symmetry	<input type="checkbox"/>	<input type="checkbox"/>
4. 'Motor/trophic'	Decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair/nail/skin)	<input type="checkbox"/>	<input type="checkbox"/>

Notes: *Allodynia* is when a normally painless sensation (e.g. touching the skin) is now painful.