



# Radiologic Findings of Polyacrylamide Gel Mammoplasty and Its Complications: A Report of Four Case Series and Review of Literature

폴리아크릴 아마이드겔을 이용한 유방확대술과 부작용: 네 개의 증례 보고 및 문헌 고찰

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Polyacrylamide gel (PAAG) has been used for augmentation mammoplasty in certain countries, such as China or Eastern European countries. However, owing to various complications, its use is currently banned in most countries. Nevertheless, because of the migratory stream of female from these countries, we also encounter patients with PAAG mammoplasty in Korea. Owing to the various imaging features of PAAG mammoplasty, it may interfere with the identification of malignancy or other pathologic conditions. Therefore, it is important to identify the imaging findings related to PAAG mammoplasty. However, there is limited literature on the radiologic findings of complications related to PAAG mammoplasty in Korea. Herein we report four cases of PAAG mammoplasty, the complications faced, and depict various radiologic features through multimodality imaging.

**Index terms** Polyacrylamide Gels; Mammoplasty; Mammography; Ultrasonography; Magnetic Resonance Imaging

## INTRODUCTION

Hydrophilic polyacrylamide gel (PAAG) was introduced as an alloplastic soft tissue filler for injection augmentation mammoplasty in China, the former Soviet Union, and

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Eastern Europe (1, 2). Various complications associated with injectable PAAG augmentation mammoplasty, such as inflammation, infection, persistent mastalgia, formation of multiple lumps, gel migration, and glandular atrophy, have been reported in the clinical literature, and its use is currently banned in most countries (1, 2). However, due to the migratory stream of female from the above countries, we often encounter patients with PAAG mammoplasty (2). The various imaging features of PAAG injection mammoplasty have become a diagnostic challenge for radiologists. Therefore, it is important to be aware of the diverse imaging findings and to arrive at an accurate diagnosis and proper planning of management.

To our knowledge, there is limited literature about the radiologic findings of complications related to PAAG mammoplasty in Korea. Moreover, imaging findings of complications derived from PAAG mammoplasty may interfere with the identification of malignancy or other pathologic conditions (1). Furthermore, it may lead to unnecessary biopsies, surgeries, or delayed treatment, resulting in poor prognosis.

Herein, we describe the various radiologic features of complications from PAAG mammoplasty through multimodality imaging assessment.

## CASE REPORT

This study was approved by the Institutional Review Board of our institution and the requirement for informed consent was waived (IRB No. HKS 2021-01-027). Here, we present four cases of PAAG augmentation mammoplasty with complications. All four patients underwent PAAG augmentation mammoplasty in China, and all patients underwent biopsy-proven foreign body reaction to PAAG. However, each patient has undergone different treatments due to various disease courses.

