# Changes in pain catastrophization and neuropathic pain following operative stabilisation for patellofemoral instability

Smith, TO.; Choudhury, A.; Fletcher, J.; Choudary, Z.; Mansfield, Michael; Tennent, D.; Hing, CB

*DOI:*
10.1007/s00264-021-05046-w

# Changes in pain catastrophization and neuropathic pain following operative stabilisation for patellofemoral instability: a prospective study with twelve month follow-up

**T. O. Smith[1,2] · A. Choudhury[3,4] · J. Fletcher[4] · Z. Choudhury[5] · M. Mansfield[6] · D. Tennent[3] · C. B. Hing[3]**

## Introduction

Patellofemoral instability (PFI) is a disabling condition. The annual incidence of primary patellar dislocation is 43/100,000 in children under 15 years [1, 2]. The incidence is lower in the second and third decade of life, estimated at seven per 100,000 [3]. Females are more likely to be affected than males, and there is an increased risk in the athletic population due to their sporting demands [4]. Addi- tionally, 70–90% of patients with PFI complain of pain [5]. Recurrent dislocation can have a major impact on quality of life [6–9]. Patellar dislocation can be very painful, but may also be episodic. In between dislocation episodes, patients frequently reported that their patella feels unstable and about to dislocate (PFI). This leads to activity modification and restriction [8, 10].

The management of patients with PFI has improved through a better understanding of the functional anatomy of the patellofemoral joint and accurate assessment of the underlying pathophysiology [11, 12]. Conservative management is the first-line treatment for these patients. This generally involves physiotherapy and rehabilitation, with the aim of targeting neuromusculoskeletal deficits through exercise therapy [12]. Surgical intervention is considered for individuals where conservative management has been unsuccessful, with persistent pain and/or instability [2, 13].

Persistent knee pain post-surgery is a complex phenom- enon. Underlying mechanisms within the peripheral and central nervous systems alter the transduction and process- ing of sensory inputs and are directly associated with the experience of knee pain and associated symptoms [14–16]. Neuropathic pain is defined as pain initiated or caused from damage or disease of the somatosensory nervous system [17]. It can develop from chronic pain states, such as chronic patellar symptoms, or after surgical procedures [18–22]. Previous literature has reported the association between a conditioning pain modulating response (with neuropathic pain being one example of this) and pain catastrophizing for people with chronic low back pain [23]. Pain carastro- phizing has been defined as a negative cognitive-affective response to anticipated or actual pain [24]. Individuals who have catastrophizing health beliefs around pain [25], anxiety and depression and pain at other sites are at a greater risk of post-operative persistent pain [26].

There is limited evidence on the relationship between neuropathic pain, catastrophizing beliefs and knee surgery outcomes. Sanchis-Alfonso et al. [27] previously reported the association between pain, psychosocial factors and sur- gical outcomes with 17 patients following patellofemoral stabilisation surgery. Whilst catastrophising symptoms have been reported in this cohort, neuropathic pain has not been explored. Given the association between these symptoms and poor outcome following operative stabilisation and reha- bilitation, and uncertainty on how prevalent pain catastro- phizing and neuropathic pain is within the PFI population, the purpose of this study was to understand both the preva- lence of these clinical features and how they may change pre- to post-operative stabilisation.

## Materials and methods

This was a registered prospective clinical audit (Clinical Audit Number: AUDI000887). With this approval, we gath- ered data from 84 patients with recurrent instability who were surgically managed after two or more episodes of patel- lar dislocation or episodes of subluxation.

One surgeon (CH) operated on all patients with a medial patellofemoral ligament (MPFL) reconstruction, a Dejour

trochleoplasty or a combination of both with or without a tibial tubercle osteotomy. The decision-making of stabilisa- tion methods was chosen based on an each patients indi- vidual patho-anatomy and shared decision-making between surgeon and patient, as recommended by Thompson and Metcalfe [28]. Surgical procedures undertaken are presented in Table 1. In brief, 42 (50%) of patients underwent a MPFL reconstruction, six (7%) had an isolated trochleoplasty, 13 (16%) underwent a combined trochleoplasty and MPFL reconstruction for trochlear dysplasia (Table 1). All patients followed a routine, exercise-based rehabilitation programme tailored to the individual patient's goals. Rehabilitation was delivered in an out-patient physiotherapy setting with the frequency and duration dictated by the shared patient and physiotherapist goals.

