

Intra-Articular Pressure in Osteoarthritis of the Knee

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Research

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Abstract

Background: IAP (intra-articular pressure) of the knee has been extensively studied in the knee of rheumatoid arthritis^{1,3}. The relationship between IAP and osteoarthritis of knee rarely mentioned in the literature. The purpose of the study was to discover the pressure profiles observed in OA (Osteoarthritis). The characteristics of osteoarthritis are multiple osteophytes, unstable chondral flaps, joint-space narrowing, sclerosis. Whether these factors effect of osteoarthritis intra-articular pressure.

Methods: Fifty three research subjects were studied. They were divided into two subgroups, group 1: Forty osteoarthritis (OA). group 2: Thirteen control knee of healthy volunteer. IAP was measured using the hand held portable water manometer. before operation of arthroscopic procedures in OA group. Research data were analyzed to identify IAP between the two groups.

Results: The main finding was that Resting IAP was positive pressure in all Osteoarthritis joints, otherwise subatmospheric or weakly atmospheric in normal subjects.

Conclusions: The IAP rising is a feature of all patients with OA group. Therefore, These observations we recognize that significantly increased resting IAP is major influences by multiple osteophytes, joint-space narrowing, sclerosis, loose bodies and definite deformity of bony ends.

Background

Through study a lot of literatures demonstrate that normal knee joint pressure is negative pressure, also have confirmed that pressure in the patients with knee joint effusion is increased, so pressure in patients with osteoarthritis of the knee joint will be how? Through literature study our team recognizes that pressure may be within the knee and osteoarthritis relationship. Worthy of further research on the changes of osteoarthritis of knee joint pressure. Jayson has also been reported the intra-articular pressure, that is the pressure in the synovial fluid (not that between the contact areas of the articulating surfaces), has been determined at rest.^[1] In previous studies of IAP at rest and during exercise have shown that normal peripheral synovial joints have a subatmospheric pressure, commonly -2 to -4 mm Hg at rest.^{[2][3]} Baxendal has also been reported the normal human synovial joint has a subatmospheric or low atmospheric intra-articular pressure (IAP) at rest and during exercise.^[4] IAP is very important to our knee. The cartilage is avascular because of the compressive forces it sustains, and its nutrition is dependent on synovial vessel perfusion.^[5] Maintenance of synovial patency by mild distraction assists cartilage nutrition despite exercise or compressive forces. It has also been proposed that negative pressure will draw loose synovial tissues towards to each other during exercise, thus offering a stabilising influence and promoting normal to joint tracking,^{[6][7]} Geborek showed clearly in their study that an increase of IAP as little as 20 mm Hg in patients with knees effusions can significantly decrease synovial blood flow suggesting the joint to be a system with a blood flow that is very sensitive to comparatively small changes in IAP.^[8] when at low intra-articular pressures the blood supply to the synovium is unimpeded and at very high pressures the vessels are compressed and all vascular flow stops. These

suggested that increased intra-articular pressure could interfere with the circulation to the synovium. [9] Intra-articular pressure is central to the mechanism of hypoxic-reperfusion injury to the joint. [10] Thus there are several cases that may influence the ability to generate high intra-articular pressures. Several types of synovitis were studied and the increase in intra-articular pressure is clearly not specific to a particular disease. [11][12][13] According to Blake so that the Rheumatoid arthritis with chronic knee effusions have significantly greater resting pressures. [14-15] Geborek reported that Exercise of the joint causes the intra-articular pressure to rise above the capillary perfusion pressure, resulting in occlusion of the synovial capillary bed and hypoxia. [16-17] Simkin studies have confirmed the intra-articular pressure (IAP) rises significantly after isometric quadriceps contraction in patients. [6] Some scholars think that joint elasticity increases with increasing age, suggesting a greater ability to generate high intra-articular pressures. Conversely, the size and strength of quadricep muscles decline with increasing age, suggesting a decreased ability for the generation of intra-articular pressure. [18-19] Thus there are several associated factors that may influence to generate high intra-articular pressures. We do not believe, as with previous studies, that the age difference is the cause of the different IAP profiles between the groups. [20] Although IAP has been extensively studied in the knee of several diseases, there is limited information available regarding human OA joints and the effect of IAP usage on OA is largely unknown. Measured IAP in a spectrum of OA and normal joints in order to evaluate the IAP dynamics, and determine whether a rising IAP is likely to occur at these OA patients and find out the reason that cause highly IAP. The question allows us to hypothesis multiple osteophytes, joint-space narrowing, sclerosis, loose bodies and definite deformity of bony ends are the major influences on whether the joint sustains significant pressure responses. The purpose of our study was to discover the pressure profiles observed in OA (Osteoarthritis) groups. The characteristics of osteoarthritis multiple osteophytes, unstable chondral flaps; joint-space narrowing, sclerosis, Whether these factors effect of osteoarthritis intra-articular pressure.

