Patients Age is a Critical Factor in Determining the Severity of Osteoarthritis of the Shoulder

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Abstract

Background:

Osteoarthritis (OA) is one of the most common musculoskeletal disorders in the aging population. The correlation of radiographic OA severity, disability and pain is variable and inconsistent for the different joints. This study aims to elucidate the relationship between histological and radiological signs of shoulder OA with pain sensation and functional impairment to potentially adapt the recommendation for surgical treatment for primary total shoulder arthroplasty (TSA).

Methods:

Forty-four patient with shoulder OA undergoing a TSA using an anatomic stemless implant were included in this study. The radiological OA severity was scored preoperatively on true ap X-rays according to the Kellgren-Lawrence-Score (KL-Score). The histological OA severity was determined according to the OARSI-Score using bone-cartilage sections from loaded areas of the humeral head. Pain was quantified with the Visual Analog Scale (VAS). The functional status was assessed by the items "mobility" and "strength" out of the Constant-Murley-Score (CS-Score).

Results:

There was no correlation between radiographic and histological severity in shoulder OA. However, a correlation between age and the severity of radiological changes was observed. Further, pain did not correlate with histological or radiological scores, whereas it correlated with age. The functional shoulder status (mobility, strength) correlated with the severity of radiological changes, but not with the histologic scoring.

Conclusion:

This study shows that increased age is the main determinant of radiological changes in shoulder OA, as well as pain. Therefore, age and pain sensation should be considered as important parameters for the recommendation for TSA.

Background

Osteoarthritis (OA) is one of the most common age related diseases.¹⁰ OA is characterized by progressive loss of cartilage, new bone formation, and inflammation of the synovial tissue.² Clinically, OA can be diagnosed by the radiographic evidence of cartilage damage and it is considered to cause increased complaints about joint pain, restricted activities of daily living, loss of function and strength of the affected joint.²³ The Kellgren-Lawrence-Score (KL-Score), therefore, has been proposed as one radiographic diagnostic method to estimate the extent of shoulder OA.¹⁶ Therefore, OA can also be approached by assessing subjective and objective determinants of the respective joint.

A correlation between structural damage and radiological appearance for hip and knee OA has been clearly shown previously.^{31,32} Additionally, some studies showed a correlation between pain and radiological OA severity.^{3,14} This correlation, however, is controversially discussed in the literature for both, the knee and the hip joint.^{4,12} One study showed, that an increased radiological score in the knee joint was associated with increased pain frequency scores.⁹ Another study showed that no significant association between radiographic lesions and pain frequency could be proven for the hip, giving rise to the assumption that the pain sensation might be joint specific.²⁵

OA of the shoulder joint is less frequent than hip or knee OA.^{2,23} Furthermore, there are even less information about the correlation between radiographic changes and pain for the shoulder joint. The optimal management of primary shoulder OA is a topic of ongoing investigation.¹ Beside conservative treatment, numerous surgical techniques exist including non-arthroplasty techniques and anatomic or reversed shoulder replacement systems.¹ Although primary total shoulder arthroplasty (TSA) has been accepted as an effective and secure procedure to relieve pain and to restore shoulder function in patients with end-stage OA, who failed to conservative treatment, it is potentially associated with a number of complications.^{8,20,30} Therefore, the indication for TSA needs to be proven carefully. Besides a justified indication for TSA considering the respective joint pathology, an accurate surgical technique with utilization of an adequate implant and the appropriate patient selection are essential factors for a successful outcome of TSA.

The aim of this study was to elucidate the relation between radiological changes and histological appearance of OA with pain sensation as well as the functional status in patients with shoulder OA. This aims to provide more insight to amend the recommendations for TSA in patients with shoulder OA.

Methods

Patients

This study included 44 patients (19 male / 25 female, 68.5 ± 17.5 years) with primary OA of the shoulder treated with a stemless humeral head replacement between December 2011 and May 2013. Informed consent obtained from all patients enrolled in the study after IRB approval of the faculty of medicine. (IRB No: 55/11).

