



Sonographic assessment of changes induced in Cartilage Health of Knee by Age and Knee Pain: A Cross-sectional Study

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ABSTRACT

Background of the Problem: Cartilage health of knee joint has been associated with number of risk factors which can be both traumatic as well as non-traumatic in origin. High Frequency Ultrasound has evolved as an important tool to assess cartilage health. The present study is aimed to find relationship between age and knee pain (VAS) with cartilage health.

Materials and Methods: This present study has cross-sectional study design. 320 subjects in the age range of 31-70 years satisfying the inclusion and exclusion criteria were recruited for the study. To ensure fair distribution of subjects, 8 sub-groups (40 subjects each) based on the age range difference of 5 years i.e. 31-35, 36-40, 41-45.....66-70 were made. After taking initial readings, the ultrasound of the subjects were performed by the radiologist and readings were noted down of cartilage thickness, cartilage health parameters (clarity and interface) as per the criteria laid down by ICRS integrity of cartilage interface.

Results: The standard error of mean was calculated for the mean values of cartilage health parameters and cartilage thickness, there came out to be non-significant difference between the right and left knee. There was significant correlation ($p < 0.0001$) between age and cartilage health parameters of right and left knee and non-significant relation between age and cartilage thickness of both right and left knee. There came out to be significant ($p < 0.0001$) relationship between knee pain and cartilage health parameters and cartilage thickness on lateral and intercondylar side and there was non-significant relationship between knee pain and medial side joint thickness for both the knees.

Conclusion: The conclusion of the present study is that there is significant correlation of cartilage health parameters with age and pain. There are non-significant differences of cartilage parameters between right and left knee.

Keywords: ICRS, Cartilage Clarity, Cartilage Interface, Cartilage Thickness

INTRODUCTION

Knee pain has become one of the most common problems encountered these days. It has become one of the most frequent reasons for a visit to an orthopaedician. Due to wide range of motion of knee joint and its function of mobility and supporting of body weight, it becomes vulnerable to injury and pain¹.

There can be number of reasons that cause knee pain. These reasons can be both traumatic as well as non-traumatic. Trauma can include fall on the knee, direct blow and twisting that could cause injury of ligaments and meniscus, road side accidents etc. Non-traumatic reasons includes age related degeneration of knee joint which include osteoarthritis and osteonecrosis, joint

inflammatory conditions like Rheumatoid arthritis, bursitis, etc. Other non-traumatic factors include cysts, loose bodies, gout etc. Traumatic causes include fracture, injury to supporting structures of knee joint such as meniscus, ligament sprain, muscle strain etc.

There is wide range of equipments used in assessment of cartilage health parameters of knee. Traditionally radiographs were used for assessing joint space width and osteophytes. More recently, advanced imaging techniques have evolved for visualizing soft tissues, cartilage and bony changes. These include High-frequency Ultrasound, Magnetic Resonance Imaging (MRI), and Optical Coherence Tomography (OCT) etc².

High-frequency pulse-echo ultrasound has evolved as an important and safe tool for the study of articular cartilage³. Ultrasound has evolved as a tool to study progression of osteoarthritis⁴. It also provides important information of cartilage health by providing vital information of its structural properties, cartilage roughness and integrity of cartilage⁵. Recently ultrasound has been developed to measure surface fibrillation and tissue thickness⁶. Previous researches have suggested that ultrasound examination is highly sensitive tool for studying cartilage health and structure^{5,7,8}.

Cartilage integrity is evaluated in terms of Cartilage clarity and Cartilage grade. Cartilage clarity is defined as how well the cartilage borders can be distinguished from the overlying intra-articular soft tissues. Cartilage clarity is ranked into 4 grades. Grade 1 implies to excellent; grade 2 implies to good; grade 3 implies to fair and grade 4 implies to poor⁹. Cartilage grade or irregularity is estimated by the criteria as laid down by the International Cartilage Repair Society (ICRS). This criterion divides the cartilage integrity or interface into 5 grades. Grade 0 implies to normal cartilage; grade 1 implies to near-normal cartilage with superficial lesions; grade 2 implies to cartilage with lesions extending to less than 50% of the depth of the cartilage; grade 3 implies to cartilage with defects that extend to more than 50% of the depth of the cartilage and grade 4 implies to severely abnormal cartilage with cartilage defects reaching to subchondral bone¹⁰.