Data were collected by the surgical team which included patient demographics, family history of patellar instability, number of previous patellar dislocations and data of initial and last dislocation, hypermobility assessed using the Beig- hton criteria [29], Apprehension test [30] and J-Sign test [31], knee flexion–extension range of motion and observable lateral tracking. Patients completed a Pain Catastrophizing Score [32], painDETECT score [33], Norwich Patellar Insta- bility (NPI) score [10] and a Kujala Patellofemoral Disorder Score [34] pre-operatively and at 12 months post-opera- tively. Whilst the NPI [10] and Kujala Patellofemoral Disor- der Scores [34] were designed for people with patellofemo- ral disorders, we acknowledge that the Pain Catastrophizing Score [32] and painDETECT [33] scores were designed for those with musculoskeletal pain and particularly low back pain. There are no specific catastrophizing scores or neuro- pathic pain scores for people with patellofemoral pain [17, 35]. Accordingly it was feel appropriate to use these vali- dated score for this population. All data were gathered and anonymised in accordance to the trust audit approval.

### Data analysis

Data were analysed using descriptive statistical tests includ- ing comparisons of the mean scores and standard deviations (SD). The prevalence of pain catastrophizing and neuro- pathic pain were determined using previously reported clinically meaningful cut-points. Using the painDETECT questionnaire, a total score of $\geq$ 19 represents "positive neu- ropathic" and $\leq$ 12 is classified as "negative neuropathic" [33]. Scores 13 to 18 are classified as "unclear" [32]. A total score of $\geq$ 30 represents catastrophizing using the Pain Catastrophizing Score [32]. Changes in clinical outcomes between pre- to 1 year post-operatively were analysed using a paired Student's *t* test as the data were normally distrib- uted. A $p$ value of $< 0.05$ was used to deemed statistical sig-nificance. All analyses were undertaken using SPSS version 25.0 (IBM® SPSS, New York, USA).

No studies have previously reported neuropathic pain for people with PFI. Accordingly it was not possible to base the sample size calculation on previous evidence. However, this was based on data from people with chronic knee pain. Based on a prevalence of neuropathic pain in people with chronic knee pain ranging from 6 to 28%, with a 10% preci- sion, the required sample size would vary from 22 [36] to 62 [37], where width of confidence interval was two SD. We therefore felt a cohort size of 84 from our clinical audit, would provide a robust estimation of prevalence of neuro- pathic pain and catastrophization following PFI surgery.

## Results

### Participant characteristics

The characteristics of the cohort are summarised in Table 2. In total, 84 participants were eligible for the study, 20 males (24%) and 64 females (76%). Mean age of participants was 26 (SD: 8) years at the time of surgery. Pre-operatively 54 participants (64%) had a positive patellar Apprehension test. Fifty-one (61%) had a negative J-sign test, 56 (66%) patients had a lateral tracking patella and 25 (30%) of these patients were recorded as having pain pre-operatively.

### Pre-operative to one year post-operative scores

The clinical outcomes for the 84 participants are summarised in Table 3. Comparing pre-operative to post-operative scores at one year from surgery, there was no significant change in painDETECT mean scores ($P$ = 0.72). This changed from a mean score of 7.3 (SD: 6.9) to post-operatively 7.8 (SD: 7.6). There was a statistically significant change in Pain Catastrophizing Score ($P$ = 0.02). This decreased from 18.9 (SD: 16.7) to 15.7 (SD: 15.4) post-operatively at one year

The prevalence of clinically meaningful pain catastrophizing scores changed over time. This decreased from 31% (26/84) pre-operatively to 24% (20/84) post-operatively. There was limited change over time in the prevalence of positive neuro- pathic pain when measured by the painDETECT thresholds. For this measure, 10% (8/84) of the cohort presented with positive neuropathic pain scores pre-operatively, whereas this was 11% (9/84) post-operatively.

Mean NPI scores significantly improved over the one year follow-up period ($P < 0.01$). These changed from 90.2 (SD: 58.6) to 61.9 (SD: 61.6). Similarly, there was a significant improvement in the Kujala Patellofemoral Disorder Scores over this follow-up period ($P = 0.01$). Mean Kujala Patel- lofemoral Disorder Score increased from 48.7 (SD: 26.2) to 58.1 (SD: 21.3). On clinical examination at one year post-operatively, 74 (88%) of participants reported they felt greater patellar stability. In total 48 (57%) reporting no pain at one year.

## Discussion

This study found that whilst catastrophizing symptoms reduce post-operatively following patellofemoral stabilisa- tion surgery, there is no change in neuropathic pain for these patients. The wider functional outcomes, as assessed by NPI score and Kujala Patellofemoral Disorder Score translate to improvements in catastrophizing. Neuropathic pain and catastrophizing symptoms are not commonly reported and did not significantly change following surgery. Whilst these associations are reported, it remains unknown what this is attributed to, i.e. surgical intervention, rehabilitation or a combination of the two through the recovery process. Fur- ther exploration to better determine this effect-modification is warranted.