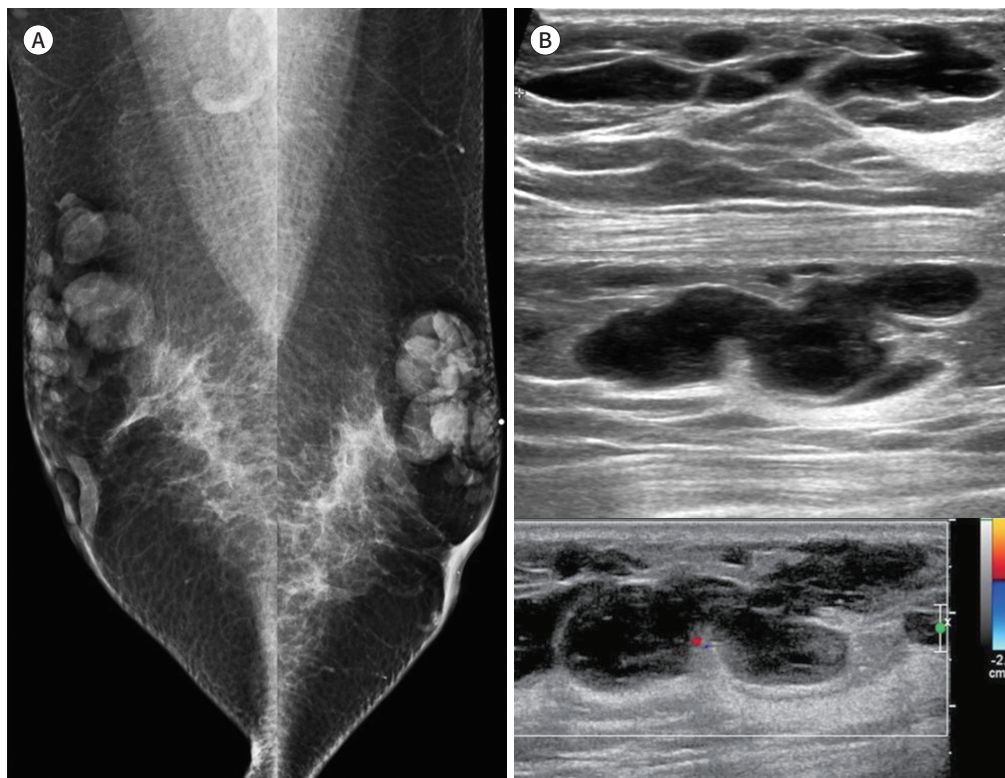
### CASE 1

A 48-year-old female presented with bilateral breast pain and palpable masses. Mammography (MMG) showed multiple conglomerated, well-circumscribed, equal density masses in the upper outer quadrants of both breasts (Fig. 1A). Ultrasonography (US) revealed multiple anechoic or complex solid and cystic masses in the upper outer quadrants of both breasts. Several masses in the upper quadrant of the left breast showed anechoic and complex solid masses and cystic masses without vascularity on Doppler ultrasound (Fig. 1B). However, she did not inform us of her mammoplasty history at the time of examination. Therefore, we performed ultrasound-guided core needle biopsy for solid and cystic lesions in the left upper outer quadrant in order to make an accurate diagnosis and differential diagnoses, such as papillary lesions, vascular malformations, or parasitic infestation. The final pathologic result demonstrated foreign body reactions. The patient was informed about her histopathology results and she divulged her history of plastic surgery in China. The lesions showed no change during follow-up imaging studies.

### CASE 2

A 48-year-old female visited our institution's emergency center with fever (37.8°C), sudden right breast enlargement, and a severely painful palpable mass in the right breast. The pa-

**Fig. 1.** A 48-year-old female with complications related to polyacrylamide gel augmentation mammoplasty.  
**A.** Mediolateral oblique mammography view of both breasts shows multiple conglomerated, well-circumscribed equal density masses at the upper breasts.  
**B.** Ultrasonography reveals multiple anechoic or complex solid and cystic masses at the upper outer quadrants of both breasts. Several masses at the upper quadrant of the left breast show internal echogenicity without vascularity on color Doppler ultrasound.