The present study was designed to find out relationship between age and non-traumatic knee pain with cartilage thickness and integrity.

Material and Methods

The study design is cross-sectional in nature. The study was conducted in Gian Sagar Hospital, Rajpura. The subjects were recruited from the patients coming to Physiotherapy OPD for treatment and surrounding

areas. Ultrasound was conducted in the Radiology department of Gian Sagar Hospital by the radiologist.

Inclusion criteria included subjects in the age range of 31-70 with or without knee pain. Knee pain should be non-traumatic in origin and both the genders were included in the study. Exclusion criteria included the subjects with any history of fracture of lower limb in the last 1 year, any history of surgery in lower limb, subjects with soft tissue injury during the last 1 year, tumour, any neurological disorders like CVA, Parkinson's disease etc.

The study was approved by the ethical committee of Gian Sagar group of Institutes. 320 subjects satisfying the inclusion and exclusion criteria were made part of the study. To ensure uniform distribution of age of subjects, 8 subgroups with age difference of 5 years were made such as 31-35, 36-40, 41-45 and so on till 66-70. 40 subjects were included in each of the subgroup.

After taking written consent from the subjects, detailed assessment of the subjects was done for knee pain. Readings of the subjects were noted down of the height, weight for calculating BMI and pain perception on the Visual Analogue Scale (VAS). Then the ultrasounds of the subjects were done by the radiologist. Readings were noted of the cartilage thickness of both knees at three levels viz. medial, lateral and intercondylar. All the readings of cartilage thickness were taken in millimeters (mm). The cartilage integrity of interface was viewed and the appropriate grade was given to the cartilage clarity and cartilage grade by the radiologist in consultation with the researcher as per the criteria laid down by ICRS (Figure 1). One time readings of the patients were taken.

Results

Table 1 presents the demographic details age, VAS and BMI of the subjects. 320 subjects with mean age of 50.4750 with standard deviation of 11.6134 were made part of study. The subjects recruited were normal to mild obese category with mean BMI score of 27.9146 ± 4.3710 . The pain perception reading as measured by VAS is 3.2250 ± 2.8305 which gives an impression that the pain level of the subjects as measured by VAS lies in mild to moderate range.

Table 2 presents the gender distribution of the subjects participating in the study. 162 male (50.625%) and 158 females (49.375%) subjects were recruited for the study. The standard error of mean was calculated and the results came out to be non-significant at 5% level of significance showing that there is non-significant difference between male and female participants in the study.

Table 3 denotes the cartilage health of right and left knee. Cartilage integrity mean score, as per the criterion laid by ICRS, of right knee is 1.5563 ± 0.6199 and of left knee is 1.5875 ± 0.6698 . The mean cartilage clarity grade of right knee is 1.5563 ± 0.5505 and of left knee is 1.5688 ± 0.5769 . The mean cartilage thickness of right knee is 1.7830 ± 0.8106 medially, 2.0328 ± 0.7160 laterally and 2.4163 ± 0.8314 at intercondylar level. The mean cartilage thickness of left knee is 1.9044 ± 0.8189 medially, 1.9723 ± 0.5995 laterally and 2.4226 ± 0.7568 at intercondylar level. Standard error of mean is calculated for all the parameters and there came out to be non-significant relationship between right and left knee at 5% level of significance. Table 4 and 5 depicts the relationship of age with cartilage health parameters of right and left knee. There is a significant relationship between age and cartilage clarity of right knee ($r = 0.3752$) and left knee ($r = 0.4469$). There was found to be significant relationship between age and cartilage interface of left knee ($r = 0.4683$) but there was less significant relationship between age and cartilage interface of right knee ($r = 0.2997$). There came out to be very less relationship between age and cartilage thickness on medial, lateral and intercondylar levels. On the medial side, the

relationship came out to be in negative direction for both right ($r = -0.0469$) and left knee ($r = -0.0457$), which means that with increase in age, cartilage thickness on medial side of both right and left knee decreases.

