MRI of Breast Implant-related Complications

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Purpose: To assess the usefulness of MRI in the preoperative diagnosis of breast implant-related complications.

Materials and Methods: Thirty four breast implants in 17 patients were examined. Eight breasts had a history of repeated surgery due to rupture and in eight others, simultaneous interstitial silicone injection had been performed. MR images of the 34 implants were prospectively analyzed for implant-related complications, without prior clinical information, and the findings were compared with the results of surgery.

Results: The implant-related complications seen on MRI were infections in three cases, seromas in two, and implant malposition in two. The linguine sign was seen in eight cases and intraparenchymal silicone in 17. Among the 32 removed implants, rupture was genuine in ten cases (nine, extracapsular; one, intracapsular). In evaluating the MR findings of implant rupture, the linguine sign showed 80% sensitivity, 100% specificity and 93.8% accuracy. Intraparenchymal silicone also revealed high sensitivity (90%), but relatively low specificity and accuracy (63.7% and 71.9%, respectively); this was due to the difficulty of differentiating granulomas still present after a previous rupture from injected silicone material. MRI was useful for visualization of implant migration, the direct relationship of extended or extruded silicone in extracapsular rupture and the localization of silicone granulomas, as seen on multiplanar images. The extent of infection was clearly demonstrated on contrast enhanced scan. There was relatively good correlation between the degree of contracture seen on physical examination and that seen on MRI.

Conclusion: MRI was an effective and useful method for the preoperative evaluation of implant-related complications; degree of contracture was successfully predicted.

Index words: Breast, MR

Breast, prostheses

Since the 1960s, approximately 2 million women have received silicone breast implants; the majority of procedures have been performed in the United States for the purpose of augmentation (80%) and reconstruction (20%)(1). In Korea, breast implants were introduced during the 1970s, but were not as popular as in the USA. Prior to that, during the 1950s and 60s, interstitial injection of silicone was performed in our country, and this illegal practice continued until recent times. There is now increased public awareness of
breast silicone gel implant-related complications (2). and for the evaluation of ruptured implants, MRI has proven to be a much better imaging modality than ultrasound or mammography (3 - 5). The purpose of the present study is to share our clinical and MR imaging experience of implant-related complications in patients who have received implants for reasons of cosmetic augmentation.

Materials and Methods

Between July 1994 and June 1996, we examined MR images of 34 implants in 17 patients (each breast is considered as one case) in order to evaluate for possible complications. Women with breast implants were referred and included in this study on the basis of clinical or imaging findings suggestive of implant-related complications. Among 34 implants, 32 were surgically removed, and in two cases, MRI findings suggested seroma. The reasons for implant removal were aesthetic concern (n = 19), pain (n = 12), palpable mass (n = 7), fear of malignancy (n = 5) and infection (n = 3). The patients ranged in age from 23 to 57 (mean, 40) years. Among 34 implants, eight had a history of repeated surgery due to rupture, and in eight others, simultaneous interstitial silicone injection had been performed. Types of implants were silicone single lumen in 30 cases, and double lumen in four. The location of 25 implants was subglandular and nine were subpectoral. In two cases, implants had been in place for two weeks, and in 34 cases, for between two and 20 years.

Breast imaging was performed with a 1.5 T superconducting magnet (General Electronic Medical Systems, Milwaukee). A dedicated breast coil was used, and the patient was in a prone position with the breasts resting dependently within the coil. The MR protocol used in this study included axial T1-weighted GRASS (gradient-recalled acquisition in the steady state) for scout images; this was followed by sagittal T2-weighted FSE (fast spin echo), axial T2-weighted FSE with water suppression, axial T1-weighted SE with fat suppression, and inversion recovery FSE sequences. The TR/TE of FSE T2 was 3500 - 5000/170 - 210/, with a matrix of 192 × 256; two NEX with 4 mm slice thickness were used to cover the entire implant area. In all 34 cases, the MRI findings were prospectively analysed in the absence of prior clinical information, and in 32 cases were compared with the results of surgery. The accuracy of known MR findings for breast implant rupture with linguine sign, parenchymal silicone (the gross spread of silicone gel into the adjacent breast parenchyme beyond the fibrous capsule) and contour change, were evaluated. Clinical degrees of contracture, assessed by Baker’s classification (6) as one of four grades, according to the severity of contracture, were compared with the degree seen on MRI, by sphericity. According to the posterior wall shape of an implant, sphericity was classified as normal (concave), mild (flat), or severe (spherical).

