

CLINICAL INVESTIGATION OF KNEE-JOINT SOUNDS IN PATIENTS WITH PATELLOFEMORAL SYNDROME

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ABSTRACT

Patellofemoral syndrome is a common disorder of the knee-joint that is known to present difficulty in clinical assessment, diagnosis and treatment. Currently, clinicians use various conservative and non-conservative methods for treating the disorder, but there are no tools for providing good, quantitative measures of their effectiveness. The goal of this research is to look at the use of knee-joint sound as a clinical tool for progress assessment in rehabilitation of patellofemoral syndrome. There is a significant amount of literature on the use of acoustics in joint research, including the knee-joint. In the literature on knee-joint sound analysis, many researchers have attempted to use sound as a diagnostic tool. It is often problematic to try and identify a single, acoustic 'signature' that is characteristic of a specific disorder. In this research, relative changes in joint sounds will be used in analysis rather than absolute measurement. Changes of the knee-joint sounds throughout different treatment modalities will be compared to the patient base line in order to provide an indicator of treatment progress.

INTRODUCTION

Auscultation of joint sounds has been used by clinicians for many years in order to obtain information about the condition of the joint. Some auscultation techniques are carried out with regular stethoscopes, while others involve complex digital recording equipment for sound analysis and playback. In 1976, Chu and Gradisar found that diseased knees exhibit different sounds than normal knees [1]. More recently in 2001, Rangayyan et al. investigated methods for computer-aided auscultation of knee joint sounds based on auditory display techniques [2]. While the current focus of knee-joint sound research seems to be centered on diagnostics, there are other clinical applications for the research in the area of rehabilitation therapy. This paper proposes a method for the clinical use of joint sound analysis in rehabilitation of patellofemoral syndrome.

Patellofemoral Syndrome

Anterior knee pain, also called patellofemoral pain or syndrome, is the most common disorder of the knee. It

is particularly prevalent in adolescent females due to the increasing angle between the hip and knee placing stress on the knee-joint during puberty. Despite its high prevalence, the pathophysiology of patellofemoral syndrome is not clearly understood. The pathophysiology is difficult to assess because, in general, all instances of anterior knee pain that can not be otherwise classified fall under the category of patellofemoral syndrome. The long-standing school of thought is that abnormal tracking of the patella relative to the femoral trochlea increases patellofemoral joint stress and subsequently causes abnormalities within articular cartilage. There is no absolute cure for patellofemoral syndrome; patients are generally referred to a rehabilitation clinic and managed by a conservative treatment program on a case by case basis. There is a significant amount of controversy in the literature regarding the effectiveness of treatments and how to measure treatment progress [3].

Clinical Assessment and Treatment Modalities

Depending on the joint mechanics that appear to be causing pain, patients are classified into either a conservative or non-conservative treatment group by the clinician performing the assessment. Non-conservative treatments consist of surgical procedures that attempt to reposition the patella in the trochlear groove. This treatment modality is extreme, invasive and highly controversial. The more common approach is to try the patient on one of the conservative treatment modalities including bracing, taping, orthotics, ultrasound therapy and exercises for strengthening the VMO (vastus medialis oblique).

While all of these conservative modalities have been shown to affect the stability of the joint, the mechanism is not entirely clear and varies among techniques. There is also a wide variation of programs within each treatment modality. For example, strengthening exercises can be done under supervision at the clinic or as an at home program, can be performed daily, weekly, before exercise or a combination of the three, and can consist of any number of stretch and strengthening maneuvers. There is a lack of consistency in both treatment program selection and design, due largely to the fact that there is no robust, repeatable method for quantifying treatment progress.

Treatment Progress Indicators

Currently, the major indicator for treatment progress and effectiveness of a patellofemoral rehabilitation program is reduction of pain. While this is obviously an important indicator, it fails to adequately represent the subtle, yet important aspects of a rehabilitation program with long term goals. The sheer nature of patellofemoral syndrome suggests that pain reduction alone is not sufficient to imply treatment progress. The converse is also true; continued pain in the beginning stages of a treatment may not necessarily indicate that the treatment program is ineffective. Anterior knee pain can flare up in patients when they walk up and down stairs or sit for long periods of time. Depending on the activities of the patient on the day of their clinic visit, external factors unrelated to the treatment program may be contributing to either presence or absence of pain. With pain reduction as the sole indicator of progress, false assessment of the treatment effectiveness may result.

We propose that reduction of pain should not be looked at in isolation as an indicator of treatment progress.

OBJECTIVES

It has been shown that diseased knees exhibit signal components spanning the entire audible range, 20Hz-20kHz, while normal knees do not. Chu and Gradisar et al. suggest that the peak magnitude of the spectrum is correlated to the severity of the cartilage damage [1].

Previous research studies have attempted to use acoustic signals from the patellofemoral joint to diagnose disorders of the knee. While this type of diagnostic research looks promising for some knee-joint disorders, diagnosis of patellofemoral syndrome poses many difficulties because of its broad range of symptoms and varying pathophysiology. Since patellofemoral syndrome is not well understood in the medical community, it is difficult to determine a unique, standard acoustic signal for a 'typical' instance of patellofemoral syndrome.

The basis for this research is the use of *relative* rather than *absolute* data. The main objective is to investigate how sounds from the knee-joint change over time during a patellofemoral rehabilitation treatment program. These sounds may provide useful quantitative information regarding the progress of the treatment program.

HYPOTHESIS

Changes in patellar tracking sounds throughout the duration of a treatment indicate the progress of the treatment program.

METHODS

In order to assess the progress of a patellofemoral treatment program with accuracy and repeatability, it is important to quantify subtle changes that may be taking place in the knee-joint. Acoustic signals from the patellofemoral joint will be used to characterize the nature of contact between the articular cartilage of the patella and the femoral trochlea.

An initial set of recordings from the knee-joint will be taken when the subject is first diagnosed with patellofemoral syndrome in order to establish a baseline for that subject. Recordings will be taken in both the weight-bearing and non-weight bearing situation as the leg is flexed and extended through a normal range of motion. Once the conservative treatment plan has been selected and assigned to the subject, subsequent recordings will be taken periodically throughout the course of the treatment when the patient returns to the clinic for a follow-up visit. The elapsed time between subsequent recordings will vary among subjects, as their return visits to the clinic will depend on personal schedules.

POTENTIAL BENEFITS

Quantifiable indicators of treatment progress have potential benefits for both the clinician and the patient. Progress indicators could be used to determine plateaus in the treatment program which may indicate that a different modality should be explored. Quantitative data may also assist in selecting the most effective device/technique within the same treatment modality (i.e. different brace manufacturers, taping techniques) for each patient. This would be a useful clinical tool in treating patellofemoral syndrome since the condition is manifested in many different ways. From the patient perspective, quantitative treatment progress indicators may encourage patients to comply with home programs, such as VMO strengthening exercises and wearing a brace.

REFERENCES

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