PM R 7 (2015) 466-473

www.pmrjournal.org

Original Research—CME

Knee Flexion Contractures in Patients with Osteoarthritis: Clinical Features and Histologic Characterization of the Posterior Capsule

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Abstract

Objective: To (1) identify demographic and clinical factors associated with knee flexion contracture (KFlC) in the setting of osteoarthritis (OA) and (2) histologically compare the posterior knee capsule of patients with OA with and without KFlC.
Design: Cross-sectional study.
Setting: Primary care, including private and institutional practice.
Patients: Thirteen patients with primary OA and KFlC and 8 patients with primary OA without KFlC.
Methods: We compared the KFlC and non-KFlC groups to identify demographic and clinical factors associated with KFlC. We examined the histology of the posterior knee capsules of 9 patients with KFlC and 6 without.
Main Outcome Measurements: Patient demographic and clinical factors. For histology we measured the proportional composition of collagenous, adipose, and synovial tissues; fibroblast and adipocyte cellularity; and synovial thickness.
Results: Patients with contracture had longer duration of OA, reduced flexion of the surgical knee, and reduced extension of the contralateral knee ($P = .04$, $<.01$, and $<.01$ respectively). Histologically, there was a greater proportion of collagenous tissue and a lower proportion of adipose and synovial tissues in the contracture group than in the noncontracture group; however, the differences were not statistically significant. Cellularity was similar between the 2 groups.
Conclusions: Longer duration of knee OA, reduced surgical knee flexion, and reduced contralateral, nonsurgical knee extension were associated with KFlC in the OA knee undergoing total arthroplasty. Monitoring bilateral knee range of motion in patients with longer-duration OA could allow earlier intervention, reducing functional loss. Capsular tissue composition analysis may indicate a fibrotic disease process. Further research in which a larger sample size is used will help clarify these novel findings.

Introduction

A joint contracture is characterized by a restriction in the full range of motion (ROM) of a joint and occurs secondary to shortening of periarticular connective tissues and muscles [1]. Joint contractures restrict mobility, have a negative impact on quality of life, limit an individual's productivity and earning potential, and can prevent basic activities of daily living [2]. A restriction in full extension of the knee is called a knee flexion contracture (KFlC).

Osteoarthritis (OA) is the most common joint disorder [3]. Knee OA affects 11%-15% of the US population 65 years of age or older, is a leading cause of chronic disability, and often is treated with total knee arthroplasty (TKA) at end-stage [3]. Ritter et al [4] reported that more than one third of patients with OA (5228 knees) who presented for TKA had a KFlC. This proportion represents a significant number considering that 719,000 knee replacements were performed in the United States in 2010 [5].

KFlCs disturb gait, increase energy expenditure, decrease function, and are difficult to treat [6-8]. The burden of KFlC in OA is further compounded as preoperative contractures put the patient at greater risk for contracture, knee pain, and poor outcome postoperatively [4]. Contractures draw heavily on health care resources because of their chronic nature and poor response to treatment, and the fact that they cause premature wear and tear of other joints [1,2]. Although some authors have examined clinical risk factors for KFlC after TKA [4,9-11], little is known about risk factors for KFlC in those who have not undergone arthroplasty, making it difficult for clinicians to stratify patients according to their risk of contracture development.

1934-1482/$ - see front matter
http://dx.doi.org/10.1016/j.pmrj.2014.12.001

The etiology and pathophysiology of KFlC in OA are poorly understood. Posterior joint capsule and lateral ligament release during TKA improve knee ROM [12,13]. Joint contracture models in animals provide direct evidence of posterior capsule involvement: immobilization of rat knees in flexion caused the posterior capsule to shorten and become fibrotic, resulting in a KFlC [1]. Full extension was regained only after complete posterior capsulotomy. Unfortunately, this option is not a routine one for OA patients with flexion contractures because of the risks for joint instability and neurovascular injury. In chronic knee OA, changes to the joint capsule include architectural distortion, synovial proliferation, perivascular inflammation, and fibrosis [14,15]. Pain during weight-bearing activity may cause the patient to restrict knee ROM. Together, capsular changes and the ROM that is not accessed over time likely contribute to posterior capsule alterations as a possible key to the disease process of KFlCs in knee OA.

The goals of this study were to identify risk factors for KFlCs in patients with OA who had not yet undergone TKA and to characterize capsular changes at the tissue and cellular levels. Our objectives were to (1) identify demographic factors associated with knee OA in patients with a KFlC and (2) report changes in the collagenous, adipose, and synovial composition of the posterior joint capsule in OA knees with KFlC.

Methods

Twenty-one consecutive patients were recruited prospectively before TKA for severe primary knee OA at a large university-affiliated hospital in southern Ontario, Canada. All participants met the American College of Rheumatology criteria for knee OA [16]. Exclusion criteria included history of inflammatory arthropathy, hemophilia, thyroid disease, cancer treatment, surgery, arthroscopy, significant trauma to the operative knee, or known genetic anomaly. The exclusion criterion of knee arthroscopy was necessary to rule out previous capsular injury (eg, surgical portals), although this limited recruitment to 21 subjects during the recruitment period.

There were limited data in the literature to help guide us in selecting demographic factors because, to our knowledge, this was the first study to examine preoperative risk factors for contracture. In a small number of studies, authors have examined risk factors for postoperative development of contracture, and we included these risk factors in our study (age, sex, height, weight, body mass index, radiologic OA severity, knee alignment, surgical knee ROM) [4,9-11]. We also included factors that, based on our clinical experience, may be associated with knee contracture before surgery (duration of OA, ROM contralateral knee; see Table 1). Duration of OA was measured by means of patient recall of duration since medical diagnosis. To reduce the recall bias associated with this approach, duration was categorized as 1-2, 3-5, 6-10, 11-20, or >20 years since diagnosis for statistical analysis. All patients provided written informed consent to participate in the study, which was approved by the local research ethics board.

Joint ROM

Knee ROM was measured for both knees with a goniometer by 2 research assistants trained by a physician via a method described previously that has been shown to have good interrater reliability [17]. In summary, the patient was placed in the supine position, hips at neutral, with the knee in extension. A rolled towel was placed under the calcaneus to maximize knee extension (this may have required slight hip flexion). The goniometer fulcrum was centered over the lateral condyle of the femur, and the proximal and distal arms were aligned with the greater trochanter and fibular head respectively. The angle formed by these landmarks was the maximal angle of extension. A lack of full 180° knee extension of ≥6° was considered a KFlC [4,17].

Radiographic Severity of OA

Radiographic severity of OA was graded independently by a radiologist and physiatrist who were blinded to the patient's identity and clinical information via the Kellgren and Lawrence criteria [18]. If there was disagreement between the evaluators, a consensus grade was reached.

Knee Alignment (Varus and Valgus) Measurements

Varus and valgus measurements were determined for each subject when an appropriate radiograph was available (11 contracture and 6 noncontracture subjects for the surgical knee and 10 contracture and 4 noncontracture subjects for the nonsurgical knee). Knee alignment was determined by anatomic axis via the use of knee radiographs obtained with the patient standing. The femoral anatomic axis was determined by drawing a line from the center of the tibial spines to a point 10 cm above the tibial spines, midway between the medial and lateral femoral surfaces [19,20]. The tibial anatomic axis was determined by drawing a line from the center of the tibial spines to a point 10 cm below the tibial spines, midway between the medial and lateral tibial surfaces [19,20]. Varus alignment was indicated by values <180° and valgus alignment was indicated by values >180°. The radiographer was