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ORIGINAL ARTICLE • KNEE - ARTHRITIS

Pressure algometry is a suitable tool to assess anterior knee pain in osteoarthritic patients

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Abstract

Purpose Anterior knee pain is a frequent symptom in the osteoarthritic knee. Its intensity has been classically evaluated by the visual analogic score (VAS). The main objective of the study was to assess whether pressure algometry (PA) can be used as a reliable tool to quantify anterior pain in the osteoarthritic knee.

Methods A prospective study was designed, including 160 patients scheduled for unilateral total knee arthroplasty. Patellar pain and function were evaluated according to a specific patellofemoral pain questionnaire and the Knee Society Score. Patients were asked about their pain at rest, while walking and in the stairs with the VAS score. PA by an algometer was used in the anterior part of the patella to determine the pressure pain threshold (PPT): the minimal pressure when the patient feels a painful sensation.

Results The mean values of PPT were 385.1 kPa in the knees going to be operated and 403.4 kPa in the contralateral knees ($p < 0.05$). The anterior knee pain in the patellar score averaged 6.9, and the total patellar score averaged 15.2. PPT values were correlated with the anterior pain in the patellar score ($\rho = 0.31$, $p < 0.001$) and also with the total patellar score ($\rho = 0.33$; $p < 0.001$).

Conclusions PA demonstrated to be suitable to measure anterior knee pain in the osteoarthritic knee. PA can specifically assess the anterior knee pain better than other methods as VAS score. PA could be used as the main measurement when comparing different treatments for the anterior knee pain caused by osteoarthritis.

Keywords Pressure algometry · Pressure pain threshold · Anterior knee pain · Osteoarthritic knee

Introduction

Anterior knee pain (AKP) is a frequent symptom in patients affected by knee osteoarthritis [1]. Moreover, it has been reported than 8% [2, 3] to more than 50% [4] of patients with a total knee arthroplasty (TKA) report AKP in different intensities.

The presence and intensity of knee pain have been classically evaluated by the visual analogic score (VAS), but many times it is difficult for the patients to isolate AKP from other causes of pain in these knees [1]. Different functional scores commonly used to evaluate osteoarthritic knees, such as the Knee Society Score (KSS), the Oxford Knee Score or the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) also take into account pain as the most important part of the outcome assessment [5]. But any of these widely used outcome scores discriminate AKP from other causes of knee pain.

Pressure algometry (PA) is a method described to evaluate pain in different locations of the body. By applying a progressive pressure in a location, there is a moment when the pressure begins causing pain and this is defined as the pressure pain threshold (PPT). PA has been validated to evaluate knee pain with excellent reliability both in healthy people and in knee osteoarthritic patients [6].

The main objective of the present study was to assess whether PA can be used as a suitable tool to quantify AKP in the osteoarthritic knee. We hypothesized that patients with an osteoarthritic knee in the preoperative period of a TKA

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who has a lower PPT in the PA when applied to the center of the anterior aspect of the patella would complain of more pain and would score worse in the specific patellofemoral pain questionnaire [7]. We also hypothesized a weak correlation between PPT values and VAS at rest or VAS when walking and a stronger correlation between PPT values and VAS when descending stairs.

Materials and methods

Prospective study including 160 patients who scheduled for TKA in one center was conducted. The inclusion criteria were patients aged 18–90 years, affected by knee osteoarthritis and planned to be operated of unilateral TKA who accepted to participate in the study. The situation of the contralateral knee (healthy, osteoarthritic or previously operated) was registered. Exclusion criteria were patients affected by inflammatory arthritis, revision knee arthroplasty, partial knee arthroplasty and patients will-less to participate in the study.

The study was approved by the ethics committee of our institution (2017/7192/I, on date 22-March-2017). Informed consent was obtained from all individual participants included in the study.

Preoperatively, patellar pain and function were evaluated according to the specific patellofemoral pain questionnaire used by Feller scoring between 1 and 30, 30 being the best possible result. The patellofemoral Feller score give a maximum of 15 points to the intensity of anterior knee pain, 5 points to the quadriceps strength, 5 points to the ability to rise from a chair and 5 points to the stair-climbing ability [7]. The KSS score was also used in the Spanish version for both the Knee and the Function scores, 0 being the worst and 100 the best possible results [8].

