

Research Article

The Clinical Value of High-Frequency Ultrasound in the Diagnosis of Psoriatic Arthritis

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Objective. To investigate the clinical value of high-frequency ultrasound in psoriatic arthritis (PSA). The study subjects were 32 outpatients and inpatients with PSA who were pathologically diagnosed from January 2018 to September 2020, including 11 males and 21 females, aged 25–70 years old, with an average of (49.8 ± 14.0) years old. All patients underwent ultrasound and physical examination, including the small joints of the hands and feet on both sides, nails, and the main attachment points of the lower limbs (quadriceps tendon, patellar ligament, Achilles tendon, and plantar fascia attachment). The involvement of these joints, attachment points, and nails was observed and counted, respectively, and statistically analyzed. **Results.** Physical examination revealed 406 (406/1792, 22.66%) joint lesions, 79 (79/320, 24.69%) attachment inflammation, and 84 (84/320, 26.25%) nail lesions. Ultrasonography revealed 492 (492/1792, 27.46%) joint lesions, 166 (166/320, 51.88%) attachment inflammation, and 203 (203/320, 63.44%) nail lesions. The positive rate of ultrasound examination was higher than that of physical examination ($P < 0.001$). **Conclusion.** Ultrasonography can detect joint, attachment, and nail lesions earlier than physical examination in patients with PSA. Ultrasonography is of great value in the diagnosis of PSA.

1. Introduction

Psoriatic arthritis (psoriaticarthritis, PSA) is an inflammatory joint disease associated with psoriasis with a variety of joint manifestations, which can be divided into single or oligoarthritis type, distal interphalangeal arthritis type, debilitating arthritis type, symmetrical polyarthritis type, and spinal joint disease type. More peripheral joint involvement, often presented as joint pain, swelling, or stiffness. Clinically, PSA is diagnosed according to patients' clinical manifestations and laboratory examinations. However, with the improvement of ultrasound resolution and the development of new ultrasound technology, ultrasound has been widely used in the diagnosis and treatment of rheumatic diseases in recent years. Ultrasound has unique advantages in the observation of synovitis, articular cavity effusion, attachment point inflammation, bone erosion, etc. This study aims to explore the diagnostic value of ultrasound in PSA by comparing the results of physical examination and ultrasound examination of the small joints of hands and feet, the

main attachment points of lower limbs, and nails of PSA patients. PSA can be manifested in five types: peripheral arthritis, axial disease, attachment inflammation, finger inflammation, and skin and nail disease. 16% to 29% of PSA is missed due to the nonspecific nature of PSA joint symptoms and the lack of awareness of PSA joint damage by physicians and patients. Ultrasonography can visually observe early inflammation and joint changes, show adhesion site inflammation features such as thickening, calcification, and bone erosion, and Doppler imaging can understand local blood flow.

2. Materials and Methods

2.1. General Information. Thirty-two outpatients and inpatients with PSA diagnosed by pathology in our hospital from January 2018 to September 2020 were collected. There were 11 males and 21 females, aged 25–70 years, with an average of 49.8 ± 14.0 years. The course of disease ranged from 6 months to 3 years. Laboratory examination:

rheumatoid factor and antinuclear antibody were negative. All patients underwent musculoskeletal ultrasonography and physical examination. Inclusion criteria are as follows: ① the PSA group met the new diagnostic criteria of psoriatic arthritis, ② there was no obvious joint pain and swelling in the PS group, ③ all patients received ultrasonographic examination of the extensor tendon of fingernail and distal interphalangeal joint, and ④ complete clinical data. Exclusion criteria are as follows: ① past history of other osteoarthritis (rheumatoid arthritis, ankylosing spondylitis, gout, etc.), ② recent nail trauma or long-term physical labor, ③ other diseases that cause nail lesions (alopecia areata, pemphigus, leprosy, syphilis, chronic eczema, tinea pedis, etc.), ④ with nail fungal infection, and ⑤ patients who had received systematic treatment within 3 months. Elimination criteria are as follows: ① those who did not follow the study plan after inclusion and ② poor ultrasonic image quality.

2.2. Instruments and Methods. Physical examination is to observe the joint from both sides; it refers to foot joints, plantar toe joints, and lower limb tendon fascia main attachment point (quadriceps tendon, patellar ligament, Achilles tendon and plantar fascia attachment points) with or without touch swelling, pain, tenderness, stiffness, dysfunction, etc., have nails without sag, discoloration, thickening, etc., all physical examination are completed by experienced dermatologists.