As reported, mean pain catastrophizing scores signifi- cantly reduced over the follow-up period. This mirrors Sanchis-Alfonso's et al. [27] findings in their cohort of 17 patients following patellofemoral stabilisation surgery. They concluded that pain catastrophizing scores reduced following surgery ($P < 0.001$) [27]. This was reflected by our study. Our study size was larger ($n = 84$) and provided important information on both pain and catastrophizing and how it relates to functional change.

Pain catastrophizing has been previously reported in cohorts including patellofemoral pain [38], anterior cruci- ate ligament reconstruction [39] and osteoarthritis [40]. However, previous literature has been limited with rela- tion to pain catastrophizing and PFI. The results from this study indicate that pain catastrophizing can present in people with patellar instability (prevalence pre-opera- tively: 31%), and surgical intervention may improve this (prevalence post-operatively: 24%). This may be because stabilisation surgery provides the patient with an oppor- tunity to move and function with a structurally more stable patella, thereby allowing them to gain a health belief that their symptoms are improving when under functional demand. Through this, the concerns regard- ing kinesophobia and catastrophizing to symptoms may diminish post-operatively. Further exploration regarding the exact mechanisms to which catastrophizing symptoms and mechanical stability enact, would be advantageous, particularly given the proportion of individuals who still experience this problem post-operatively. This could inform both identification for surgical candidates, but also provide insights into how people who do experience catastrophizing may be better supported in their rehabili- tation post-operatively.

Jenson et al. [41] suggested that in theory, this cohort should present with patients who have neuropathic pain. Their cohort of patients with chronic patellofemoral pain syndrome frequently presented with "positive neuropathic pain" components such as lower thermal detection and pain thresholds [41]. Our cohort reported low neuropathic pain scores with a relatively low prevalence of this in the PFI population post-operatively (11%). We reported a mean score of 7.3 and 7.8 for pre- and post-operatively, respectively ("negative neuropathic" symptoms). This low prevalence and overall neuropathic pain score may account for why we reported no clear difference in neuropathic pain scores, particularly as the cohort reported "sub-neu- ropathic" scores. Examination of a large cohort, targeting those specifically with a neuropathic involvement, may provide a clearer understanding on whether neuropathic pain changes over time with this cohort. Alternatively, it may be that neuropathic pain is low in this population. This may be on account of the principal symptoms for PFI being instability and not pain [8]. Further considera- tion of the importance of neuropathic pain may therefore be of value.

### Strengths and limitations

This study presents with strengths and limitations. Given that PFI is a relatively rare condition, a strength of this study is that it is a single surgeon audit of the largest cohort pre- viously reporting key psychological outcomes

following patellofemoral surgery. Furthermore, the cohort reported underwent the same pre-operative analysis and indications for surgical treatment with the same post-operative reha- bilitation and follow-up protocol to aid standardisation. However, external validity may have been improved by reporting cohorts from other sites. The decision on what stabilisation methods used was made by the single partici- pating surgeon. This reflects the audit design of this study. It is not possible to ascertain differences in outcomes by surgical procedure as the data were underpowered to do so, but there is potential bias for such analysis by surgical selec- tion bias. Accordingly, a randomised control trial may be indicated to formally assess this, in order to minimum such bias. Thirdly, we did not assess wider psychological fac- tors such as anxiety and depression. There is also the issue that other psychological features such as anxiety, depression and fear of pain may confound catastrophizing. However, a number of papers have shown that although factors such as depression strongly correlate with pain catastrophizing, it is distinct. When depression is controlled for, pain catastro- phizing remains a good predictor of pain [32, 42]. Consid- eration of different psychological factors may be prudent in future assessment. Finally, the number of participants with clinically meaningful pain catastrophizing scores, and neu- ropathic pain was relatively low (24 and 11% of the cohort at follow-up). Accordingly, the results may be attributed to a type two statistical error, particularly for the assessment of neuropathic pain. Examination of these variables with a larger cohort may provide further data to reflect on these indicative findings.

## Conclusions

Neuropathic pain is not commonly reported in people with PFI and does not change following surgical procedures. However, people following patellofemoral stabilisation sur- gery may report reduced pain catastrophizing and improved functional outcomes.

**Authors'contributions** Toby O Smith: Study analysis, preparation and review of the manuscript.

Aliya Choudhury: Data gathering, study analysis and preparation of the manuscript.

Joshua Fletcher: Preparation and review of manuscript. Zareen Choudhury: Preparation and review of manuscript.