Radiographic analysis

Standardized X-ray images in true anterior-posterior view in neutral position of the forearm of the patients were performed preoperatively. The KL-Score was used for scoring of shoulder OA severity.¹⁶ As we did not include instability of the shoulder joint as well as rotator cuff arthropathy in our study, we decided to use the KL-Score instead of the Samilson- or Hamada Fukuda-Score. The KL-Score is mainly based on the quantification of osteophytes, joint space narrowing and subchondral bone sclerosis. These are the

key features we investigated in this study. All radiographs were reviewed by two independent observers and a consensus score was generated during a meeting.

Histological analysis

OA grade was evaluated using a histology score (OARSI-Score). Briefly, the resected humeral head were cut into quarter slices (centre to periphery). All specimens were fixed in 4 % PFA for 24 h, decalcified, and embedded in paraffin. 3-4 μ m sections were cut and stained using Safranin-Orange. OARSI Score was used to assess the histological osteoarthritis score was used (grades 0–6).²⁶ The classification OARSI scoring for of each blinded sample, which was reviewed by two independent observers and a consensus score was generated during a meeting..

Clinical Evaluation

One of the authors clinically examined all patients before and after TSA procedure. The functional status of the patients was assessed with the items "mobility" and "strength" accordingly to the Constant Murley-Score.⁶ The pain sensation of each patient was assessed using a visual analog scale (VAS; 0 – no pain, 15 – max. pain).

Statistical analysis

Statistical analysis performed using GraphPad 6 Software (La Jolla California, USA). The statistical significance was analysed using a linear regression. Statistical significance was considered for a p-value < 0.05.

Results

Description of the patient cohort

The pre-operative functional joint status of the patients was measured using the Constant-Murley (CS) Score with an average of 13.2 ± 7.4 points for "mobility" and 2.6 ± 2.3 points for "strength" in the total cohort. The pre-operative pain sensation of the patients was measured using the VAS-Pain score (8.7 ± 2.6 points). The radiographic evaluation of the true anteroposterior X-rays showed a grade 1 in 5 patients, a grade 2 in 10 patients, a grade 3 in 6 patients and a grade 4 in 23 patients according to the KL-Score.

No correlation between radiological and histological OA grade

Additionally, we scored cartilage-bone sections from the main loaded area of the humeral head using the OARSI-Score. When comparing the radiographic OA severity with histological signs of OA, there were patients with severe radiographic and histological OA (figure 1a). Interestingly, we also observed patients with low radiographic OA severity, but marked histological OA severity (figure 1b). However, we also found patients with severe radiographic OA and mild OA like cartilage changes (figure 1c). The classification of the histological OA grade of the specimens according to the OARSI-Score demonstrates grade 1 in 1 patient, a grade 2 in 3 patients, a grade 3 in 13 patients and a grade 4 in 6 patients, grade 5 in 11 patients and grade 6 in 7 patients. In line with the above mentioned observations, we found no correlation in the anterior-posterior projection in KL classification and OARSI scoring for comparing the grade of shoulder OA ($p=0.4$) (figure 1d).

Correlation between pain and OA severity

To understand whether there is a correlation between pain and the radiographic OA severity, the KL-Score was plotted against the values from the VAS-Pain-Scale specific for the shoulder for each patient. There was no significant correlation between KL-Score and VAS-Pain-Scale ($p=0.2$) (figure 2a). Furthermore, there was no correlation between the VAS-Pain-Scale and the OARSI-Score ($p=0.4$) (figure 2b) in the tested cohort. Interestingly, a correlation was found when comparing age with pain ($p=0.04$) (figure 2c) for each patient. This finding indicates that older patients had significantly more pain compared to younger patients.

Joint function correlated with KL-Score, but not with histological assessment

Furthermore, we tested the influence of radiological and histological signs of OA on the joint function. The correlation analysis between the KL-Score and the functional status of the shoulder joint, represented via the items “mobility” and “strength”, was significant ($p=0.0003$, $p=0.04$ respectively) (figure 3a, b). However, the items “mobility” and “strength” did not correlate with the histological OARSI-Score ($p=0.6$ and $p=0.8$, respectively) (figure 3c, 3d).