Ultrasonography: Philips Sepiq 5 and IU22 color Doppler ultrasound diagnostic instrument, L12-5 probe, frequency 12 MHz are used. The client was placed in the sitting position, applied an appropriate amount of coupling agent to the fingernail, selected the conventional musculoskeletal and superficial musculoskeletal option modes, fine-tuned the probe position, and set the gain range of 70 to 90 HB to clearly show the fingernail and extensor finger tendon structure of the distal interphalangeal joint. A multiplane scan was performed from the middle of the nail to both sides and from the semilunar to the end of the nail. Deck thickness (the maximum vertical distance between the upper edge of the dorsal deck and the lower edge of the ventral deck), nail bed thickness (the distance between the ventral plate and the bone margin of the distal phalanx), and nail matrix thickness were measured at the proximal end of the nail bed on the longitudinal axis section. The probe is then placed in the middle of the dorsal part of the finger being examined, and the probe position is adjusted so that the extensor digitalis tendon can be clearly displayed, frozen, and its thickness measured. All measured values were repeated twice, and the average value was taken. CDFI was used to evaluate nail blood supply in patients with psoriasis. Morphological characteristics of deck were classified according to Wortsman classification standard: type I, with focal hyperecho, type II, showing the edge of the ventral plate is loose and the dorsal plate is normal, type III, the dorsal and ventral sides are the wavy plate, and Type IV, showing lack of two deck structures with unclear demarcation. Clinical data acquisition: all patients were examined

by experienced dermatologists, and their clinical data, course of nail lesions, treatment methods, use of anti-rheumatic drugs (DMARD), and treatment effects were recorded. Whether the nails have cracking, peeling, depression, lamellar bleeding, nail plate thickening, hyperkeratosis, etc. were observed as well. The modified psoriatic nail severity index (MAPSI) was used to score the lesions, and the psoriatic area and severity index (PASI) was used to evaluate the severity of psoriasis. The disease activity score (DSA) for PSA was calculated from 28 joints, including the number of tender joints and the number of swollen joints.

2.3. Diagnostic Criteria. A physical examination is positive if one of the following symptoms or signs is found in the facet joints of the hands and feet (including metacarpophalangeal, metatarsophalangeal, and interphalangeal joints): (1) joint swelling, (2) pain, (3) tenderness, (4) stiffness, and (5) dysfunction. An ultrasound examination is positive if one of the following signs is found: ① joint cavity effusion, (2) synovial hyperplasia of the articular cavity, ③ blood flow signal in the synovial membrane, and ④ bone erosion. The examination is negative if no such findings are found. Physical examination shows swelling, pain, or tenderness at the major attachment points of the lower limbs (quadriceps tendon, patellar ligament, Achilles tendon, and plantar fascia attachment points). Ultrasound findings of thickening of the attachment, spur formation, bursitis, bone erosion, or blood flow signal are positive. Quadriceps tendon thickness ≥ 6.1 mm, proximal/distal patellar ligament thickness ≥ 4 mm, Achilles tendon thickness ≥ 5.29 mm, and plantar fascia thickness ≥ 4.4 mm were used as the criteria for ultrasonic diagnosis of attachment thickening. Bone spur formation or bone erosion is sonically manifested as irregularity or depression of the bone cortex where tendons or ligaments are attached. Ultrasonographic manifestations of bursitis were cystic effusion around the attachment point, showing localized hypoechoic or anechoic areas, which could be compressed when the probe was pressed. A positive nail is found on physical examination to be depressed, detached, discolored, thickened, rough, or hyperkeratosis of the transverse crest or subnail. Normal nail sonograms show two layers of high echo (dorsal and ventral decks, respectively), with a layer of low echo in between. When the lower high echo line is blurred, uneven, or thickened, part or all of the hypoechoic middle layer disappeared; the echoes of the upper and lower layers are highly thickened and even fused with each other; nail bed thickening (the distance from the lower hyperechoic line to the surface of the distal phalanx) > 2.5 mm. When CDFI shows increased blood flow signal in the nail bed, ultrasound indicates psoriatic nail lesions, that is, ultrasound examination results are positive.

