行政院國家科學委員會補助專題研究計畫成果報告

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中文摘要

我們嘗試使用非侵入性的檢查—動態增強顯影之磁振造影(MRI)來觀察急性期與慢性期粘連性囊炎的影像變化，並與復健療效做比較分析。本研究前瞻性的蒐集 30 位評估為粘連性囊炎之患者，動態掃描使用 T_1 加權序列並加上脂肪去除參數，每張掃描 7 秒，間隔 1 秒，並使用 0.2cc/kg 的 gadopentate dimeglumine 以每秒 1.5cc 的速度經注射器注入患側的上肢靜脈，連續掃描約 7 分鐘，成像後測量最大顯影與顯影速度(rate)並作分析。其中剔除因成像技術失誤的 5 名病患，最後包括 18 名病患患有滑膜囊炎和 7 名無症狀受檢者。結果顯示動態增強顯影的 MRI 成像對於炎性變化應該有較快速（正常 vs.異常，0.48）與最大顯影（正常 vs.異常 62%）的效果（$p<0.05$）。我們初步結論動態的增強顯影 MRI 有助於了解粘連性囊炎急、慢性期的病理過程，並可能用來代替侵入性的關節囊攝影檢查，進一步提供治療前的評估。另外，侵入性的關節囊擴張術療程可能較短，但療效則有待探討。

關鍵詞：冰凍肩、粘連性囊炎、磁振造影、關節囊攝影

Abstract

We prospectively evaluated 30 subjects with dynamic contrast-enhanced MR imaging in assessment of adhesive capsulitis with clinical correlation. Of these 30, five were excluded due to technical failure during the MR examinations. Finally, 18 patients with adhesive capsulitis (18 shoulders) and 7 asymptomatic shoulders were recruited. Dynamic contrast-enhanced MR imaging was obtained at oblique coronal plane. A FAT-SAT T1-weighted sequence (TR=150msec, TE=15msec) was acquired at 7-sec scanning (including 1-sec interval) for 7 minutes after bolus injection of 0.2cc/kg of gadopentate dimeglumine. The greatest differences of peak enhancement as measured in the axillary capsule were higher in the symptomatic shoulder with adhesive capsulitis than that in the asymptomatic shoulder (avearge difference 62%). Time to peak enhancement were 322sec after bolus injection of gadopentate dimeglumine. Their difference in slopes of enhancement was 0.48 (% signal increase per second) with the slope of the diseased shoulder higher than that of the controls. Their differences in both of the peak and slope of enhancement reached statistic significant ($P < 0.05$). We conclude that dynamic contrast-enhanced MR imaging can be helpful in assessing and monitoring shoulder adhesive capsulitis.

Keywords： Frozen shoulder, Adhesive capsulitis, MR imaging, Arthrography

PRELIMINARY RESULTS OF THIS GRANT

Background

Adhesive capsulitis (frozen shoulder) is the main cause of shoulder pain and dysfunction in middle and elderly populations. The natural history includes three stages: In preadhesive stage, there is edematous fibrinous pannus over the synovium; in stage II, there is a proliferation of synovium and early adhesive synovitis; in stage III, maturation with loss of axillary fold and synovitis subsides; in stage IV, adhesives are fully mature and markedly restrictive. In general, double-contrast arthrography is the definite test for diagnosis of adhesive capsulitis. Joint capacity, normally 14cc or greater, is usually less than 10cc in adhesive capsulitis. Physical therapy is commonly employed for treatment. However, it may not show early stage of the disease and it may not be an optimal test in monitoring treatment for its invasive procedure.

Purpose

To investigate a noninvasive diagnostic test, we attempt to employ dynamic contrast-enhanced MR imaging in

assessment of adhesive capsulitis with clinical correlation.

Patients and Methods

Patients

We prospectively studied 23 patients with clinical suspicious shoulder adhesive capsulitis. Patients' inclusion criteria were as follows: i) history of shoulder pain and stiffness for more than one month; ii) no previous surgery or intervention procedures of the affected shoulder joint; iii) shoulder pain elicited at terminal range in all planes of shoulder motion; iv) the range of motion (ROM) limited to flexion of < 140 degree, abduction of < 120 degree, internal rotation of < 70 degree, and external rotation of < 50 degree. Patients co-exited with rotator cuff tears were excluded. Of these 23, five patients were excluded due to some technical problems during MR examinations. Finally, a total of 18 patients with documented adhesive capsulitis were recruited. We also evaluated 7 asymptomatic volunteers who received the same techniques for MR studies.

