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TITLE PAGE

Title: Changes in pain catastrophization and neuropathic pain following operative stabilisation for patellofemoral instability: a prospective study with 12-month follow-up.

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ABSTRACT

PURPOSE: To determine the prevalence and change in neuropathic pain or pain catastrophizing before and 12-months following patellar stabilisation surgery for patellofemoral instability.

METHODS: We conducted a prospective clinical audit within a UK NHS orthopaedic surgical centre. Data from 84 patients with patellofemoral instability requiring stabilisation were analysed. Fifty per cent (42/84) underwent MPFL reconstruction alone and 16% (13/84) had both trochleoplasty and MPFL reconstruction. Neuropathic pain was assessed using painDETECT score. Pain catastrophizing was assessed using the Pain Catastrophizing Score. The Norwich Patellar Instability (NPI) Score and Kujala Patellofemoral Disorder Score were also routinely collected pre-operatively and one year post-operatively.

RESULTS: At 12-months post-operatively there was a statistically significant reduction in mean Pain Catastrophizing Scores (18.9 to 15.7; $p < 0.02$) but no change in mean painDETECT scores (7.3 to 7.8; $p = 0.72$). There was a statistically significant improvement in NPI scores (90.2 to 61.9; $p < 0.01$) and Kujala Patellofemoral Disorder Scores (48.7 to 58.1; $p = 0.01$). The prevalence of pain catastrophizing decreased from 31% pre-operatively to 24% post-operatively, whereas the prevalence of neuropathic pain remained consistent (10% to 11%).

CONCLUSIONS: Neuropathic pain and catastrophizing symptoms are not commonly reported and did not significantly change following patellofemoral stabilisation surgery. Whilst low, for those affected, there remains a need to intervene to improve outcomes following PFI surgery.

KEYWORDS: Patellofemoral instability; pain catastrophizing scale; psychological outcomes; neuropathic pain; patellar dislocation.

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]. Additionally, 70% to 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. [10,11]

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 [12,13]. 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 [13]. Surgical intervention is considered for individuals where conservative management has been unsuccessful, with persistent pain and/or instability [2,14].

Persistent knee pain post-surgery is a complex phenomenon. Underlying mechanisms within the peripheral and central nervous systems alter the transduction and processing of sensory inputs and are directly associated with the experience of knee pain and associated symptoms [15-17]. Neuropathic pain is defined as pain initiated or caused from damage or disease of the somatosensory nervous system [18]. It can develop from chronic pain states, such as chronic patellar symptoms, or after surgical procedures [19-23]. 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 [24]. Pain catastrophizing has been defined as a negative cognitive-affective response to anticipated or actual pain [25]. Individuals who have catastrophizing health beliefs around pain [26], anxiety and depression and pain at other sites are at a greater risk of post-operative persistent pain [27].

There is limited evidence on the relationship between neuropathic pain, catastrophizing beliefs and knee surgery outcomes. Sanchis-Alfonso et al [28] previously reported the association between pain, psychosocial factors and surgical outcomes with 17 patients following patellofemoral stabilisation surgery. Whilst catastrophizing 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 rehabilitation, and uncertainty on how prevalent pain catastrophizing and neuropathic pain is within the PFI population, the purpose of this study was to understand both the prevalence of these clinical features and how they may change pre- to post-operative stabilisation.

MATERIALS & METHODS

This was a registered prospective clinical audit (Clinical Audit Number: AUDI000887). With this approval, we gathered data from 84 patients with recurrent instability who were surgically managed after two or more episodes of patellar 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 stabilisation methods was chosen based on an each patients individual patho-anatomy and shared decision making between surgeon and patient, as recommended by Thompson and Metcalfe[29]. 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 included: patient demographics, family history of patellar instability, number of previous patellar dislocations and data of initial and last dislocation, hypermobility assessed using the Beighton criteria[30, Apprehension test[31] and J-Sign test[32], knee flexion-extension range of motion and observable lateral tracking. Patients completed a Pain Catastrophizing Score[33], painDETECT score[34], Norwich Patellar Instability (NPI) score[11] and a Kujala Patellofemoral Disorder Score[35] pre-operatively and at 12-months post-operatively. Whilst the NPI[11] and Kujala Patellofemoral Disorder Scores[35] were designed for people with patellofemoral disorders, we acknowledge that the Pain Catastrophizing Score[33] and painDETECT[34] scores were designed for those with musculoskeletal pain and particularly low back pain. There are no specific catastrophizing scores or neuropathic pain scores for people with patellofemoral pain[18,36]. Accordingly it was feel appropriate to use these validated 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 including comparisons of the mean scores and standard deviations (SD). The prevalence of pain catastrophizing and neuropathic pain were determined using previously reported clinically meaningful cut-points. Using the painDETECT questionnaire, a total score of ≥ 19 represents "positive neuropathic" and ≤ 12 is classified as "negative neuropathic" [34]. Scores 13 to 18 are classified as "unclear" [33]. A total score of ≥ 30 represents catastrophizing using the Pain Catastrophizing Score [33]. Changes in clinical outcomes between pre- to one year post-operatively were analysed using a paired Student's T-Test as

the data were normally distributed. A p-value of <0.05 was used to deemed statistical significance. 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% precision, the required sample size would vary from 22[37] to 62[38], 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 neuropathic 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 neuropathic 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 Patellofemoral 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 stabilisation 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. Further exploration to better determine this effect-modification is warranted.