2.4. Statistical Analysis. SPSS22.0 statistical software was used. Measurement data were expressed as $\bar{x} \pm s$. Analysis of variance was used for comparison between groups, and independent sample t test was performed for pair comparison. Enumeration data were expressed as frequency or

rate, and χ^2 test was performed. The continuous variables consistent with the normal distribution were represented by (mean \pm standard deviation), while the continuous variables inconsistent with the normal distribution were represented by the interval between median and quantile. Categorical variables are expressed by frequency and percentage. Independent sample *t* test was used for the comparison between two groups of continuous variables consistent with normal distribution, rank sum test was used for the comparison of continuous variables inconsistent with normal distribution, and chi-square test was used for the comparison between classified variables. All the analyses, using IBM SPSS Statistics Version 20 (SPSS Inc, Chicago, IL, USA) software analysis, are double side ($P < 0.05$) statistically significant.

2.5. Current Means of Examination

2.5.1. Clinical Manifestations and Laboratory Tests.

Psoriatic arthritis can involve the joints of the whole body, among which the facet joints are the most common, showing as oligoarthritis or oligoarthritis involving the terminal interphalangeal (phalangeal) joints. The main clinical manifestations are joint swelling, pain and deformation, dysfunction, and stiffness of the joints. "Dachshang finger" is a typical manifestation of psoriatic arthritis that is different from other arthritis. When oligoarthritis is the main manifestation, in addition to affecting the distal interphalangeal (phalangeal) joints, the lower limb joints are often involved. Joint damage may also be accompanied by ocular damage, oral ulcers, cardiac damage (sinus tachycardia), and renal damage (proteinuria).

In the laboratory examination, there is no exact specific laboratory examination index at present, and the diagnosis is mainly made from the following aspects. ① Platelet: PSA patients in the active stage are often accompanied by thrombocytosis, and increased platelet can reflect the activity degree of synovial inflammation to a certain extent. ② Erythrocyte sedimentation rate: the increased erythrocyte sedimentation rate can be seen in 40%~60% of patients with psoriatic arthritis. ③ C-reactive protein: it is an indicator of disease activity and can be used as an indicator to evaluate the effectiveness of treatment programs. ④ Immunoglobulin: it is related to the severity of the disease. Hyperhemoglobinemia and elevated immunoglobulin A (IgA) level can occur in some PSA patients, and IgA serum concentration is significantly correlated with the CRP level. ⑤ Human leukocyte antigen HLA-B27: it has been reported that the positive rate of HLA-B27 in psoriatic arthritis is 96%, and there are also reports that the positive rate of HLA-B27 can indicate the damage of axial joint. ⑥ Rheumatoid factor (RF) was mostly negative in patients with psoriatic arthritis.

2.6. On-Site Histopathological Study of PSA.

The histopathological manifestations of PSA are as follows. ① Synovitis: hyperplasia of inner synovium, polypannus of synovium, and infiltration of lymphocytes are common

around psoriatic arthritis joints, but there is no synovium villus proliferation, fibrinogen deposition, and ulcer formation common in rheumatoid arthritis. ② Bone destruction and bone marrow edema: Ritchlin et al. pointed out that it may be the bone changes caused by dysplasia of bone cell regeneration. Inflammatory reaction can cause bone marrow edema. It has been reported that TNF- α can prevent the further development of bone edema. In 11 of the 6 PSA patients studied, the finger inflammation was found to be caused by inflammation at the insertion point of the tendonosseous bone. The edema of the bone marrow usually begins at the insertion point of the synovial sac and spreads to the whole phalanx with the progression of the disease. Osteoporosis is not found in PSA as in RA. Inflammatory joints cause hyperplasia of subchondral granulation tissue, which leads to bone destruction of cartilage. ③ Tendonosseous insertion inflammation: tendonosseous insertion inflammation is in the ligament or tendon attached to the bone, and tenosynovitis is often symmetrically and widely distributed. Chronic tenosynovitis and its underlying bone marrow often infiltrate T lymphocytes. A large number of inflammatory factors can cause edema of the synovial sac and edema of the adjacent bone, as well as thickening of the adjacent periosteum. However, Jevtic et al. pointed out that the chance of both edema of the bone and the adjacent endosinopathy was less than 50%, which means the two characteristics do not always occur together. ④ Finger (toe) inflammation, tendonitis, and soft tissue edema: finger (toe) performance for the proximal, distal, and diffuse swelling of the metacarpophagia (toe) joint, finger (toe) inflammation, and tendon sheath slip pathological basis are inflammatory factor-induced inflammatory cell infiltration and acute exudation. Tenosynovitis, especially, flexor tenosynovitis, combined with synovitis and soft tissue edema, can cause finger (toe) inflammation and "dachshund" changes in the hand. The flexor tendons of digititis were more frequently involved than the extensor tendons, and synovitis adjacent to the facet joint was involved in only 6 to 23 percent of the cases they studied.