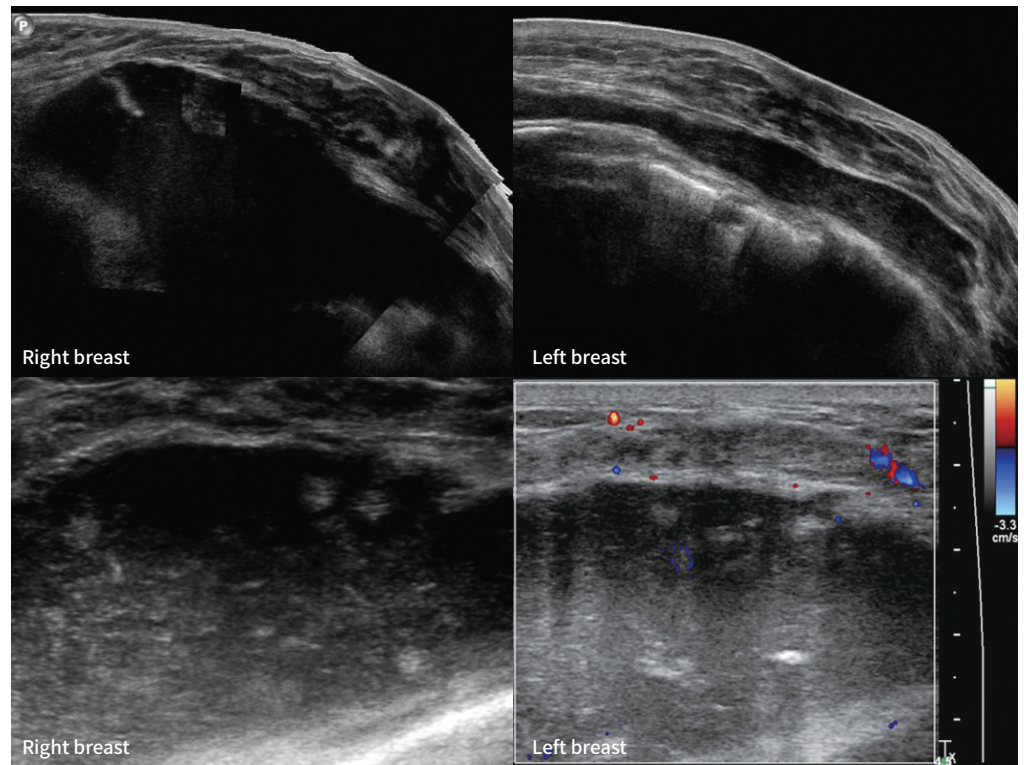
tient underwent PAAG mammoplasty 14 years prior to the visit. She could not perform MMG due to severe pain. On US, the right breast showed a large amount of fluid collection with internal debris in the retropectoral space, suggesting an infection in the PAAG collection. On the contralateral side, a smaller amount of PAAG had collected without echogenic debris (Fig. 2). Furthermore, laboratory tests showed an increased leukocyte level of 22550/ $\mu$ L and an increased neutrophil ratio of 93.2%. Due to severe breast pain and infection, as described above, the patient underwent immediate incision and drainage. Intraoperative findings included a large amount of pus at the posterior aspect of the pectoralis muscle, and the biopsy revealed an abscess with a foreign body reaction. The gel culture showed *Streptococcus agalactiae* growth, and the patient was further treated with antibiotics.

### CASE 3

A 53-year-old female presented with left breast pain. She had undergone PAAG mammoplasty 20 years before the first symptom presentation. MMG showed multiple round- or oval-shaped equal density masses with calcifications in both breasts (Fig. 3A). On US, there were multiple complex solid and cystic masses and heterogeneous echoic lesions with calcifications in both breasts (Fig. 3B). The patient had undergone both skin-sparing subcutaneous

**Fig. 2.** A 48-year-old female with complications related to polyacrylamide gel augmentation mammoplasty. US reveals a large amount of fluid collection with internal debris in the retropectoral space of the right breast, suggesting an infection in the polyacrylamide gel collection. On the contralateral side, US shows a smaller amount of polyacrylamide gel collection without echogenic debris. Color Doppler imaging shows mildly increased peripheral vascularity.

US = ultrasonography



mastectomy, and histopathology results showed a foreign body reaction. After three months, the patient had planned a latissimus dorsi muscle flap and underwent preoperative CT angiogram of the chest. Chest CT angiogram showed multiple low attenuated cystic lesions in both chest walls, surrounding and intervening into the pectoralis muscles, suggesting incomplete removal of the PAAG (Fig. 3C). The patient underwent an excisional procedure to remove the residual PAAG, before latissimus dorsi muscle flap with a silicone implant.

