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The Norwich Patellar Instability Score: Validity, internal consistency and responsiveness for people conservatively-managed following first-time patellar dislocation

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ABSTRACT

Background: This paper assessed the validity, internal consistency, responsiveness and floor-ceiling effects of the Norwich Patellar Instability (NPI) Score for a cohort of conservatively managed people following first-time patellar dislocation (FTPD).
Methods: Fifty patients were recruited, providing 130 completed datasets over 12 months. The NPI Score, Lysholm Knee Score, Tegner Level of Activity Score and isometric knee extension strength were assessed at baseline, six weeks, six and 12 months post-injury.
Results: There was high convergent validity with a statistically significant correlation between the NPI Score and the Lysholm Knee Score ($p < 0.001$), Tegner Level of Activity Score ($p < 0.001$) and isometric knee extension strength ($p < 0.002$). Principal component analysis revealed that the NPI Score demonstrated good concurrent validity with four components account for 70.4% of the variability. Whilst the NPI Score demonstrated a flooring-effect for 13 of the 19 items, no ceiling effect was reported. There was high internal consistency with a Cronbach Alpha value of 0.93 (95% CI: 0.91 to 0.93). The NPI Score was responsive to change over the 12 months period with an effect size of 1.04 from baseline to 12 months post-injury.
Conclusions: The NPI Score is a valid tool to assess patellar instability symptoms in people conservatively managed following FTPD.
Level of evidence: Level II

1. Introduction

The evidence-base for the management of patellar dislocation has been hampered by the lack of a dedicated scoring system to demonstrate treatment efficacy. The Norwich Patellar Instability (NPI) Score was developed based on patient-reported activities associated with instability [1]. The early validation of this tool has been reported with a cohort of patients managed surgically following recurrent patellar dislocation [1]. However, the NPI Score has not been evaluated against those following first-time patellar dislocation (FTPD), or those solely conservatively managed following this injury. Therefore it has not been previously possible to ascertain the psychometric properties of this outcome measure specifically for a FTPD cohort compared to people who have experienced recurrent dislocations. This is important as the latter group may have different experiences of instability symptoms from both physical/morphological factors in addition to health perceptions and beliefs towards instability and functional capability [2,3]. Furthermore, the responsiveness of the NPI Score over time has yet to be determined. The purpose of this study was therefore to answer the following four research questions:

1. Does the NPI Score correlate to previously validated outcome measures used to evaluate people conservatively managed following FTPD?
2. What is the internal consistency of the NPI Score for people conservatively managed following FTPD?
3. Is the NPI Score responsive to change over the first 12 months following injury for people conservatively managed following FTPD?
4. Does the NPI Score demonstrate a floor-ceiling effect for people conservatively managed following FTPD?

2. Materials and methods

Fifty people participating in a pragmatic randomised controlled trial assessing two exercise programmes for people following FTPD were

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recruited from November 2011 to March 2013, from three centres in the East of England. Ethical approval was gained from the National Health Service Research Ethics Committee — East of England (Ref: 10/H0310/1) to conduct this trial and this sub-study of the NPI Score assessment.

Study eligibility criteria included aged 16 years or over referred to out-patient physiotherapy following FTPD, presenting with a history of a single episode of patellar dislocation requiring reduction or having reported that their knee cap visibly "popped" out of joint, and one of the following physical examination findings:[4,5]

i. Apprehension when a lateral-directed force was applied to the patella
ii. Pain or tenderness along the medial retinaculum
iii. Abnormal patellar tracking or position e.g. lateralised, tilted, excursion such as J-sign.

Patients were excluded if they had: a history of two or more self-reported or documented patellar dislocations on the knee which was referred to physiotherapy anytime during a participant's lifetime; an osteochondral fracture on plain x-ray requiring surgical management; were immobilised for longer than four weeks from injury to first physiotherapy appointment; or presented with meniscal, anterior cruciate ligament, posterior cruciate ligament, lateral collateral ligament or medial collateral ligament injury on the knee referred to physiotherapy as determined through clinical examination. Those with radiological evidence of gross osteoarthritic changes of the patellofemoral joint i.e. Kellgren and Lawrence Grade 3 or above; [6] and those with previous surgical interventions on the affected knee for anterior knee pain or patellar instability symptoms were excluded.

All were enrolled on a physiotherapy programme. The mean duration of this programme was six weeks, and was predominantly exercise based. Data was collected prospectively at four time-points; baseline (pre-rehabilitation), six weeks, six months and 12 months post-commencement of rehabilitation. Data collected at each time-point included the NPI Score [1], Lysholm Knee Score [7], Tegner Level of Activity Score [8], isometric knee extensor muscle strength at 0°, 30°, 60° and 90° knee flexion, assessed using a hand-held dynamometer (Basic Force Gauge, Mecmesin, Slinfold, West Sussex, UK).

2.1. Data analysis

Descriptive statistical tests including the mean and standard deviations were calculated to assess the participant's demographic characteristics including age, gender, duration of symptoms and Beighton score for hypermobility [9]. The Shapiro Wilk W test was used to confirm that the dataset was normally distributed.