2.7. Results.

A total of 320 metacarpophalangeal joints, 320 metatarsophalangeal joints, 640 proximal interphalangeal joints, 512 proximal interphalangeal joints, 320 fingernails, and 320 main appendages of lower extremities were successfully examined by physical examination and ultrasound in 32 patients diagnosed with PSA.

2.8. Small Joint Lesions of Hands and Feet.

A total of 1792 hand and foot facet joints were involved in 32 PSA patients, of which 406 were positive in physical examination and 1386 were negative (Table 1). Ultrasonographic examination was positive in 492 cases, including 246 cases of joint cavity effusion, 487 cases of synovial hyperplasia, 402 cases of synovial blood flow signal, 97 cases of bone erosion (Figure 1), and 1300 cases of negative. The positive rate of ultrasound examination (492/1792, 27.46%) was higher than that of physical examination (406/1792, 22.66%), and

TABLE 1: Physical examination and ultrasonic examination results of hand, foot, and facet joints in 32 PSA patients (pieces).

Ultrasound	Physical check		A combined
	Positive	Negative	
Positive	216	276	492
Negative	190	1110	1300
A combined	406	1386	1792

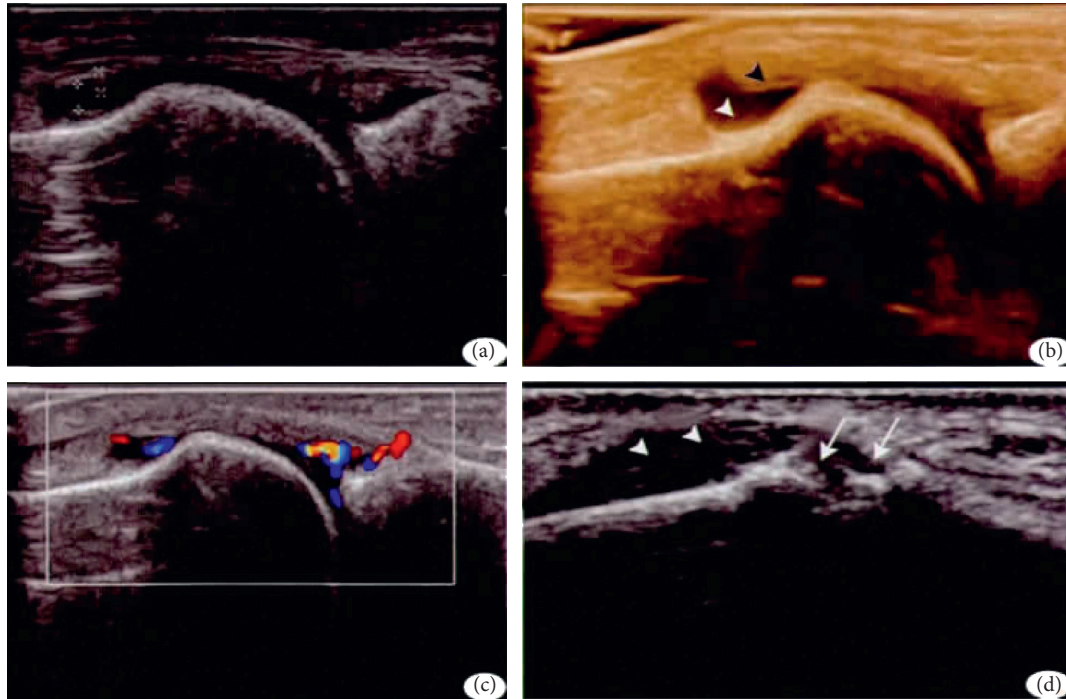


FIGURE 1: Ultrasound manifestations of synovitis in patients with PSA (A). First metatarsophalangeal joint cavity effusion with synovial hyperplasia (B). Three-dimensional ultrasound showed joint cavity effusion (white arrow) and synovial hyperplasia (black arrow) (C). CDFI showed color blood flow signal in hyperplastic synovial membrane, (D). Synovial hyperplasia of interphalangeal joint with bone erosion is indicated by the arrows.

the difference was statistically significant ($\chi^2 = 174.706$, $P < 0.001$).