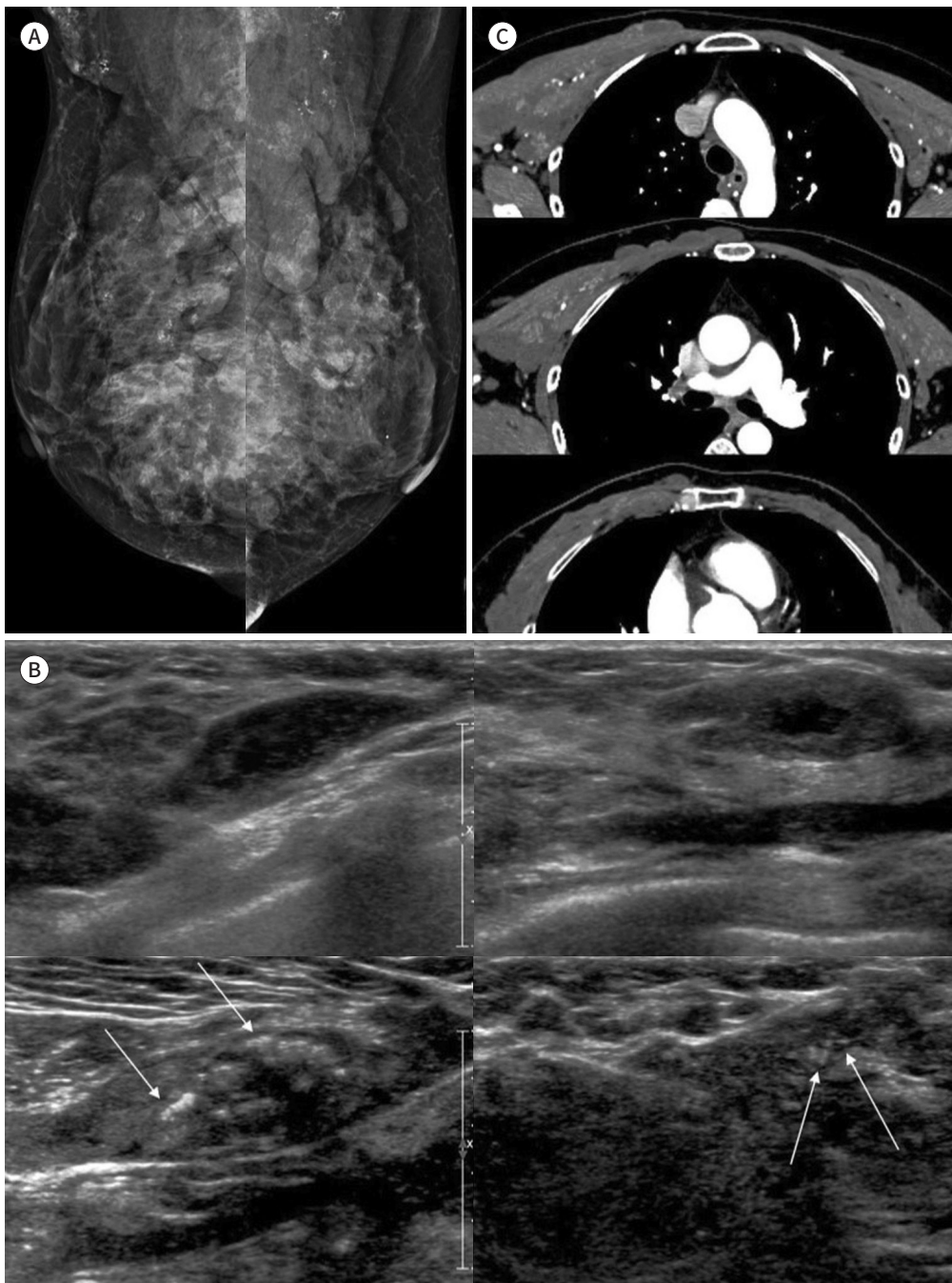
#### CASE 4

A 50-year-old female who had undergone PAAG mammoplasty 20 years ago visited our institution for breast cancer screening. MMG showed multiple equal-density masses having replaced both breasts, and breast parenchyma and masses could not be clearly distinguished on MMG (Fig. 4A). US also showed multiple variable-sized anechoic, complex solid, cystic, or heterogeneous echogenic masses in the parenchyma of both breasts, retromammary area, and interpectoral space (Fig. 4B). However, due to the variable spectrum of characteristics for multiple lesions, breast cancer screening with only MMG and US had its limitations. Therefore, she underwent breast MRI to rule out breast cancer. MRI clearly revealed a large amount of fluid collection in both the intramammary, retromammary, and interpectoral spaces, which