VAS scores referred preoperatively by the patients were registered. The patients were asked about their pain at rest, when walking and when going up and downstairs in the previous week with the VAS score for each activity, with 0 as the minimum value (meaning no pain at all) and 10 as the maximum value (meaning the maximum possible pain the patient could imagine).

PA is a method described to determine the PPT: the minimal pressure when the patient feels a painful sensation. The PPT was assessed three times by a trained rater in each of the knees 1 min apart every assessment from the previous one. The assessment was done causing an increasing pressure by a previously calibrated electronic algometer (Algometer, Somedic Sales, Hörby, Sweden) with a 1 cm^2 probe that was held perpendicular to the skin in the center of the anterior aspect of patella (Fig. 1), without quadriceps contraction, increasing the pressure 20 kPa/s until the patients said "stop," meaning that the pressure sensation in their knees was beginning to become painful. The PPT could be seen in the algometer digital display and was registered. The final PPT value of each knee was considered as the average of the measurements. An excellent test–retest reliability of PPT has been previously reported [6].

Fig. 1 1 cm^2 probe algometer applied perpendicularly at the center of the anterior aspect of the patella. PPT can be seen in the display

Statistical analysis

All data were analyzed using the SPSS software package. Descriptive statistics was used for demographic data. Unpaired Student's *t* test and Chi-square tests were used for numeric and categorical variables. Spearman's rho tests were used for correlations. p values <0.05 were considered as significant.

Results

The mean age of the patients was 72.6 years (SD 8.0). There were 110 (68.7%) women and 50 (31.2%) men. The average body mass index (BMI) of the tested patients was 30.9 kg/m^2 (SD 4.4). The right knee was operated in 79 cases and the left one in 81 cases. There were 115 varus knees (71.9%), 22 normoaxed (13.7%) and 23 valgus knees (14.4%).

The mean values (and standard deviation) of PPT obtained in the anterior aspect of the knees that were going to be operated were 385.1 (SD 165.8) kPa and 404.2 (SD 172.5) kPa in the contralateral knees ($p=0.02$). The mean value of PPT in female patients was 373.4 (SD 161.3) kPa and was significantly lower than that in male patients 457.7 (SD 177.3) kPa ($p<0.001$)

PPT in the contralateral knee was lower in the patients with contralateral TKA (344.3 kPa, SD 120.7) than that

in the knees without significant osteoarthritic disease (431.5 kPa, SD 159.2) ($p = 0.03$).

Mean preoperative values of VAS were 3.9 (SD 3.1) at rest, 7.1 (SD 2.1) when walking and 7.6 (SD 2.2) when descending stairs. PPT values in the anterior knee were not correlated with VAS at rest or VAS when walking ($p =$ n.s.) and were only marginally correlated with the VAS when descending stairs ($p = 0.05$).

Mean preoperative values of KSS Knee score were 51.3 (SD 11.9), and the ones of KSS Function score were 50.4 (SD 11.3). PPT values were not correlated with KSS Knee or KSS Function scores ($p =$ n.s.)

AKP in the patellar score averaged 6.9 (SD 4.6, range 0–15), and the total patellar score averaged 15.3 (SD 5.9, range 2–29). VAS at rest, VAS when walking and VAS at stairs were not correlated with the patellar score or with AKP in the patellar score ($p =$ n.s.). PPT values were correlated with AKP in the patellar score (Fig. 2) ($\rho = 0.31$, $p < 0.001$) and the total patellar score (Fig. 3) ($\rho = 0.33$; $p < 0.001$), indicating that patients scoring higher in the