Age correlated with Kellgren-Lawrence Score, but not OARSI-Score

Since OA proposed to be an age related disease, we investigated the correlation between radiological signs of OA using the KL-Score and age. We observed a strong correlation between both parameter ($p=0.03$) (figure 4a). A correlation analysis between the histological OA grade and the age of the respective patient, revealed no correlation between both parameters ($p=0.8$) (figure 4b).

Discussion

The aim of the study was to investigate the interaction between typical clinical findings in patients with shoulder OA who failed to conservative treatment in consideration to the indication of primary TSA. Therefore, correlation analysis performed including the parameters pain, functional involvement, radiological and histological appearance and age in patients undergoing a stemless humeral head replacement.

The findings of the present study lead to the assumption that pain sensation correlates with patient age. Furthermore, our data show a correlation between severity of radiographic changes of arthritic shoulder joint and the functional impairment of the involved shoulder. The characteristic histologic evaluation of structural cartilage damage in shoulder OA does not seem to be directly associated with the radiographic severity as well with the limitations in function and pain sensation of the affected arthritic joint (overview in suppl. table 1).

The success of TSA as a treatment option in patients with shoulder OA is depending on many factors.¹¹ Objective parameters such as the improvement of range of motion and an increase of strength as well as subjective values like pain reduction are involved in patient satisfaction after surgery.^{15,27} The observation that the radiographic OA signs increase with increasing patient age is in line with a previous study.¹⁷ However, the missing correlation between radiographic OA changes and histological OA changes has not been described so far. To our knowledge, only one study has analysed the relationship of signs of OA e.g. the hyaline articular cartilage calcification with age and histologic OA grade using the OARSI-Score before.¹³ In line with our findings, the authors did not observe a correlation between OARSI-Score and age. However, the study did not include the KL-Score or the VAS-Pain-Score of the patients since this study included only post-mortem samples. The phenomenon that the histological OARSI-Score correlates with the radiographic changes has been described for hand and knee OA before.^{31,32} A possible explanation for this discrepancy in the shoulder joint might be due to limitations of grading osteochondral lesions with x-ray radiographs utilizing the KL-Score, which was not originally applied to the glenohumeral joint.¹⁶ Furthermore, shoulder OA is often associated with a posterior humeral head dislocation. The size and location of resulting osteochondral lesions ("posterior wear") may be not detectable using X-ray analyses.²⁸

The data of the present study suggest that neither the radiographic nor the histological joint changes had a significant influence on the pain sensation in patients with OA. This observation is in line with a previous study also showing that the radiographic changes in the shoulder do not correlate with the VAS-Pain-Score.¹⁸ In contrast, other studies show a correlation between pain intensity and KL-Score for other joints e.g. the knee^{3,22} or hip.¹⁴ These incongruent results within several joints lead to the assumption that pain intensity and disease severity in radiographs may differ for each joint of the body. This discrepancy may also be explained by some aspects of the pathology of OA that are related to pain like synovitis or bone marrow edema that cannot be seen in X-ray imaging.²⁴ Additionally, periarticular

pathologies such as subacromial bursitis and / or rotator cuff - and biceps tendinitis are also common in patients with shoulder OA resulting in local pain and not depicted in x-ray pictures. These numerous “non-articular pain conditions” might also contribute to the discrepancy between pain intensity and the radiographic severity in the shoulder OA.²⁴

The average age in this study population is in the typical range for OA.²⁹ In this context the present study shows, that the age of the patient correlated with pain intensity estimated by a VAS score. This finding indicates that age-related effects might influence pain sensation in shoulder OA. Several studies have evaluated the impact of age as a risk factor for pain perception.^{19 21, 34} Interestingly, animal studies demonstrated that the sensitization of nociceptors to mechanical stimulation depended on age and the chronicity of the inflammation.^{20, 31} Moreover, human OA pain sensation is a complex phenomenon and beside structural articular pathologies like cartilage alterations or inflammation due to synovitis it is caused and modulated by various other factors, e.g. central pain pathways and genetic factors.^{7, 33, 35}