showed a bright high-signal intensity (SI) on fat-saturated T2-weighted images (T2WI) and low SI on T1-weighted images (T1WI). Contrast-enhanced subtraction T1WI did not show abnormal enhancing lesions, suggesting breast cancer (Fig. 4C).

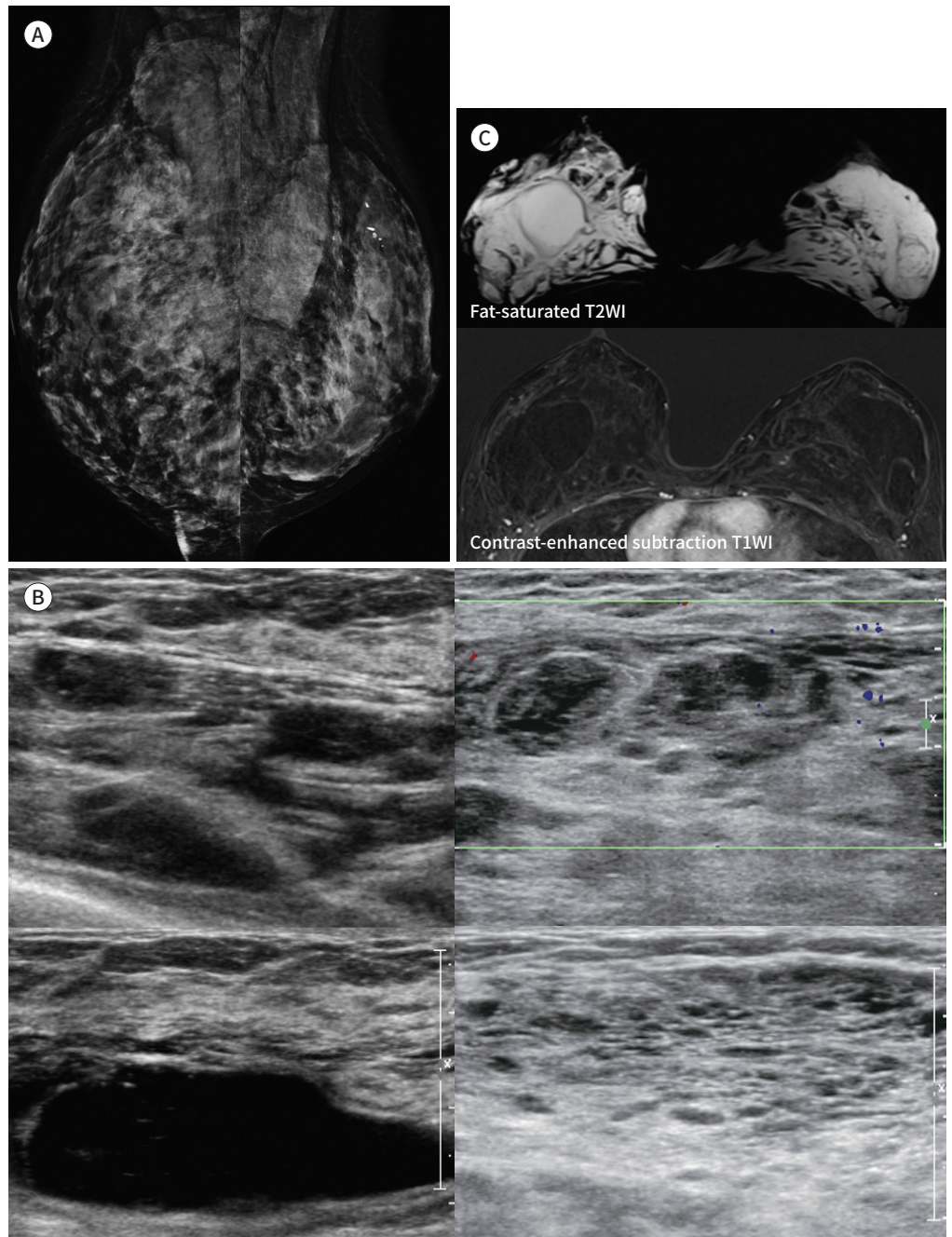
**Fig. 3.** A 53-year-old female with complications related to polyacrylamide gel augmentation mammoplasty.  
**A.** Mediolateral oblique view of the mammography shows multiple round- or oval-shaped equal density masses with calcifications in both breasts.  
**B.** Ultrasonography shows multiple complex solid and cystic masses and heterogeneous echoic lesions with calcifications (arrows) in both breasts.  
**C.** Chest CT angiogram shows multiple low attenuated cystic lesions in both chest walls, surrounding and intervening into the pectoralis muscles, suggesting an incomplete removal of the polyacrylamide gel.