2.9. Adhesion Site Inflammation. Among the 320 sites, 79 (79/320, 24.69%) were found to be positive by physical examination and 166 (166/320, 51.88%) by ultrasound examination, the difference being statistically significant ($\chi^2 = 75.898$, $P < 0.001$, Table 2). Ninety-two of the sites showed no clinical manifestations, but ultrasound showed thickening of the sites, echogenic hypoplasia, bursitis, etc. Of the 166 positive ultrasonographic findings, 51 were Achilles tendon, 38 were plantar fascia, 33 were tibial ligament, 25 were patellar ligament, and 19 were quadriceps tendon.

2.10. Nail Lesions. 17 cases (17/32, 53.13%) of PSA patients had 84 nail lesions on their hands, with a positive rate of 26.25% (84/320); 29 cases (29/32, 90.63%) of PSA patients had 203 nail lesions (Figure 2), with a positive rate of 63.44% (203/320). The positive rate of ultrasound examination was significantly higher than that of physical examination ($\chi^2 = 65.646$, $P < 0.001$).

TABLE 2: Physical examination and ultrasonic examination results of 320 attachment points in 30 PSA patients (1).

Ultrasound	Physical check		A combined
	Positive	Negative	
Positive	74	92	166
Negative	5	149	154
A combined	79	241	320

3. Discussion

PSA is an inflammatory joint disease associated with psoriasis, with a psoriatic rash and can cause pain, swelling, tenderness, stiffness, and dyskinesia in the joint and surrounding soft tissues. About 75 percent of PSA patients have a rash that precedes arthritis, while about 15 percent have a rash that precedes arthritis and about 10 percent have arthritis. “Thimble-like” depression and “sausage finger (toe)” are the characteristic clinical manifestations of PSA patients. About 80% of PSA patients have finger (toe) nail lesions, some patients have attachment inflammation, and a few have fever, anemia, and ocular lesions such as iritis and

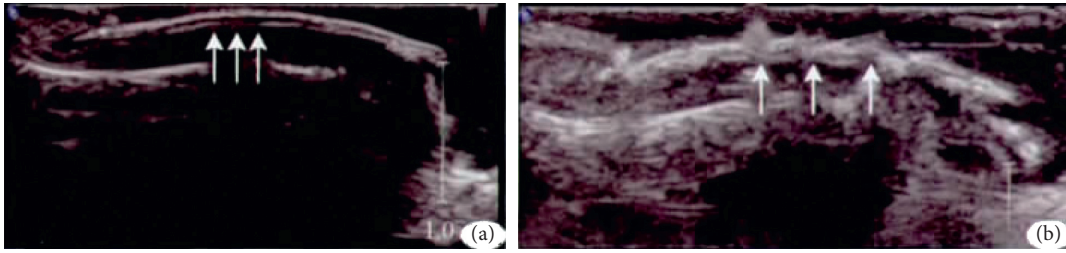


FIGURE 2: Nail lesions.

uveitis. For patients with PSA after cutaneous psoriasis, the diagnosis of PSA can be established based on skin silver, joint symptoms, nail lesions, combined with serological indicators, etc. Imaging examination at this time is helpful to evaluate the severity of PSA lesions. X-ray plain film is one of the traditional assessment of joint damage in patients with PsA levels of gold standard, and it can show bone destruction and bone hyperplasia. Typical “pencil cap” or “telescope” refers to the stenosis, fusion, stiffness, and deformation of joints between the joints, but these signs appear after the deterioration of disease progression. High-frequency ultrasound has the advantages of high soft tissue resolution and real-time dynamic imaging. It has high sensitivity and specificity in the diagnosis of synovitis, attachment site inflammation, and tenosynovitis of inflammatory arthropathy and can detect subclinical lesions, and color energy Doppler imaging can also evaluate the degree of inflammatory activity.