Validity was assessed in accordance with the Medical Outcomes Trust health instrument assessment criteria [10]. Convergent validity was assessed by correlating the NPI Score to the Lysholm Knee Score, Tegner Level of Activity Score and isometric knee extensor muscle strength using a Spearman's Correlation Coefficient. This was appropriate since the Lysholm Knee Score was designed to specifically assess knee instability, the Tegner Level of Activity Score specifically assesses functional capability which would be impaired through patellofemoral instability, whilst isometric muscle strength is a direct cause of patellar instability, therefore a surrogate for instability capability. Secondly, convergent validity was assessed specifically, using the knee instability domains from the Lysholm Knee Score (Item 4) using a Spearman's Correlation Coefficient. Internal consistency was evaluated by comparing the relationship of the responses to each NPI Score's individual questions to one another, using the Cronbach's Alpha Coefficient. For interpretation, values of Cronbach's alpha between 0.7 and 0.9 were considered optimal [11]. The a priori hypothesis was that the NPI Score would demonstrate high convergent validity and internal consistency based on previously assessment of a FTPD and recurrent patellar dislocation cohort [1].

Responsiveness was determined for the NPI Score by calculating the mean difference (MD) in NPI Score between each of the follow-up periods. The effect size (ES) of the NPI Score between the different follow-up periods was determined through the pooled standard deviation for all data to calculate a standardised effect size. Through these two analyses, the responsiveness of the NPI Score for individuals following rehabilitation after FTPD was made for the follow-up periods. This was also undertaken for the Lysholm Knee Score, the Tegner Activity Score and the isometric knee extension strength measurements at each measured range of knee flexion. The frequency of respondents with the highest (ceiling) and lowest (floor) scores for each item and total scores was determined for the NPI Score dataset. A ceiling-effect assessed the proportion of respondents who report the highest possible response option [11]. Conversely a floor-effect indicated the proportion of respondents which reported the lowest possible response option [7]. Based on previous studies of musculoskeletal populations, a 15% threshold was adopted to indicate high floor or ceiling-effects [12,13]. A principal component analysis (PCA) was performed of the NPI Scores to assess whether the NPI Score assessed a single or multiple dimensionality to assess construct validity. Interpretation of the PCA was conducted with the varimax rotation method to simplify the interpretation of factors. A Kaiser–Meyer–Olkin value was calculated to determine the adequacy of sampling. A probability value of less than 0.05 was considered statistically significant. All analyses were performed on STATA version 11.0 (STATA Corp LP, Texas, USA).

3. Results

The baseline characteristics for the cohort are summarised in Table 1. Of the 50 participants (28 male, 22 female) initially recruited, completed data were available for 130 data points over the four follow-up periods. Therefore the analysis consisted of 130 NPI Scores. Participants had a mean age of 23.8 years (Standard Deviation (SD) 7.0). The groups presented with a mean Beighton hypermobility score of 2.8 (SD 2.9). Participants reported a mean interval of 26.6 days (SD 28.9) between initial dislocation and commencement of rehabilitation.

3.1. Convergent validity

A summary of the convergent validity data is presented in Table 2. The NPI Score demonstrated good convergent validity against the Lysholm Knee Score, Tegner Level of Activity Score and isometric quadriceps strength measurements. There was a good correlation between total Lysholm Knee Score (Rho = −0.63; 95% CI: −0.73 to −0.52; $p < 0.001$). This was also reported against the Instability Item on the Lysholm Knee Score (Rho = −0.56; 95% CI: −0.67 to −0.44; $p < 0.001$). The Tegner Level of Activity Score was also significantly correlated to the NPI Score (Rho = −0.44; 95% CI: −0.57 to −0.25; $p < 0.001$). Whilst less than the other outcomes, there was a statistically significant correlation between the NPI Score and each of the isometric knee extension strength measurements (Rho = −0.27 to −0.44; $p < 0.002$).

Table 1
Demographic characteristics and summary of data collected.

	Frequency/mean (SD)
Number of participants	50
Number of completed NPI Scores	130
Age (mean/SD)	23.8 (7.0)
Gender (m/f)	28/22
Beighton Hypermobility Score	2.8 (2.9)
Duration since FTPD	26.6 (28.9)
NPI Score	19.9 (20.8)
Lysholm Knee Score (total score)	69.0 (28.5)
Lysholm Knee Score (Instability Item)	16.4 (8.2)
Tegner Activity Score	3.9 (2.4)
Isometric knee extension strength at 0° flexion (N)	75.5 (55.5)
Isometric knee extension strength at 30° flexion (N)	143.9 (80.2)
Isometric knee extension strength at 60° flexion (N)	163.3 (83.4)
Isometric knee extension strength at 90° flexion (N)	166.2 (88.1)

FTPD — first time patellar dislocation; m — male; N — Newtons; n — number of participants; NPI Score — Norwich Patellar Instability Score.