## DISCUSSION

Hydrogel PAAG is a nonresorbable sterile watery suspension made with 2.5%–5% acryl-

**Fig. 4.** A 50-year-old female with complications related to polyacrylamide gel augmentation mammoplasty.  
**A.** Mediolateral oblique view of the mammography. Multiple equal density masses are replacing both breasts.  
**B.** Ultrasonography shows multiple variable-sized anechoic, complex solid, and cystic or heterogeneous echoic masses in both breast parenchyma, retromammary area, and interpectoral space.  
**C.** Fat-saturated T2WI shows high signal intensity lesions, suggesting a large amount of fluid collections in the intramammary, retromammary, and interpectoral spaces. Contrast-enhanced subtraction T1WI did not show abnormal enhancing lesions that suggest a breast cancer.  
 T1WI = T1-weighted image, T2WI = T2-weighted image



amide monomers and 95%–97.5% water (1). The material is composed of a gelatinous medical gel, so it can be easily injected into the breast under local anesthesia. However, its final location is variable and it cannot be drawn out completely (2, 3). Although it was initially marketed as a “minimally invasive” procedure, recent literature revealed several complications associated with PAAG augmentation, such as gel migration, breast lumps and pain, contour abnormality, and inflammation (3).

The mammographic appearance might be non-specific or masked by breast parenchyma in asymptomatic patients, but it becomes easily recognizable once a proper history is obtained and radiologists are made aware of this entity (4). The gel has a density similar to that of saline and is less dense than silicone implants, and it usually does not form a fibrous capsule around the implant (1, 2). Therefore, injected PAAG collection within the parenchyma is not well distinguished from the parenchyma. However, depending on the location of injection, for example, in subcutaneous or retromammary fatty tissue, it can sometimes be easily identified, as in our first case. Even in superimposed infections, as in the third patient, the PAAG collection appears denser than fibroglandular tissue, and recurrent infection may result in calcification. In complex solid and cystic masses accompanied by microcalcifications, it can mimic malignancy (4).

US is a very useful technique and can depict the location of the injected PAAG in uncomplicated situations, such as the first case (1). PAAG usually appears as multiple anechoic masses without a fibrous capsule (1). However, in our second and third cases, a thickened capsule was present around the anechoic or hypoechoic gel collection, accompanied by diffuse increased echogenicity within the gel, suggesting inflammation. Furthermore, ultrasound can provide guidance for aspiration or biopsy for an inflamed collection (1).