All patients (n=18) were treated non-invasively by physical modality and exercise intervension. In addition, five patients with adhesive capsulitis received aggressive treatment by arthrographic injection. These five patients were part of our ongoing longitudinal study. All patients will begin physical therapy and weekly follow-up by the same physiatrist with the same measurable parameters.

MR Imaging

MR imaging was performed with use of shoulder surface coil. After rountine spin-echo MR imaging in three planes, dynamic contrast-enhanced MR imaging was obtained at oblique coronal plane. A FAT-SAT T1-weighted sequence (TR=150msec, TE=15msec) was acquired at 7-sec scanning (including 1-sec interval) for 7 minutes after bolus injection of 0.2cc/kg of gadopentate dimeglumine. The rate of injection was 1.5cc/sec via a 21-G catheter in an antecubital vein. Other imaging parameters included 15-cm field-of-view, 5-mm slice thickness, 1-mm interval, 128x256 matrix, and 5 NEX. Shoulder arthrography was performed as a gold standard in selective cases. The diagnosis of adhesive capsulitis was established when a) joint capacity less than 10cc, b) diminished axillary reccess, and c) tightness or irregularity of capsular margin.

Data Analysis

Quantitative analysis was performed on each set of MR images of each patient. One operator consistently measured SI at the axillary recess. Subsequently, the SI before contrast injection (SI prior), the time lapse between the start of contrast injection and the point of maximum SI increase (T max), and the SI at T max (SI max) were determined. The percentage of peak enhancement was calculated as follows: SI increase = (SI max – SI prior) x 100 / SI prior. The rate of enhancement was calculated as percentage of increase of SI over baseline value SI prior per minute as follows: Slope = (SI max – SI prior) x 100 / (SI max x T max). Differences in peak and rate of enhancements between symptomatic and asymptomatic shoulders of each region-of-interest were compared.

Results

A progressive increase in percentage of peak enhancement was observed in the symptomatic axillary capsule. The greatest differences of peak enhancement as measured in the axillary capsule were higher in the symptomatic shoulder with adhesive capsulitis than that in the asymptomatic shoulder (avearge difference 62%). Time to peak enhancement were 322sec after bolus injection of gadopentate dimeglumine. Their difference in slopes of enhancement was 0.48 (% signal increase per second) with the slope of the diseased shoulder higher than that of the controls. Their differences in both of the peak and slope of enhancement reached statistic significant ($P < 0.05$).

In follow-up 4 patients who were treated by conservative therapy revealed

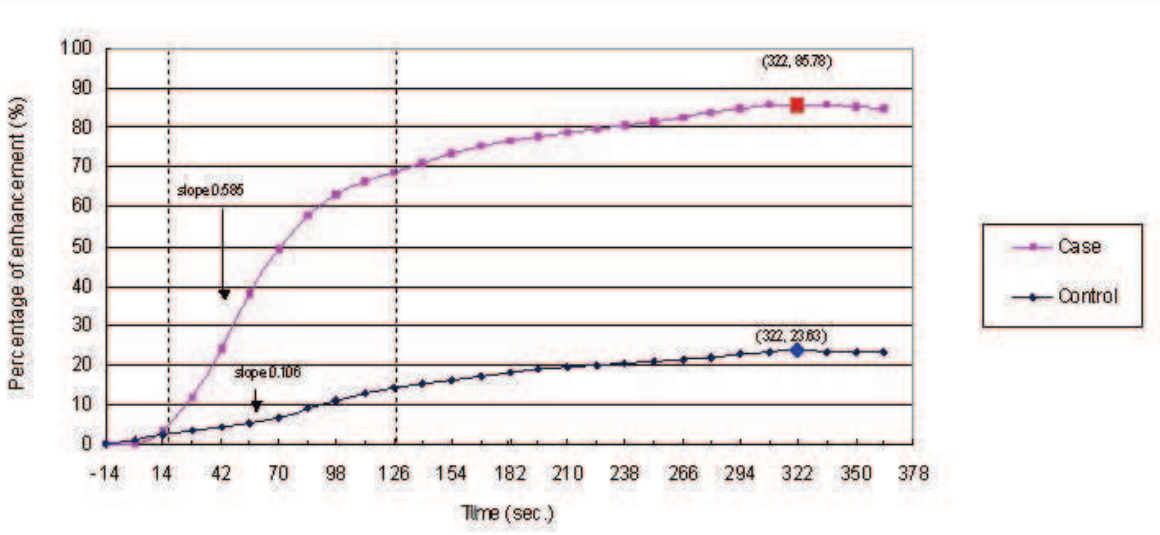

Figure: Time-intensity curve shows differences of slope and peak of enhancement between diseased (pink, n=18) and control (blue, n=7) shoulders.