Michael Mansfield: Preparation and review of manuscript. Duncan Tennent: Preparation and review of manuscript. Caroline B Hing: Study design, preparation and review of the

manuscript.

**Funding** The authors received no funding to undertake this work.

**Data availability** Data and statistical code will be released on reason- able request to the corresponding author.

## Declarations

**Ethical approval** Approval for this clinical audit was obtained from the XXXXX Hospital (XXXXX) Clincal Audit Department (Ref: AUDI000887).

**Consent to participants** Consent for participants was obtained as part of the audit approval consent processes.

**Consent for publication** Consent for publication from participants was obtained as part of the audit approval consent processes.

**Conflict of interest** No conflict of interest to declare.

## References

1. Nietosvaara Y, Aalto K, Kallio PE (1994) Acute patellar disloca- tion in children: incidence and associated osteochondral fractures. J Ped Orthop 14:513–515

2. Saccomanno MF, Sircana G, Fodale M, Donati F, Milano G (2016) Surgical versus conservative treatment of primary patel- lar dislocation. A systematic review and meta-analysis. Int Orthop 40:2277–2287

3. Atkin DM, Fithian DC, Marangi KS, Stone ML, Dobson BE, Mendelsohn C (2000) Characteristics of patients with primary acute lateral patellar dislocation and their recovery within the first 6 months of injury. Am J Sports Med 28:472–479

4. Fithian DC, Paxton EW, Stone ML, Silva P, Davis DK, Elias DA, White LM (2004) Epidemiology and natural history of acute patellar dislocation. Am J Sports Med 32:1114–1121

5. Bolgla LA, Boling MC, Mace KL, DiStefano MJ, Fithian DC, Powers CM (2018) National Athletic Trainers' Association Posi- tion Statement: Management of individuals with Patellofemoral Pain. J Athlet Training 53:820–836

6. Sanders TL, Pareek A, Hewett TE, Stuart MJ, Dahm DL, Krych AJ (2018) High rate of recurrent patellar dislocation in skeletally immature patients: a long-term population-based study. Knee Surg Sports Traumatol Arthrosc 26(4):1037–1043

7. McGuine TA, Winterstein AP, Carr K, Hetzel S (2014) Changes in health-related quality of life and knee function after knee injury in young female athletes. Orthop J Sports Med 2(4):2325967114530988

8. Smith TO, Donell ST, Chester R, Clark A, Stephenson R (2011) What activities do patients with patellar instability perceive makes their patella unstable? Knee 18:333–339

9. Magnussen RA, Verlage M, Stock E, Zurek L, Flanigan DC, Tompkins M et al (2015) Primary patellar dislocations without surgical stabilization or recurrence: how well are these patients really doing? Knee Surg Sports Traumatol Arthrosc:2–6.

10. Smith TO, Donell ST, Clark A, Chester R, Cross J, Kader DF et al (2014) The development, validation and internal consistency of the Norwich Patellar Instability (NPI) score. Knee Surg Sports Traumatol Arthrosc 22:324–335

11. Smith TO, Donell S, Song F, Hing CB (2015) Surgical versus non-

surgical interventions for treating patellar dislocation. Cochrane

Database Syst Rev 26:CD008106

12. Subramanian P, Patel R (2016) Patellofemoral instability: an over-

view. Orthop Traumatol 33:119–126

13. Rhee SJ, Pavlou G, Oakley J, Barlow D, Haddad F (2012) Modern

management of patellar instability. Int Orthop 36:2447–2456

14. Fingleton C, Smart K, Moloney N, Fullen BM, Doody C (2015) Pain sensitization in people with knee osteoarthritis: a systematic

review and meta-analysis. Osteoarthr Cartil 23:1043–1056

15. Thakur M, Dickenson AH, Baron R (2014) Osteoarthritis pain: nociceptive or neuropathic? Nat Rev Rheumatol 10:374–380
16. Woolf CJ (2011) Central sensitization: implications for the diag-

nosis and treatment of pain. Pain 152:S2–S15

17. Callin S, Bennett MI (2008) Assessment of neuropathic pain.

Contin Educ Anaesth Crit Care Pain 8:210–213

18. Buchanan G, Torres L, Czarkowski B, Giangarra CE (2016) Cur- rent concepts in the treatment of gross patellofemoral instability.