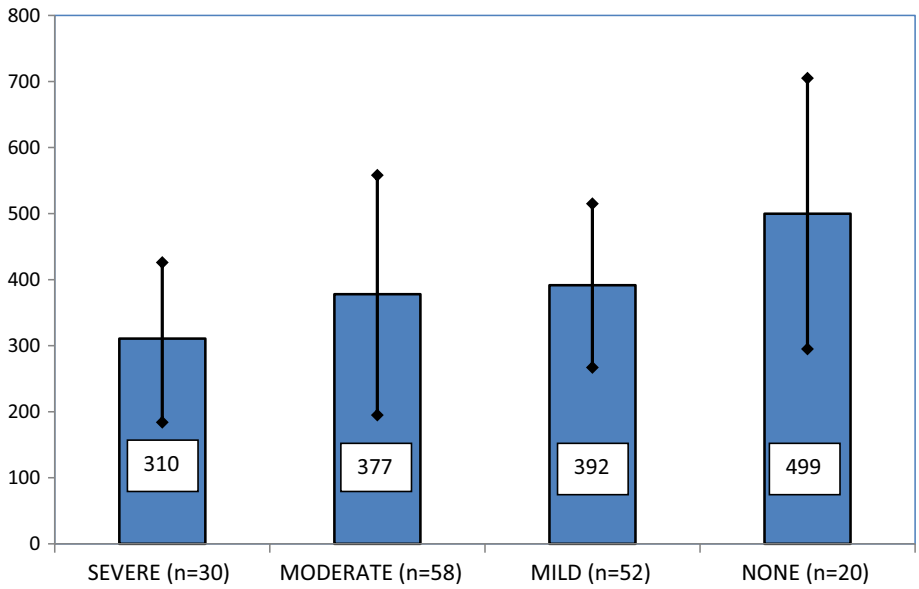

Fig. 2 Mean pressure pain threshold (kPa) in the pressure algometry related to the anterior knee pain referred by the patients in the patellofemoral score

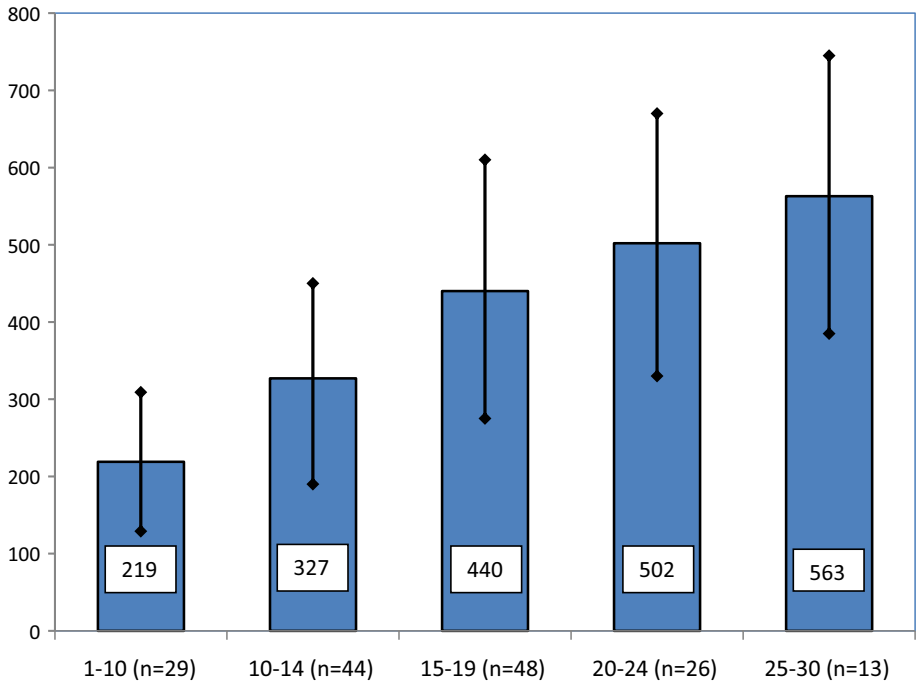

Fig. 3 Mean pressure pain threshold (kPa) in the pressure algometry related to the values of patellar score

patellar score (less AKP and better function) tolerate higher pressures in algometry before feeling pain.

Discussion

The main finding of this study is that PA is a suitable tool to quantify AKP in the osteoarthritic knee. A significant correlation between PPT values evaluated by PA and the AKP and the patellofemoral score has been found. Moreover, no correlation was found between VAS scores and AKP and the patellofemoral score.