Table 6 and 7 shows correlation between knee pain with various cartilage health parameters of right and left knees. There was less-significant relationship of knee pain with cartilage clarity of right knee ($r = 0.3434$) but there was a significant relationship of knee pain with cartilage clarity of left knee ($r = 0.4084$). Regarding the relationship of knee pain with cartilage interface, there was less significant relationship with right knee ($r = 0.2924$) and significant relationship with left knee ($r = 0.4155$). From the table it is clear that cartilage clarity as well as cartilage interface of left knee has more significant positive relation as compared to right knee. The correlation between knee pain with cartilage thickness of right and left knee came out to be very less at all the sites i.e. medial, lateral and intercondylar. It means there is hardly any relationship between knee pain with cartilage thickness.

Table 1: Mean Age, BMI and VAS (Demographic) details of the subjects

S. No	Parameters	Mean \pm SD
1	Age	50.4750 ± 11.6134
2	BMI	27.9146 ± 4.3710
3	VAS score	3.2250 ± 2.8305

Table 2: Gender distribution of the subjects

S. No	Gender	No. of subjects	%age	S.E. of Mean	5% LOS
1	Males	162	50.625%	0.22	NS
2	Females	158	49.375%		

Table 3: Cartilage health of Right and Left Knee

S. No	Cartilage Parameter	Right Knee (Mean ± SD)	Left Knee (Mean ± SD)	S.E.of Mean	5% LOS
1	Cartilage grade (Interface)	1.5563 ± 0.6199	1.5875 ± 0.6698	0.612	NS
2	Cartilage Clarity	1.5563 ± 0.5505	1.5688 ± 0.5769	0.280	NS
3	Thickness (Medial) (mm)	1.7830 ± 0.8106	1.9044 ± 0.8189	1.885	NS
4	Thickness (Lateral) (mm)	2.0328 ± 0.7160	1.9723 ± 0.5995	1.159	NS
5	Thickness (Intercondylar) (mm)	2.4163 ± 0.8314	2.4226 ± 0.7568	0.100	NS

Table 4: Correlation between Age with Cartilage Health parameters of Right Knee

S. No	Parameters	r- value	P Value	Sig./Non-sig.
1	Age and Cartilage clarity	0.3752	<0.0001	Significant
2	Age and cartilage interface grade	0.2997	<0.0001	Significant
3	Age with Medial side joint thickness	-0.0469	0.2354	Non-significant
4	Age with Lateral side joint thickness	0.0309	0.4345	Non-significant
5	Age with Intercondylar joint thickness	0.0659	0.0953	Non-significant

Table 5: Correlation between Age with Cartilage Health parameters of Left Knee

S. No	Parameters	r- value	P value	Sig./Non-sig.
1	Age and Cartilage clarity	0.4469	<0.0001	Significant
2	Age and cartilage interface grade	0.4683	<0.0001	Significant
3	Age with Medial side joint thickness	-0.0457	0.2476	Non-significant
4	Age with Lateral side joint thickness	0.0135	0.7328	Non-significant
5	Age with Intercondylar joint thickness	0.0582	0.1407	Non-significant

Table 6: Correlation between Knee Pain with Cartilage Health parameters of Right Knee

S. No	Parameters	r- value	P value	Sig./Non-sig.
1	Knee Pain and Cartilage clarity	0.3434	<0.0001	Significant
2	Knee Pain and cartilage interface grade	0.2924	<0.0001	Significant
3	Knee Pain with Medial side joint thickness	0.0173	0.6617	Non-significant
4	Knee Pain with Lateral side joint thickness	0.1667	<0.0001	Significant
5	Knee Pain with Intercondylar joint thickness	0.1554	<0.0001	Significant