Zhao et al. (2) reported that, on average, 3–36 months after PAAG mammoplasty, female present with complications. However, in our cases, most of the patients had undergone the procedure about 8 to 20 years before the manifestation of symptoms, which means that the time interval between the procedure and symptom presentation may differ for each patient. Therefore, we assume that PAAG injection-related complications may occur at any time after the procedure.

As in our second case, severe infection associated with PAAG breast augmentation might require prompt surgical removal. However, considering the third case, complete surgical clearance of the material may be difficult. It was technically impossible in our case, because PAAG did not remain confined to a single collection (1). The gel usually forms multiple small locules occupying different layers of the breast, rather than being confined to a single collection, which can then be found even outside of the breast (3, 5, 6). Residual PAAG could be left behind, even after the surgery, as in our third case (3, 5, 6).

In the last case, the patient ultimately underwent breast MRI to detect or rule out breast cancer. On MRI, PAAG has a similar SI to water and is hypointense on T1WI and hyperintense on T2WI (3, 7). MRI is superior to US or MMG, as it can depict the exact location of the injected gel and is the most sensitive technique for assessing the volume and distribution of PAAG in extramammary areas, such as the interpectoral, retropectoral, and axillary areas or over the sternum (1, 3).

In summary, radiological evaluation has a significant role in the investigation of female

with PAAG mammoplasty, especially those presenting with complications. The radiologist must be familiar with the spectrum of imaging findings of patients who have experienced breast augmentation with intramammary PAAG injections in order to make an accurate diagnosis and suggest proper management.

Furthermore, without information on mammoplasty history, complex cystic lesions with internal echogenicity should be differentiated from benign lesions, such as papillary neoplasms, vascular malformations, or parasitic infestations, and also malignancy. Therefore, it is important to be aware of PAAG breast augmentation and obtain pertinent patient history in order to avoid unnecessary procedures.

#### Author Contributions

Conceptualization, H.J.; data curation, H.J., K.J.H., M.J.H.; formal analysis, H.J., K.J.H., M.J.H.; investigation, H.J., K.J.H., M.J.H.; methodology, H.J., K.J.H., M.J.H.; project administration, H.J., W.J.Y., Y.I.; resources, H.J., K.J.H., M.J.H.; software, all authors; supervision, H.J., W.J.Y., Y.I.; validation, H.J., M.J.H.; visualization, H.J., K.J.H.; writing—original draft, H.J., K.J.H.; and writing—review & editing, H.J., K.J.H.

#### Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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## 폴리아크릴 아마이드겔을 이용한 유방확대술과 부작용: 네 개의 증례 보고 및 문헌 고찰

김중희·황지영\*·문진희·양 익·우지영

폴리아크릴 아마이드겔(polyacrylamide gel; 이하 PAAG)은 중국, 동유럽 등에서 유방 확대술에 이용되던 물질이었으나, 다양한 부작용을 일으키는 것으로 밝혀져 현재는 사용이 금지된 물질이다. 그러나 위에서 언급된 국가의 여성들이 다른 국가로 이주하게 되면서, 우리나라에서도 PAAG를 이용한 유방 확대술을 시행한 환자들을 만나게 되었다. 이를 시행한 경우, 매우 다양한 영상의학적 소견을 보이며, 이로 인해 악성 종양이나 다른 진단과의 감별이 어렵기 때문에 정확한 진단 및 치료 계획을 세우기 위해 다양한 영상의학적 소견에 대해 숙지하는 것이 필요하다. 현재까지 한국에서의 PAAG 유방 확대술에 의한 부작용과 관련된 영상의학적 소견에 대해 보고된 바가 적기 때문에, 이에 PAAG 유방 확대술을 시행한 네 개의 증례 통해 다양한 영상의학적 진단 도구를 통한 영상의학적 소견에 대하여 보고하고자 한다.

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