As reported, mean pain catastrophizing scores significantly reduced over the follow-up period. This mirrors Sanchis-Alfonso's et al [28] findings in their cohort of 17 patients following patellofemoral stabilisation surgery. They concluded that pain catastrophizing scores reduced following surgery ($p < 0.001$) [28]. 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 [39], anterior cruciate ligament reconstruction [40] and osteoarthritis [41]. However, previous literature has been limited with relation to pain catastrophizing and PFI. The results from this study indicate that pain catastrophizing can present in people with patellar instability (prevalence pre-operatively: 31%), and surgical intervention may improve this (prevalence post-operatively: 24%). This may be because stabilisation surgery provides the patient with an opportunity 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 regarding 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 rehabilitation post-operatively.

Jenson et al [42] 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 [42]. 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-neuropathic' 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 [10]. Further consideration 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 previously 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 rehabilitation 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 participating 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 selection 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 factors 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 catastrophizing remains a good predictor of pain [33,43]. Consideration of different psychological factors may be prudent in future assessment. Finally, the number of participants with clinically meaningful pain catastrophizing scores and neuropathic 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 surgery may report reduced pain catastrophizing and improved functional outcomes.

DECLARATIONS

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

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Conflict of interest: No conflict of interest to declare

Availability of data and materials & statistical code: Data and statistical code will be released on reasonable request to the corresponding author.

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.

FIGURE AND TABLE LEGENDS

Table 1: Summary of surgical management and post-operative findings at one year.

Table 2: Summary of demographic and pre-operative characteristics of analysed patellofemoral instability cohort.

Table 3. Summary of the patient reported outcome measure results at pre-operative and one year post-operatively.

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Table 1: Summary of surgical management and post-operative findings at 1 year.

Surgical Intervention	N	%
MPFL	42	50
MPFL + trochleoplasty	13	16
MPFL + removal of loose body	5	6
MPFL + tibial tubercle osteotomy	1	1
MPFL + tibial tubercle osteotomy + trochleoplasty	1	1
Tibial tubercle osteotomy	1	1
Trochleoplasty	6	7
Trochleoplasty + lateral release + medial reefing	11	13
Trochleoplasty + tibial tubercle osteotomy + lateral release	1	1
Trochleoplasty + lateral release + microfracture	3	4

MPFL – medial patellofemoral ligament

Table 2: Summary of demographic and pre-operative characteristics of analysed patellofemoral instability cohort.

Characteristics	N (of 84)	%
Age (Years) (Mean/SD)	26	SD: 8
Age of 1 st Dislocation (Years)		
<10	4	5
11- 15	35	42
16-20	13	15
21-25	2	2
26-30	3	4
≥31	1	1
Unknown	26	31
Gender		
Male	20	24
Female	64	76
Side		
Right	45	54
Left	39	46
Ethnicity		
White	49	58
Asian	4	5
Black	5	6
Mixed	4	5
Other	22	26
Family History		
Yes	19	23
No	27	32
Not reported	38	45
BMI (Kg/m ²)		
<18.5	0	0
18.5 <25	4	5
25 <30	4	5
≥30	6	7
Unrecorded	70	83
Degree of Laxity (Mean/SD)		
Beighton Score	2.89	SD: 2.9
Apprehension Test		
Positive	54	64
Negative	30	36
J-Sign		
Positive	16	19
Negative	68	81
Lateral Tracking Patella		
Positive	56	66
Negative	28	34
Pain		
Positive	25	30
Negative	59	70

BMI – body mass index; N – number of participants; SD – standard deviation.

Table 3. Summary of the patient reported outcome measure results at pre-operative and one year post-operatively (n=84).

	Pre-operative		1-Year Follow-up		P-Value
	Mean	SD	Mean	SD	
NPI Score	90.2	58.6	61.9	61.6	<0.01
Kujala Patellofemoral Disorder Score	48.7	26.2	58.1	21.3	0.01
PainDetect Score	7.3	6.9	15.7	15.4	0.72
Pain Catastrophizing Score	18.9	16.7	15.7	15.4	0.02

NPI – Norwich Patella Instability score; SD – standard deviation.