Table 7: Correlation between Knee Pain with Cartilage Health parameters of Left Knee

S. No	Parameters	r- value	P value	Sig./Non-sig.
1	Knee Pain and Cartilage clarity	0.4084	<0.0001	Significant
2	Knee Pain and cartilage interface grade	0.4155	<0.0001	Significant
3	Knee Pain with Medial side joint thickness	0.0006	0.9879	Non-significant
4	Knee Pain with Lateral side joint thickness	0.1787	<0.0001	Significant
5	Knee Pain with Intercondylar joint thickness	0.2040	<0.0001	Significant

**Figure 1: Ultrasound Image Depicting Cartilage Thickness and Cartilage Parameters****Discussion**

The present study was conducted to evaluate the effect of age and knee pain on cartilage health of knee. 320 subjects with and without knee pain were made part of study and Ultrasound of the knees were done by the Radiologist. The readings were taken of Cartilage thickness and grading was done by the radiologists in consultation with the researcher of Cartilage Clarity and Cartilage Interface.

Table 1 represented the mean age, VAS and BMI (demographic details) of the subjects. The mean age of the subjects is 50.4750 ± 11.6134 . This shows that the subjects were fairly distributed in the age range taken for the study. The mean BMI of the subjects is 27.9146 ± 4.3710 . The subjects taken are normal to mild obese category. The mean VAS score of the subjects is 3.2250

± 2.8305 . The subjects recruited for the study has mean VAS score in mild to moderate category.

162 males (50.625%) and 158 females (49.375%) were made part of the study (Table 2). It is clear that there is no significant difference between the male and female ratio. The uniform distribution of the subjects in the study helps the result to be generalized to the whole population.

The uniform distribution of the subjects selected has been supported by the study done by Slemenda et al., 1997 in which almost same number of male and female subjects were recruited¹¹.

There is found to be non-significant differences between the right and left knees with cartilage health and thickness as criterion (Table 3). This might be attributed to the fact that there is equal loading of both the knees and probably there will be equal changes to

the cartilage with age¹². This finding is supported by the study done by Shakoor et al., 2002 who have concluded that there is high incidence of bilateral knee osteoarthritis and there will be almost equal changes in the left and right knee joint¹³.

There was significant relationship of age with cartilage parameters of both knees (Table 4 & 5). This might be attributed to the loss of cells and reduced growth factor activity as well as reduced water content¹⁴. These results are in compliance to the result of the study done by Ding et al, 2005 who also concluded that increasing age leads to increase of cartilage defects and cartilage thinning¹⁵.

There came out to be very less-significant relationship between age and cartilage thickness. Medially the relationship came out to be negatively related which means that with advancement of age, the thickness of the cartilage on medial side decreases. This might be attributed to the fact that maximum joint loading during weight bearing is on medial side.

There was significant relationship between VAS with cartilage health parameters of both right and left knees (Table 6 & 7). VAS is having significant relationship with age which has been epidemiological studies and is also proved to have significant positive correlation with cartilage health parameters^{12, 14, 15, 16}. This might be the reason that there is significant positive correlation

between VAS and cartilage parameters. There is very less-significant relationship of VAS with cartilage thickness. It gives an impression that cartilage thickness is not the criterion that decides the pain in the joint though more studies of this type will be required to establish the fact.

The major limitation of the study is that the study is limited to small strata and small sample size in each age group. This study can be replicated with large samples covering larger population from different strata.

Conclusion

The conclusion of the present study is that the cartilage thickness is not the criterion to decide the pain in the knee joint. There came out to be significant correlation of cartilage health parameters with age and pain. Also there are non-significant differences of cartilage parameters between right and left knee.

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Conflict of Interest: The authors declare that there are no conflict of interests.

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