In this study, 32 patients with PSA with 1792 facet joints in hand and foot were included. Ultrasound examination revealed 492 involved joints, 276 of which were at the subclinical stage. It can be seen that the presence of small joint lesions on ultrasound is earlier than that on physical examination. For the swelling of fingers (toes), it is often difficult to distinguish between synovitis and flexor tendonitis. Ultrasound can be used to distinguish the cause according to different ultrasonographic manifestations. In this study, 406 joints were found to be affected by physical examination, of which 190 had no synovial lesions on ultrasound examination, but were found to have thickened tendon sheath/tendon, decreased echogenicity, increased blood flow signal and other sonographic changes, which were diagnosed as flexor/extensor tendonosynovitis, tendonitis, etc. In addition, after the detection of articular synovitis by ultrasound, synovitis hyperplasia, synovial blood flow signal, and bone erosion can be graded to realize the semiquantitative assessment of synovitis. Foreign scholars divide the synovitis hyperplasia into four grades with the thickness of synovitis exceeding 2 mm and 4 mm as the boundary. The blood flow was divided into 4 grades by the boundary of 30% and 60% of the hyperplastic synovial area. Bone erosion is also classified into four grades according to the number and extent of bone destruction. This semiquantitative assessment will provide important information for disease monitoring and efficacy evaluation. Early onset of bone erosion and an increase in the number and extent of bone erosion have been reported, suggesting a poor prognosis in patients with PSA.

Attachment points’ inflammation is a typical pathological characteristics, a serum negative spinal joint disease but without any clinical symptoms, easily overlooked in clinical, or confused with other joint soft tissue diseases, often need to be identified with the help of imaging examination, combination of conventional ultrasound color doppler ultrasound not only earlier than clinical find tendons, ligaments attached end morphology change, also tissue blood flow signal can be shown, Determine the level of inflammatory activity. The Achilles tendon and plantar fascia attachment points are the most commonly involved sites of PSA attachment points. Ultrasonography is required to distinguish the attachment points from tendonitis, retrocalcaneal bursitis, and plantar fasciitis, although physical examination may reveal swelling of the Achilles tendon, plantar pain, etc. In addition, ultrasound can also detect many subclinical stage of attachment site inflammation. In this study, a total of 166 attachment sites were detected by ultrasound, 92 of which were not found at all on physical examination, suggesting that high-frequency ultrasound is of great value in the diagnosis of subclinical stage of attachment site inflammation. Ultrasonography plays an important role in the early identification and accurate evaluation of attachment point inflammation, synovitis, and tenosynovitis in PSA patients. In this study, 119 subclinical nail lesions were detected by ultrasound prior to physical examination, showing vague, uneven, and thickened ventral deck echo (lower hyperechoic line) or thickened nail bed and increased blood flow signals. Sandobal et al. compared and observed the ultrasonic manifestations of fingernails in patients with PSA, cutaneous psoriasis, and rheumatoid arthritis and found that the ventral deck boundary of fingernails in patients with PSA was blurred. The nails of patients with cutaneous psoriasis mostly showed localized echogenic enhancement on the ventral deck, but no involvement on the dorsal deck. Rheumatoid arthritis patients did not show any of the above. Nail lesions are an important clinical manifestation of psoriasis that may develop into PSA, and it is difficult to diagnose some PSA patients that occur before cutaneous psoriasis. Ultrasound findings of synovitis, attachment point inflammation, tenosynovitis, and nail changes indicate the possible presence of PSA. In addition, some other ultrasonic signs, such as “double track sign” and “blizzard sign,” are also of great value in the differential diagnosis of PSA from other joint diseases such as gouty arthritis and osteoarthritis. In conclusion, ultrasound is superior to physical examination in the evaluation of hand and foot facet joints, nail lesions, and attachment

point inflammation in patients with PSA. Although no PSA-specific sonographic findings have been found at present, ultrasound is still of great value in the diagnosis and differential diagnosis of PSA. In addition, due to the advantages of simple operation, economy, real time, and no radiation, ultrasound can be used in the follow-up of PSA and the evaluation of efficacy and guide the suction and injection treatment of articular cavity effusion. In the future, to establish a unified, simple, and effective ultrasonographic scoring standard for PSA will be of great significance for the diagnosis and prognosis evaluation of PSA [1–10].

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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