Materials And Methods

General information

40 clinically well defined patients with OA were recruited to the study before operation. Fifty three research subjects were studied. They were divided into two subgroups; group 1: 40 osteoarthritis the mean patient age was 56 years (45-72); group 2: 50 years (45-78) for 13 control knee of healthy volunteer. Specify the inclusion criteria for each group included patients with their clinical diagnosis was not in dispute on examination, capsular integrity, forty patients met these criteria. Exclusion criteria included knees with incomplete radiographic studies, synovitis, rheumatoid, rupturing the capsule, patients with a joint effusion with a positive bulge sign or positive patellar tap were also excluded. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of the Affiliated No.2 Hospital of Harbin Medical University. Written informed consent was obtained from all participants.

Measurement of intra articular pressure

Measurements were performed on patients who agreed to these studies after detailed explanations before operation. We did not use subcutaneous tissues were infiltrated with 2% lignocaine taking care to avoid capsular or intra-articular contact. [21]

We use the method of anesthesia is lumbar epidural anesthesia .The Measurements were performed after a spinal anesthetic was administered. A tourniquet was never used.In the picture fig 1a might see the proximal thigh tourniquet but tourniquet is not inflated, when measuring, only after the measurement used in the operation. Patients were rested in a supine position for at least 15 minutes before the procedure. The subject was encouraged to relax completely with the knee extended. IAP was measured before operation of arthroscopic in OA , In this studies the techniques for cannulating the joint by using a parapatellar approach injection site with a water manometer in order to record the intra articular pressure, The tube was calibrated against a water manometer, After assembly, the water manometer is fitted with a needle. A sterile disposable piezometer tube containing a pre-filled saline syringe . The tube by slowly filling saline(solution of 0.9 percent sodium chloride,) through tube to the needle tip to ensure hydrodynamic communication with the joint lumen. The needle introduced into the joint cavity (parapatellar approach anteromedial), sterile precautions were observed throughout. Figure 1a shows us in the operation of intra-articular pressure measurement. Figure 1b the measured pressure tube local amplification. There was no infection of any specimens every steps were sterile. IAP was measured at rest, when a needle was attached to the water manometer to record the pressure were subatmospheric in group 2.In this studies the techniques for cannulating the joint, recording the intra-articular pressure , the lumen of the joint was placed in hydrodynamic communication with the water manometer. this methods we used are able to distinguish between atmospheric and subatmospheric (Positive and negative pressure)IAP recordings.

Statistical analysis

The mean resting pressure in the knees of patients with OA knees were positive and in control knees were negative. The two groups were compared by the t test. There is a clear difference in the generation of intra-articular pressure between the two groups. This is significant both at rest ($P < 0.01$). Statistical analysis was performed by using an SPSS (version 16.0; SPSS,) software.

Result

The result is group 1: $220 \pm 80 - 300 \text{ cmH}_2\text{O}$ for the Osteoarthritis; group 2: demonstrates a sub-atmospheric negative pressure produced. We cannot measure the definitely negative figure due to our appliance, but negative is sure. No negative phase of intra-articular pressure was found in the OA. Figure 2 shows IAP in the first group produced very much higher pressures and the patients with control joints intra-articular pressure at rest was subatmospheric.