This study also shows that the functional status of the shoulder, evaluated according to the CS-Score items “mobility” and “strength” are clearly associated with the severity of the radiographic articular changes. This might be explained by the fact that a decreased joint volume, a tight capsule, osteophytes and the deformation of the articular surface may cause a mechanical restriction of the joint motion as well as a reduced ability to raise and hold a specific weight in a given position. However, the histopathological evidence of glenohumeral cartilage degeneration, did not seem to affect shoulder function and pain sensation as shown in this present study. It is well known that in contrast to osteochondral defects of weight-bearing joints such as the hip, knee, and ankle, even large degenerative glenohumeral cartilaginous lesions can be well tolerated.⁵ As the shoulder is a non-weight-bearing joint, a strong correlation between the extent of cartilage damage, pain intensity and functional disability is lacking.

We are well aware of the limitation of our study, which includes only 44 patients. More patients are needed to unravel the complex relations between structural joint damage and pain sensation.

Conclusion

The diagnosis and treatment options of shoulder OA are commonly based on functional impairment and radiographic signs of OA. This study shows that particularly pain intensity and patient age are important parameters in supporting treatment plans for shoulder OA and should be taken into account for decision making in TSA. However, further investigations are needed to evaluate the exact impact of the structural pathology, functional limitations and pain for the recommendation of TSA in patients with shoulder OA.

Abbreviations

Total shoulder arthroplasty (TSA); Osteoarthritis (OA); Constant Murley Score (CS); Kellgren and Lawrence Score (KL Score); Histology score (OARSI Score); visual analog scale pain score (VAS pain score)

Declarations

Ethics approval and consent to participate

The IRB of the medical faculty (Ethik -Kommission der Otto-von-Guericke Universität an der Medizinischen Fakultät und am Universitätsklinikum A.ö.R. Univ. Prof. Dr.med. C. Huth) approved the study (IRB No: 55/11). Written informed consent was obtained from all patients before including them in the study.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from the authors, Data are however available from the authors upon reasonable request.

Competing interests

Professor Christoph H. Lohmann is a paid consultant for the following companies Waldemar Link GmbH & Co. KG, Mathys Medical GmbH and ImplanTec GmbH and has royalties from ImplanTec GmbH. Dr. Alexander Berth is a paid consultant for Mathys Medical GmbH. The authors confirm that there has been no significant financial support for this work that could have influenced its outcome.

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Authors' contributions

NM performed all experiments, VM enrolled the patients and measured the VAS-Score, JB helped with the evaluation of the OARSI Score and writing of the manuscript, CHL helped writing of the manuscript and evaluation of the clinical data, Ab identified the patients and evaluated all data and wrote the manuscript. All authors have read and approved the manuscript.

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Figures

Figure 1

No correlation between radiological and histological OA grade A) Representative true anteroposterior X-ray picture with- Kellgren-Lawrence grade 4 and corresponding histological cartilage evaluation (OARSI 5). B) True anteroposterior X-ray picture with KL grade 2 and corresponding histology (OARSI 6). C) True anteroposterior X-ray with KL grade 4 and corresponding histology (OARSI 4) D) Correlation between OARSI Score.

A **B** **C** **Figure 2**

No correlation between radiological and histological OA grade. A) Linear regression analysis of pain (VAS-Score) data with Kellgren-Lawrence Score (N=33, $p=0.21$) B) Linear regression analysis of pain (VAS-Score) with OARSI score (N=31, $p=0.41$) C) Linear regression analysis of pain (VAS-Score) with age (N=31, $p=0.0354$).

Figure 3

Joint function correlated with KL-Score, but not histological assessment. A) Linear regression analysis of the Constant-Murley Score item “strength” and “mobility (B) with radiological changes (N=31, $p = 0.042$ and $p = 0.0003$, respectively. C) Linear regression analysis of the Constant-Murley-Score item “strength” and “mobility” (D) with the histological OARSI score (N=31, $p = 0.5558$ and 0.823 , respectively).

Figure 4

Age correlated with Kellgren-Lawrence Score, but not OARSI-Score. A) KL-Score correlation with age (N= 44, $p=0.0299$) B) OARSI score correlation with age (N=41, $p= 0.819$)

Supplementary Files

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