Results

As seen on MRI, complications associated with the 34 implants were as follows: seroma in two cases, infection in three, malposition in two, and the migration of silicone granuloma to the axilla in one. With regard to rupture, MRI revealed the linguine sign in eight cases, parenchymal silicone in 17, and contour change in 11. Among 32 removed implants, rupture was genuine in ten cases (nine, extracapsular; one, intracapsular) (Table 1). Among 32 extracted implants, 30 had been in place for four years or more, and they showed varying degrees of contracture (6) as one of four grades I, II, III, or IV.

<table>
<thead>
<tr>
<th>MR Findings</th>
<th>Operation Findings (n=32)</th>
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<tr>
<td>Linguine sign (n=8)</td>
<td>Ruptured (n=10)</td>
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<tr>
<td>Intraparenchymal</td>
<td>8</td>
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<tr>
<td>silicone (n=17)</td>
<td>9</td>
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<tr>
<td>Contour change (n=11)</td>
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Fig. 1. The most reliable MR findings of implants rupture. Axial FSE T1-weighted image (A) shows thin serpentine lines (black arrows) within the implant, termed linguine sign, representing a collapsed implant shell in intracapsular rupture. IR sagittal image (B) demonstrates break of implant shell and extruded silicone into parenchyme (white arrows) indicating extracapsular rupture.
degrees of sticky gel bleeding. Ten ruptured implants had been in place for between eight and 20 years. For evaluation of the MR findings of implant rupture, the linguine sign was most reliable; it showed 80% sensitivity, 100% specificity and 93.8% accuracy. Intraparenchymal silicone showed 90% sensitivity, but relatively low specificity and accuracy (63.7% and 71.9%, respectively) (Fig. 1). The sensitivity, specificity and accuracy of contour change were lower than those of linguine sign, but similar to those of parenchymal silicone (Table 2). In four cases, a small amount of fluid had collected around the implant, but in only one was rupture observed. The inverted tear drop sign was seen in three cases; in two of these, was severe. In all three, severe gel bleeding was observed, but there was no evidence of rupture. Among cases involving rupture, five were false positive and one was false negative. Three of the former arose because injected silicone granulomas, which are in contact the deformed implant shell, were confused with silicone granulomas still present after a previous rupture (Fig. 2). On MRI, a false-positive case involving a double lumen-type implant showed remarkable asymmetry of the amount of saline, together with contour change; it appeared that saline had been totally absorbed after a tear of the outer layer of the implant (Fig. 3). The removed implant was, in fact, intact, and there was a history of asymmetric saline infusion for the purpose of breast-size adjustment. The remaining false-positive case involved infection; FSE T2 and contrast-enhanced images revealed iso-signal intensity material with intraluminal silicone outside the implant. The appearance of this was similar to that of extracapsular silicone seen after a rupture, but—in fact—pus was present in an abscess pocket within the operative field (Fig. 4). In the false negative case, a short folded structure was seen in the peripheral area of the implant, without a break in the implant shell, and this suggested severe gel bleeding; in fact an intracapsular rupture had occurred within the surgical field.

On MR images, a malposed implant and migrated silicone granulomas caused by silicone extruded from an extracapsular rupture or silicone injection were clearly visualized (Fig. 5), and two cases of seroma showed low signal intensity on T1- and high signal in-

<table>
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<th>Table 2. MR Findings of Implant Rupture (N=10)</th>
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<tr>
<td>Linguine sign</td>
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<td>Parenchymal silicone</td>
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<td>Contour change</td>
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* PPV; Positive predictive value  ** NPV; Negative predictive value
Fig. 4. False positive case related with infection. Sagittal FSE T2 (A) and contrast enhanced T1 (B) images showed iso-signal intensity material (arrows) with intraluminal silicone outside the implant (arrow heads). That was similar to the extracapsular silicone in rupture. But it was pus in abscess pocket in operative field. The extent of inflammation is well visualized on enhanced scan (B).