Adequate data was recorded on thirteen control knees and forty (OA) knees, the mean resting pressure in the knees of patients with OA knees were positive and in the 13 control knees were negative. The difference was statistically highly significant ($P < 0.01$). There is correlation was found between IAP and multiple osteophytes, joint-space narrowing sclerosis, loose bodies and definite deformity of bony ends in the OA knees.

Discussion

Our experimental research and results are consistent with our original expectations. To compare the IAP of the Osteoarthritis and the control subjects find out the IAP rise in OA group. The group of normal knee joint internal pressure measurement is negative pressure. IAP as an indicator to judge the severity of osteoarthritis, just like human blood pressure to judge the condition of people. By our experimental the hypothesis was confirmed that significantly increased resting IAP is major influences by multiple entophytes, joint-space narrowing sclerosis, loose bodies and definite deformity of bony ends. A lot of literatures demonstrate that normal human knee joint is negative, but the phenomenon of intra-articular pressure changes of OA patients is rarely mentioned, which is the difference between us and the other scholars. Measured IAP in a spectrum of OA in order to evaluate the IAP dynamics, and determine whether a rising IAP is likely to occur at these OA patients and find out the reason that cause highly IAP. The IAP were found in normal knees were similar to those reported elsewhere, Muller (1929) found the pressure in normal living joints to be several cm. of water less than atmospheric pressure; Dixon (1966) similarly found that the pressure in the normal human knee fell below the atmospheric level by up to 30 mm. Hg; Reeves (1966) confirmed that the resting pressures in the knees of normal humans and of animals was usually between -2 and -10 mm. Hg. We cannot measure the definitely negative figure due to our appliance, but negative pressure is sure. Our recording in group 1 is consistent with the findings of above researcher^{2 3}. Number of factors influence the development of intra-articular pressure. Rheumatoid subjects with chronic knee effusions have significantly greater resting pressures^{13 14}. Exercise of the joint causes the intra-articular pressure to rise above the capillary perfusion pressure, resulting in occlusion of the synovial capillary bed and hypoxia^{15 16}. The intra-articular pressure (IAP) rises significantly after isometric quadriceps contraction in patients⁶. With increasing volumes of simulated effusion, joint use produced higher pressures³. thus synovitis, exercise, isometric quadriceps contraction, Rheumatoid, rupturing the capsule (external injury), patients with a joint effusion with a positive bulge sign or positive patellar tap were also excluded by our study. During our study, the procedures were performed after a spinal anesthetic was administered; quadriceps contraction and stretching the unsupported parts of the synovium were avoided. Although this was somewhat artificial, it enabled comparisons to be made under similar conditions.¹ Our experimental results showed that OA patients increased pressure within the knee. What causes increased? Pressure within the knee joint effusion, inflammation, unit four quadriceps contractions are factors affecting intra-articular pressure, but we have no choice in these patients. From the X-ray and observe arthroscopic joint space narrowing, osteophyte formation, may be likely to be the main factors leading to joint increased pressure. The higher pressures in the OA knees may have been produced the mechanisms is reduced the joint space by multiple entophytes, joint-space narrowing,

sclerosis, and definite deformity of bony ends. Joint volume reduction leads to increased intra-articular pressure. We think that through the intra-articular pressure level, to judge the severity in patients with OA. Intra-articular pressure increases judgments osteoarthritis severity index. Our studies question is to study the cases were too few, performed at rest and did not give further study about changes in intra-articular pressure during joint exercise.

Conclusions

We found that the IAP rising is a feature in OA group. The change of joint pressure was positively correlated with the severity of osteoarthritis. IAP as an indicator to judge the severity of osteoarthritis, just like human blood pressure to judge the condition of people. The higher pressures in the OA knees may have been produced the mechanisms is reduced the joint space. Joint volume reduction leads to increased intra-articular pressure. These observations we recognize that significantly increased resting IAP is major influences by multiple osteophytes, joint-space narrowing, sclerosis, loose bodies and definite deformity of bony ends.

Abbreviations

IAP: intra-articular pressure; OA: Osteoarthritis;

Declarations

Authors' contributions

NK and HL Pan were responsible for the conception, design, and acquisition of data, NK drafted the initial manuscript and revised it critically for important intellectual content. HL Pan analyzed and interpreted the data. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

All data and materials are available.

