Sonography in capsular contracture after breast augmentation: value of established criteria, new techniques and directions for research

Johannes Gossner¹

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Abstract Capsular contracture or capsular fibrosis is the most common complication following breast augmentation with implants. Sonography is usually the initial imaging test performed to examine a suspicious implant. In contrast to the large number of patients developing capsular fibrosis there is only sparse literature reporting about sonographic findings. In this letter after a brief review of normal sonographic findings after breast augmentation, established ultrasound findings suggestive of capsular fibrosis (deformity, increased number of radial folds and thickening of the fibrous capsule) are discussed. The possible value of new techniques and possible directions for further research are addressed.

Keywords Sonography · Capsular contracture · Breast augmentation

Riassunto La contrattura capsulare o fibrosi capsulare è la complicanza più comune dopo un intervento di mastoplastica additiva. L'ecografia è di solito l'indagine iniziale eseguita per esaminare un impianto sospetto. A fronte del gran numero di pazienti che sviluppano tale complicanza c'è solamente poca letteratura che riporta studi ecografici sull'argomento. Dopo una breve rivisitazione dei quadri ecografici normali dopo mastoplastica additiva, in questa lettera vengono discussi i reperti ecografici tipici della contrattura capsulare (deformità, aumento delle aderenze, ispessimento della capsula fibrosa). Viene discusso anche il

valore delle nuove tecniche e date eventuali direzioni della futura ricerca.

Introduction

Capsular contracture or capsular fibrosis is the most common complication following breast augmentation with implants and most studies report about incidences around 10% [1]. Like with any other non-biologic implant, the body forms a fibrous capsule around the implant. With an excessive foreign body reaction, fibrosis occurs due to collagen production and the capsule around the implant contracts, which is leading to hardening and deformation of the implant [1, 2]. Clinically, the patient reports about a firm and deformed implant with discomfort and pain in advanced cases [1, 2]. Traditionally, capsular fibrosis has been graded according to the Baker classification system (Baker I–IV) (Table 1). Given the high number of breast augmentations performed, capsular fibrosis is a common problem in clinical practice. After clinical inspection, sonography is usually the next diagnostic test performed to examine the implant. Intriguingly, in contrast to the large number of patients developing capsular contracture, there is only sparse literature reporting about the sonographic findings.

The normal breast implant is anechoic with an echogenic shell. Normally, there is a three-layered appearance with two echogenic lines and an anechoic line between them, a finding which has been named the “oreo cookie sign” (Fig. 1) [3]. Small radial folds and a small amount of periprosthetic fluid are also considered a normal finding. In double-lumen implants, two distinct chambers may be seen. The fibrous capsule may be seen as an echogenic line superficial to the implant shell separated by a small

✉ Johannes Gossner
johannesgossner@gmx.de

¹ Department of Diagnostic and Interventional Radiology,
Evangelisches Krankenhaus Göttingen-Weende, An der
Lutter 24, 37074 Göttingen, Germany

Table 1 Baker's classification of capsular contracture

Baker class	Firmness/pain	Implant	Implant visibility
I	Soft	Non-palpable	Not visible
II	Minimal	Palpable	Not visible
III	Moderate	Easily palpable	Distortion visible
IV	Severe	Hard, tender, cold	Marked distortion

Fig. 1 Sonographic findings of a normal implant shell showing the typical two-layer appearance and an implant valve **Fig. 2** Sonographic findings of a normal implant showing a radial fold, minimal periprosthetic fluid and the fibrous capsule

anechoic line [3–5]. In some implant types, the fibrous capsule cannot be seen, because the capsule grows in the sponge structure of the outer shell [3]. Usually, the fibrous capsule is not uniform. The differentiation of the fibrous capsule is sometimes challenging and it is helpful to search for a small radial fold, where the fibrous capsule is usually lifted of the implant and easy to measure (Fig. 2).