good respond in 3 patients and poor in one patient. For the five patients treated with aggressive arthrographic expansion of joint capsule, four of them had a good outcome.

Discussion

Adhesive capsulitis is an insidious painful condition of the shoulder characterized by progressive loss of range of motion. Neviaser suggested that an inflammatory reaction in the capsule and the synovium leads to adhesions, particularly in the axillary fold. At surgery, he observed a generalized capsular thickening and diminished joint fluid. Histologically, no synovial cell proliferation was noted. Instead, subsequent investigators saw fibroblast proliferation.

Radiographically, double contrast shoulder arthrographic features document the diminished joint capacity to less than 10ml as compared to normal joint of 14ml. The axillary fold can be obliterated by the adhesions, and evidence of irregularity of the capsular/synovium appearance. ON MR imaging, Emig et al. observed that the joint capsule and synovium thickness greater than 4mm in patients with adhesive capsulitis (specificity, 95%; sensitivity, 70%). However, they found that the volume of articular fluid seen on MR images was not significantly diminished in their patients. Manton et al used MR arthrography in the diagnosis of adhesive capsulitis with negative results. Comparing to their control subjects, they concluded that capsular/synovial thickness ($P > 0.05$), static fluid volume ($P > 0.05$), and the presence of corrugation ($P < 0.05$) were inconclusive as MR arthrographic signs for distinguishing shoulders with adhesive capsulitis.

We explore the use of dynamic contrast enhanced MR imaging to probe the hemodynamic change of the synovium in patients with adhesive capsulitis as compared to normal subjects. Initial results of our study revealed that the values of peak and slope of enhancement were far greater than those in control subjects, indicating an increased blood perfusion to the synovium in the adhesions. Histologically, Hannafin et al described three stages of the disease. In stage 1, the majority of motion loss of the patients is secondary to painful synovitis, rather than a true capsular contration. Arthroscopic examination reveals a hypertropic vascular synovitis that coats the entire capsular linning. Biopsy specimens show rare inflammatory infiltrates, a hypervascular synovitis and normal underlying capsular morphologic characteristics. In stage 2, a loss of capsular volume and a response to the painful

synovitis are noted. Histologically, there is notable for a hypervascular synovitis with perivascular scar formation and capsular fibroplasias with deposition of disorganized collagen fibrils and a hypercellular appearance. No inflammatory infiltrates have been reported in stage 2. Stage 3 reflects painful stiffness of the shoulder and significant loss of range of motion. A filmy synovial layer is visible with patches of synovial thickening without hypervascularity. Capsule biopsy reveals a dense, hypercellular collagenous tissue.

Study Limitations

Certain study limitations should be acknowledged. First, we made no comparison of patients with adhesive capsulitis with other abnormalities of the shoulders that could potentially thicken the capsule and synovium, such as rheumatoid arthritis or rotator cuff pathology. Second, we did not perform arthrography in all cases that might lack of a gold standard in this study.

Conclusion

Dynamic Contrast-Enhanced MR imaging can be helpful in assessing and monitoring shoulder adhesive capsulitis. In particular, the dynamic technique also can give benefit in screening patients with histological acute, inflammed joint capsule which can be effectively treated by conventional or possibly more aggressive procedures.

References

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SCIENTIFIC DIFFICULTIES DURING THE RESEARCH PERIOD

It was difficult to collect asymptomatic volunteers who were willing to receive injection of gadolinuium contrast medium in this preliminary MR study. Similarly, it seemed to be difficult to obtain data from the contra-lateral unaffected shoulder since the dynamic study of both shoulders was unable to be performed simultaneously. These limitations can be solved by further longitudinal study of the affected shoulder in patients with adhesive capsulitis.