Table 3. The Degree of Contracture between PE* and MRI (N=34)

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<thead>
<tr>
<th>PE* \ MRI</th>
<th>Normal</th>
<th>Mild</th>
<th>Severe</th>
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<td>I</td>
<td>10</td>
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<td>1</td>
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<td>III &amp; IV</td>
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PE*; Physical examination finding by Baker’s Classification

tensity on T2-weighted images. Among the three cases involving infection, two implants were ruptured and the other was intact. The extent of infection was clearly demonstrated after contrast enhancement, and abscess pockets showed typical peripheral rim enhancement.

The severity of degree of contracture seen on physical examination showed some correlation with that seen on MRI. MR imaging of 17 implants associated with Baker grade I or II contracture showed that 11 were normal and six showed mild contracture. Among 15 cases associated with Baker grade III or IV, the degree of contracture was mild in four cases and severe in ten (Table 3). The relationship between ruptured implants and the degree of capsular contracture defined by Baker’s grade and seen on MRI is shown in Table 4. In addition, there was relative correlation between implant rupture and capsular contracture. In nine of ten implants, contracture was shown to be greater than Baker grade II, and in eight of ten, the degree of contracture seen on MRI, was mild to severe.

Table 4. Ruptured Implant* and the Degree of Contracture (N=10)

<table>
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<td>I</td>
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Ruptured implant*; confirmed by operation
PE**; Physical examination finding by Baker’s Classification

Discussion

During the last century, many different methods have been utilized to augment or reconstruct the breast. Unfortunately, most approaches were cosmetically disappointing and had many associated complications (7); among these, the major complications included hematoma in the early postoperative period, infection, capsular contracture, rupture and silicone granulomas.

An important advantage of MR imaging over other imaging modalities is its ability to differentiate silicone from surrounding breast parenchyma through the use of specially designed pulse sequences (2, 4, 8). It allows not only imaging of the entire implant in a variety of
sectional planes, but is also relatively comfortable. For the evaluation of silicone rupture and leakage, particularly in intracapsular ruptures, mammography is somewhat limited (5, 9), though ultrasound is capable of detecting both intra- and extracapsular rupture with a reported sensitivity of 70% and specificity of 92% (10). It is, however, operator dependent, and needed to be proficient in ultrasound evaluation of implants.

Early postoperative seroma formation is a complication which usually becomes evident on the second or third postoperative day (11). We also had seroma cases which were clinically evident from postoperative day three, and MRI on postoperative day was seven helped to differentiate these from hematoma. The frequency of this latter condition hematomas is less than two percent, and when it exists, a higher rate of capsular contracture and infection co-occurs (6). De Camara and colleagues (12) demonstrated a positive correlation between the duration of implantation time and the numbers of ruptured and leaking implants. Implant ruptures can be divided into intra- and extracapsular; the former, the most common type, is defined as rupture of the implant shell with silicone leakage that does not macroscopically extend beyond the fibrous capsule. Multiple low-signal intensity wavy lines within the fibrous capsule represent the collapsed implant envelope surrounded by silicone gel, and the presence of these lines has been termed the “linguine” sign (13, 14). Radial folds are normal infoldings of the silastic elastomer shell, and should not be confused with the linguine sign. The extracapsular type is defined as rupture of both the implant shell and the fibrous capsule with macroscopic silicone leakage that extends beyond this capsule into surrounding tissues (8, 15). The multiplanar capabilities of MR imaging allow a precise localization of free silicone with a sensitivity of approximately 94% and specificity of 97% (3). For the detection of implant rupture, the most reliable MR findings are the linguine sign and free silicone within the breast parenchyma (10, 16). In the present study, linguine sign showed the highest diagnostic accuracy but intraparenchymal silicone showed high sensitivity (90%) and relatively low specificity and accuracy (63.7% and 71.9%, respectively). This is because in this prospective study, it was difficult to obtain a precise past history, for reasons related to medical cost. In some of our cases, it was thus difficult to differentiate silicone granulomas still present after a of previous rupture from injected interstitial silicone material. In the detection of implant rupture, morphologic abnormalities are nonspecific findings, regardless of the imaging modality. Asymmetrical implant positions, focal bulging or diffuse irregularity of the implant contour, and peri-implant fluid collection, are not reliable indications of rupture (8, 17, 18). Our study also revealed that MR findings which suggested those conditions were not, in fact, helpful predictors of implant rupture.