With capsular contracture, three typical findings on imaging have been described: deformation of the implant,

increased number of radial folds and thickening of the fibrous capsule. Deformation of the implant has been especially described for mammographic imaging [5]; it may also be seen with magnetic resonance imaging. Judgement of deformity with sonography is complicated because of the usually small field of view. It has been suggested that with capsular fibrosis, the implant shows a more spherical than elliptic shape [3]. With the help of extended field-of-view imaging, an overview of the whole implant may be gained. From our point of view, sonographic judgment of the shape is not easily applicable and should be used with caution. It has to be considered that small asymmetries which can be seen on clinical examination or are mentioned by the patient may go undetected with imaging alone. Increased number of radial folds is described regularly as a finding of capsular contracture [2–6]. With contracture of the fibrous capsule, the surface for the extension of the implant is diminished and radial folds occur. The diagnostic problem is that some radial folds are regarded as normal findings after breast implants, and no study reports about a possible distinction between a normal and a pathological number of folds [2–6]. If augmentation has been performed bilaterally, the number of folds can be compared and a difference in the number of radial folds can be interpreted as a sign of capsular contracture. The development of new radial folds over time indicates progressive shrinkage of the fibrous capsule. But it is obvious that the interpretation of this finding is highly subjective and should be made with caution unless there is an excess number of radial folds or an undulating surface of the implant (Fig. 3). The most specific finding and also the most objective finding is the measurable thickening of the fibrous capsule (Fig. 4). As described after the implantation of a breast prosthesis, a fibrous capsule forms, which can be seen with ultrasound. Ganott et al. first described this finding. In their study of 133 patients with breast augmentation, they described the normal fibrous capsule with a thickness of around 1 mm and considered a thickness of more than 1.5 mm to be pathologic [5]. This cutoff value has been used by other authors [3]. In a more

Fig. 3 Increased number of radial folds creating an undulated implant surface in a patient with clinical findings of capsular contracture. Note also the prominent and irregular fibrous capsule

Fig. 4 Thickened fibrous capsule in a patient with capsular contracture

systematic study of 27 implants, Zahavi et al. compared the clinical assessment (using the Baker score) and the measurement of the fibrous capsule on ultrasound. They found that in cases with a Baker score of III or IV, the mean thickness of the capsule was around 2.39 mm compared to a mean thickness of 1.14 mm in cases with a Baker score of I or II. They concluded that the thickness of the capsule correlates with the Baker system and they proposed a cutoff value of 2 mm for the diagnosis of more severe capsular contracture [7]. Because of the small number of patients in this study, confirming data from larger trials would be desirable.

With capsular contracture, the implant gets palpable and gets more tender in the clinical course. To get an objective measurement of the implant stiffness, Prantl et al. examined 17 patients with ultrasound elastography and reported about a high correlation between the clinical Baker score and elastography measurements [8]. If the initial findings can be replicated, elastography may evolve into a clinically valuable tool in the diagnosis of capsular contracture. After the administration of contrast media, enhancement of the fibrous capsule may be observed with magnetic resonance imaging, a condition called “capsulitis” [6]. The clinical relevance of this finding is unclear. It may be speculated that this “capsulitis” may represent an active stage of capsular contracture. This hypothesis is strengthened by the observation that ultrasound-guided steroid injections showed therapeutic efficacy in cases of capsular contracture [9]. Contrast-enhanced ultrasound could be a more accessible tool than magnetic resonance imaging to study the possible changes in enhancement of the capsule and seems worth to be studied.

In conclusion, capsular contracture is a common and serious clinical problem after breast augmentation or reconstruction with implants. Sonography, with its inherent strengths of being easy to perform and widely available, is a valuable tool in the assessment of suspicious implants. Especially in more advanced cases, documentation of a thickened fibrous capsule is an objective marker of capsular contracture. Further research on this topic involving more patients and the study of newer techniques is, nonetheless, thoroughly needed.

Compliance with ethical standards

Conflict of interest The author declares that there is no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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