Consent for publication

All participants signed informed consent.

Ethics approval and consent to participate

This study was conducted with approval from the Ethics Committee of the Affiliated No.2 Hospital of Harbin Medical University. Written informed consent was obtained from all participants.

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Figures



Figure 1

a) Figure 1a shows us in the operation of intra-articular pressure b) the measured pressure tube local amplification

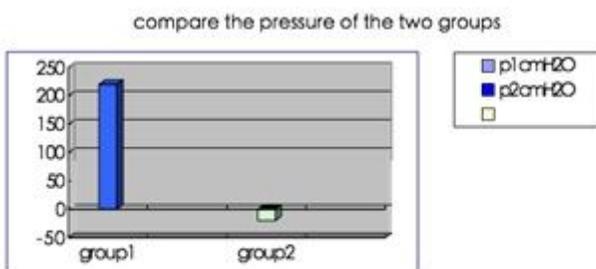


Figure 2

Figure 2 shows IAP in the first group produced very much higher pressures and the patients with control joints intra-articular pressure at rest was subatmospheric.



Figure 3

Typical X-ray shown narrowing of the joint space from OA subject. Typical pathology from OA patients was confirmed by the arthroscopy.

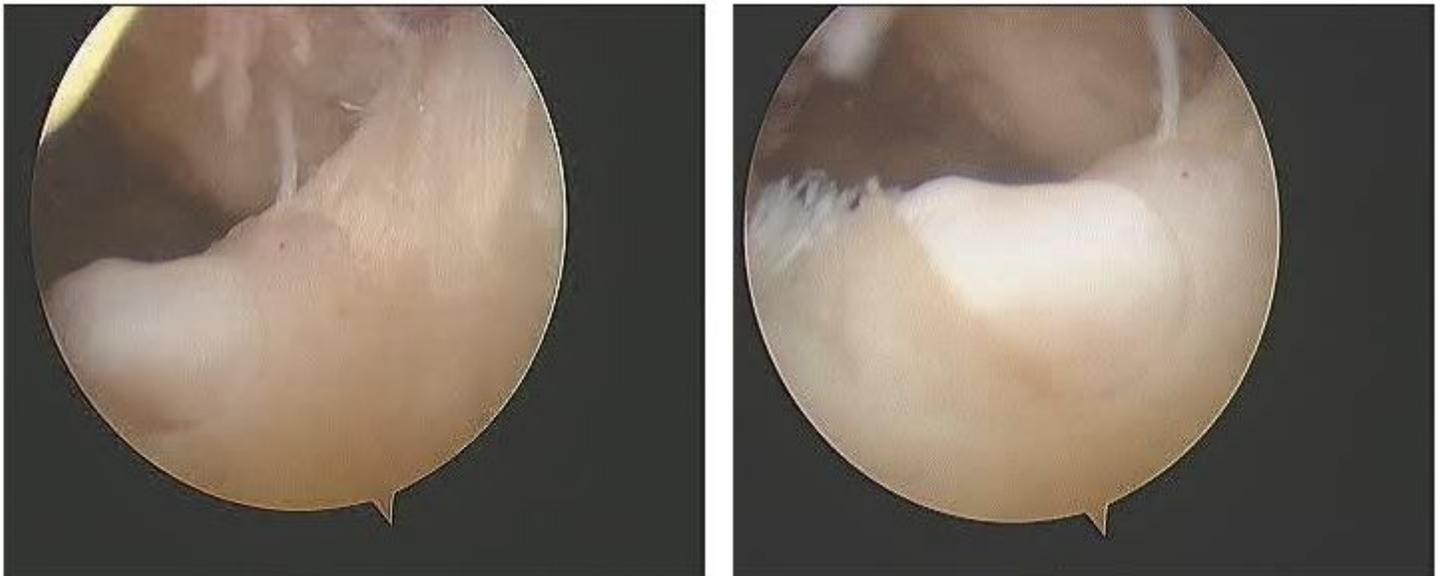


Figure 4

Typical pathology from OA patients was confirmed by the arthroscopy.