Gel bleeding is microscopic silicone leakage through an intact implant shell, thought to be present in all implants. A focal or early intracapsular rupture can have a similar appearance to a large gel bleed, and it can be difficult if not impossible to differentiate these two entities on MR images (4, 18). The “inverted teardrop”, “noose”, or “key-hole” sign, which marks the presence of a loop-shaped hypointense structure, represents a small invagination of the implant shell, with silicone gel on either side of it, caused by extensive gel bleed (8). In our study, one case of intracapsular rupture, mimicking severe gel bleed, led to a false-negative result.

Capsular contracture is a common complication of silicone gel implants, and may be the result of hematoma, hypertrophic scarring or subclinical infection. On MR images, capsular contracture may be identified by increased thickening of the hypointense margin surrounding the implant or by the rounded appearance of the implant. The classification of capsular contracture is also highly subjective; we classified degree of contracture according to the shape of an implant, as seen on MRL and according to the Baker system after physical examination; these two approaches appear to be the most reproducible. In our study, the degree of contracture between physical examination and MRI correlated relatively well.

In conclusion, MRI was an effective and efficient method for the preoperative evaluation of implant-related complications, even predicting the degree of contracture.

References

유방 삽입물과 연관된 합병증의 자기공명영상소견

목적: 미용을 목적으로 삽입물을 사용하여 유방확대성형술을 시행한 후 동반된 합병증의 수술전 진단에 있어서 자기공명영상의 소견과 그 유용성에 대하여 알아보고자 하였다.

대상 및 방법: 유방삽입물에 의한 합병증을 호소하여 삽입물 제거를 목적으로 수술전 자기공명영상 검사를 시행받은 17명의 34유방을 대상으로 하여 자기공명영상소견을 분석하고 그 결과를 수술 소견과 비교하였다. 34예 중 8예에서 삽입물파열로 반복 수술을 시행하였고 8예에서 삽입물과 함께 실리콘 실질주입시술을 받은 과거력이 있었다.

결과: 34유방중 MRI 소견상 linguisne sign 8예, 유방실질내 실리콘 17예, 감염 3예, 장액종 2예, 위치이동 2예를 관찰하였으며 32예의 수술 소견상 실제 삽입물의 파열은 10예(피막외 파열 9예, 피막내 파열 1예)에서 동반되었다. 삽입물 파열 및 누출의 소견인 linguisne sign의 민감도, 특이도, 정확도가 80%, 100%, 93.8%로 높았으며, 유방실질에서 유리된 실리콘 발견의 경우 민감도가 90%로 높았으나, 특이도 및 정확도가 63.7%, 71.9%로 비교적 낮았는데 이는 실리콘 실질 주입이나 이적 삽입물의 파열로 인한 장애물과의 감별에 어려움이 있었다.

MRI는 다변영상을 통하여 삽입물의 위치변화, 피막 파열의 정확도가 높은 실리콘의 확산범위, 실질내 실리콘의 위치를 쉽게 알 수 있었다. 이학적 검사의 연속의 정도와 자기공명영상 검사의 연속의 정도, 또 한 연속의 심한 정도에 따른 삽입물의 파열 반도는 비교적 연관성이 있었다.

결론: 삽입물을 사용한 유방확대성형술에 동반된 합병증을 평가하는데 있어서 수술전 자기공명영상 검사는 상기한 소견들로서 합병증의 정확한 진단에 매우 유용하였다.