Anterior pain in the knee is a cause of concern for many patients affected by knee osteoarthritis and also in many others after a TKA has been implanted. Nevertheless, a valid method of specific assessment of AKP has not been validated. VAS score is the most widely used method of evaluation of pain in the knee with OA, and it has been used as the measurement tool for pain to evaluate noninvasive treatments [9], different types of joint injections [10, 11] or surgical treatments for OA knees [12, 13]. Some studies only consider one VAS value in each moment of the treatment [10], while others discriminate VAS at rest and during physical activities [13]. However, VAS score is very unspecific with respect to the location and the source of the knee pain, and many times it is very difficult for the patients to specifically evaluate the VAS score in the anterior part of the knee without taking into consideration other locations of pain around their knees. Discriminating VAS scores at rest and when walking with respect to VAS scores when ascending or descending stairs (situations with higher pressures in the patellofemoral joint) was hypothesized that could help in better identifying AKP [14]. Nevertheless, in this study VAS scores at rest and when walking showed no correlation with AKP of patellofemoral score, but VAS score during climbing and descending stairs showed only a weak correlation, suggesting VAS scores are not representative of AKP in patients with osteoarthritic knees.

PA is a validated method of quantitative sensory testing that has been used in the assessment of pain in the knee in healthy subjects with high interclass correlation coefficients [6, 15] and in the assessment of some disorders of the knee as patellar tendinopathy [16], the effect of high tibial osteotomy [17] or patellofemoral pain patients [18, 19].

Imamura et al. [20] found some correlations between PPT values and VAS scores, WOMAC function scores and SF-36 scores in a group of osteoarthritic knee patients when PA was assessed in different dermatomals and myotomals in the lower limbs, but AKP was not specifically evaluated.

VAS score has been previously correlated with PPT values in patients with tibial end-of-stem-pain after revision TKA, but in that situation this could be identified as the main cause of pain in that group of patients [21], while AKP is probably not the main source of pain in most of the osteoarthritic patients of this study. This is probably the cause why we have not found a strong correlation between VAS score and PPT values in this study.

PA has also been validated as a tool of pain assessment in patients with knee osteoarthritis [6, 20, 22–24], but in most of those studies PA was applied in the medial part of the knee, assessing mainly the pain in this region of the knee because this is the region with more correlation between PPT and severity of osteoarthritic pain [22]. As far as we know, this is the first time that PA has been used as a tool to specifically evaluate AKP in osteoarthritic patients.

Skou et al. [24] stated that the interclass correlation coefficient is improved when more than one PPT measurement is taken, as we did in this study. The PPT values found in the center of the patella in this study (384.4 kPa average in the osteoarthritic knees) are similar to PPT values found in the study by Rathleff et al. [18] in a Danish population and Noehren et al. [25] in an American population, suggesting there are not big differences in these values in different ethnics. We have found a significant difference showing lower PPT in female patients, as it has been previously described [19]. However, we could not identify a clear cutoff of the PPT value to categorize the presence of moderate or severe AKP, suggesting that PPT could be used as a monitoring tool for the same patient before and after a treatment or comparing the effect of different treatments applied in different groups of patients on AKP, but not to categorize AKP. This finding is similar to other studies which also suggest the lack of a single value of PPT as a marker of pain in the knee [26] or the lack of correlation between PPT values and the degree of osteoarthritis in the radiographic studies [22, 27].

This study has some limitations: First, the opposite knee has also osteoarthritic disease in many patients and a TKA has been previously implanted in others, but the main objective of the study was not comparing both knees in the same patient but evaluating the PA as a tool to assess AKP. Second, we have failed to find a PPT value to be used as a cutoff to clearly discriminate those patients who have a significant AKP from those without AKP.

The study has also some strengths: It is a prospective study including a significant number of patients, and the PA has been evaluated by a trained rater. The clinical relevance of this study is that PA can be used as a tool to more specifically estimate AKP in knee osteoarthritic patients, and it presumably allows monitoring some treatments as TKA in AKP and also to compare different treatments that could be related to a different effect on AKP, as replacing or not the patella in TKA. The effect of different treatments on AKP could have been historically underestimated if VAS score or KSS scores were the only tools used to compare them, as we have demonstrated a poor correlation of those scores with AKP in this study.

Conclusion

PA can be used as a tool to quantify AKP in the knee of osteoarthritic patients.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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