Int J Sport Phys Ther 11:867–876

19. de Oliveira V, de Souza V, Cury R, Camargo OP, Avanzi O, Sev-

erino N, Fucs P (2014) Medial patellofemoral ligament anato- my: is it a predisposing factor for lateral patellar dislocation? Int Orthop 38:1633–1639

20. Goubert D, Danneels L, Cagnie B, Van Oosterwijck J, Kolba K, Noyez H et al (2015) Effect of pain induction or pain reduction on conditioned pain modulation in adults: a systematic review. Pain Pract 15:765–777
21. Klyne DM, Schmid AB, Moseley GL, Sterling M, Hodges PW (2015) Effect of types and anatomic arrangement of painful stim- uli on conditioned pain modulation. J Pain 16:176–185
22. Kurien T, Arendt-Nielsen L, Petersen KK, Graven-Nielsen T, Scammell BE (2018) Preoperative neuropathic pain-like symp- toms and central pain mechanisms in knee osteoarthritis predicts poor outcome 6 months after total knee replacement surgery. J Pain 19:1329–1341
23. Christensen KS, O'Sullivan K, Palsson ST (2020) Conditioned pain modulation efficiency is associated with pain catastrophizing in patients with chronic low back pain. Clin J Pain 36:826–832
24. Quartana PJ, Campbell CM, Edwards RR (2009) Pain catastro- phizing: a critical review. Expert Rev Neurother 9:745–758
25. Burns LC, Ritvo SE, Ferguson MK, Clarke H, Seltzer Z, Katz J

(2015) Pain catastrophizing as a risk factor for chronic pain after

total knee arthroplasty: a systematic review. J Pain Res 8:21–32

26. Lewis GN, Rice DA, McNair PJ, Kluger M (2015) Predictors of persistent pain after total knee arthroplasty: a systematic review

and meta-analysis. Br J Anaesth 114:551–561

27. Sanchis-Alfonso V, Puig-Abbs C, MartÍnez-Sanjuan V (2011)

Evaluation of the patient with anterior knee pain and patellar instability. In: Sanchis-Alfonso V (ed) Anterior knee pain and patellar instability. Springer, London, pp 105–133

28. Thompson P, Metcalfe AJ (2019) Current concepts in the surgical management of patellar instability. Knee 26:1171–1181

29. Beighton PH, Horan F (1969) Orthopedic aspects of the Ehlers- Danlos syndrome. J Bone Joint Surg [Br] 51:444–453

30. Reider B, Marshall JL, Warren RF (1981) Clinical character- istics of patellar disorders in young athletes. Am J Sports Med 9:270–274

31. Sheehan FT, Derasari A, Fine KM, Brindle TJ, Alter KE (2010) Q-angle and J-sign: indicative of maltracking subgroups in patel- lofemoral pain. Clin Orthop Relat Res 468:266–275

32. Sullivan MJL, Bishop S, Pivik J (1995) The Pain Catastrophizing Scale: Development and validation. Psychol Assess 7:524–532

33. Freynhagen R, Baron R, Gockel U, Tolle TR (2006) painDETECT: a new screening questionnaire to identify neuropathic components in patients with back pain. Curr Med Res Opin 22:1911–1920

34. Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O (1993) Scoring of patellofemoral disorders. Arthroscopy 9:159–163

35. Bennett MI, Attal N, Backonja MM et al (2007) Using screening tools to identify neuropathic pain. Pain 127:199–203

36. Bouhassira D, Attal N (2011) Diagnosis and assessment of neuro- pathic pain: the saga of clinical tools. Pain 152(3 Suppl):S74-83 37. Lavand'homme PM, Grosu I, France MN, et al (2014) Pain tra-

jectories identify patients at risk of persistent pain after knee arthroplasty: an observational study. Clin Orthop Relat Res 472:1409–1415

38. Priore LB, Azevedo FM, Pazzinatto MF, Ferreira AS, Hart HF, Barton C et al (2019) Influence of kinesiophobia and pain cata- strophism on objective function in women with patellofemoral pain. Phys Therap Sport 35:116–121

39. Jockimsen KN, Pelton MR, Mattacloa CG, Huston LJ, Reinke EK, Spindler KP et al (2019) Relationship between pain catastrophiz- ing and 6-month outcomes following anterior cruciate ligament reconstruction. J Sport Rehabil 18:1–5

40. Campbell CM, Buenaver LF, Finan P, Bounds SC, Redding M, McCauley L, Robinson M et al (2015) Sleep, pain catastrophiza- ing and central sensitization in knee osteoarthritis patients with and without insomnia. Arthritis Care Res 67:1387–1396

41. Jensen R, Hystad T, Kvale A, Baerheim A (2007) Quantitative sensory testing of patients with long lasting patellofemoral pain syndrome. Eur J Pain 11:665–676

42. Sulllivan MJL, Stanish W, Waite H, Sullivan M, Tripp DA (1998) Catastrophizing, pain and disability in patients with soft-tissue injuries. Pain 77:253–260