Med. J. Cairo Univ., Vol. 90, No. 1, March: 39-51, 2022
www.medicaljournalofcairouniversity.net

The Added Value of Ultrasound in Detecting Hip Arthroplasty Related Complications

NOUR M.M. KANDIL, M.D. and BASMA M.A. ALKALAAWY, M.D.

The Department of Radiology, Faculty of Medicine, Cairo University

Abstract

Background: Complications of total hip arthroplasty are common and it is essential for the radiologist to be aware of them in the assessment of any imaging modality after total hip replacements. Complications are many and can occur at various time intervals following the initial surgery.

Aim of Study: The aim of this study is to report the added value of ultrasound in evaluating prosthesis related complications after hip arthroplasty and to compare the findings with X-ray, computed tomography (CT), clinical examination, laboratory and operative findings.

Material and Methods: This prospective study was carried out on ninety two patients (33 males & 59 females). All patients were complaining of hip pain after hip arthroplasty. All patients were subjected to relevant history taking, local examination, laboratory studies, plain X-ray, multidetector computed tomography, +/- operation. 35 patients underwent revision surgery. The results were compared to high resolution ultrasound with color Doppler findings.

Results: 92 patients with hip arthroplasty implants were subjected to history taking, local examination, laboratory studies, plain X-ray, multi-detector computed tomography, +/- operation and the results were compared to high resolution ultrasound with color Doppler. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound were calculated for detecting each complication.

Our study showed that ultrasound is a very useful imaging tool in detecting soft tissue complications and in guiding for needle aspiration. On the other hand, it has limited role in detecting bony complications as loosening, fractures and dislocations.

Conclusion: We concluded that ultrasound has a valuable added role in evaluating hip arthroplasty soft tissue complications.

Key Words: *Plain X-ray – CT-Ultrasound – Hip arthroplasty – Prosthesis related complications.*

Correspondence to: Dr. Nour M.M. Kandil, The Department of Radiology, Faculty of Medicine, Cairo University

Introduction

HIP arthroplasty has become the standard treatment method for advanced hip diseases, the most successful and commonly used method; it can relieve symptoms, improve the activity level and quality of life for many patients. Many implants eventually fail with time **[1,2]**. There is a diagnostic dilemma faced by clinicians for the patients presenting with a complicated hip following arthroplasty and satisfactory postoperative radiographs **[3]**. Radiologists must study the varied imaging appearances of those complications, to accurately diagnose symptoms related to hip arthroplasty implants **[4]**.

Radiography is the initial investigatory method for the evaluation of hip arthroplasty and postoperative complications. The initial films are done as a baseline study and are used for comparison and follow up with all future studies to detect any possible complications. Postoperative complications as dislocation, heterotopic ossification and peri-prosthetic fracture can be clearly detected on plain radiographs. However, the sensitivity of radiography to detect infection, aseptic loosening and soft-tissue pathology is limited **[4,5]**.

Normal or unclear radiographic findings are indications for CT. CT is comparatively inexpensive, readily available and easy to perform making it an excellent tool to supplement radiographs when trying to evaluate hip prostheses. However, its value is limited due to considerable artifacts from the prosthesis. The intensity of metal artifact depends on the metal used, with most intense artifacts observed with chromium-cobalt implants and less intense artifacts observed with titanium implants **[6,7]**.

US is readily accessible and quick, with the possibility of interaction with the patient, lack of

ionizing radiation, visualize the surrounding soft tissues and bursae, dynamic evaluation of moving structures, and comparison with the opposite side. The addition of power Doppler can help in examining the blood flow within and around the joint. US guided fluid aspirations can also be used to detect the causative organism of the infection. However, ultrasound is not recommended to assess peri-prosthetic bone complications due to the deep location of the hip prosthesis and the inability of sound to penetrate bone or metal **[8,9]**.

Material and Methods

The current study had been approved by Kasr El-Aini Hospital, Research and Ethical committee.

This prospective study was carried out on ninety two patients (33 males & 59 females) referred to us from either the orthopedic or rheumatology outpatient clinics between August 2018 and February 2020. Their age ranged from 23 to 80 years (mean age 57). Eight of them have bilateral hip prosthesis (6 females and 2 males).

All patients were complaining of hip pain after hip arthroplasty (the right in 50 patients and the left in 34 and bilateral in 8 patients). 35 of the examined hips were hemiarthroplasty and 65 were total hip arthroplasty.

All patients were subjected to relevant history taking, local examination, laboratory studies, plain X-ray, multidetector computed tomography, +/- operation. 35 patients underwent revision surgery. The results were compared to high resolution ultrasound with color Doppler findings.

X-ray examination:

Examination was performed using Rad speed (UD 150L-40E), Shimadzu. The radiographs were done in the following positions: Standing antero-posterior pelvic radiograph and lateral radiograph of the hip prosthesis. X-ray analysis was performed by qualified radiology consultants and the higher suggestion was taken in consideration.

Table (1) summarizes the parameters to be analyzed in each postoperative radiograph after hip arthroplasty.

Table (1): Analyzed Parameters in each postoperative radiograph after hip arthroplasty.

Parameters	Abnormal Findings
Osteolysis (Aseptic loosening)	- Peri-prothetic lucency more than 2mm thick at the cement-bone or metal-bone interfaces around the entire circumference. - Progressive lucent lines around the prosthesis on serial imaging.
Osteolysis (Infection)	- Periprothetic irregular lucency more than 2mm and frank bone destruction.
Heterotopic ossification	*According to Brooker's Classification (Bone bridging across the joint):* Grade 0: No heterotopic ossification. Grade 1: One or two foci of heterotopic ossification < 1 cm. Grade 2: Ossification or osteophytes occupying less than half of the space between the femur and the pelvis. Grade 3: Ossification or osteophytes occupying more than half of the space between the femur and the pelvis. Grade 4: Ossification bridges between the pelvis and femur, indicative of hip ankylosis.
Periprothetic Fracture	*Classified by Vancouver classification (according to its location) into:* Type A: The fracture involves the trochanteric region. Type B: The fracture is around or just distal to the femoral stem. Type C: The fracture is so far below the stem that the treatment is independent of the hip replacement.
Dislocation/Subluxation	Abnormal separation of the joint. A partial dislocation was referred to as a subluxation.
Prosthetic acetabular protrusion	Medial migration of the acetabulum cup past Kohler's line and into the pelvis.
Adverse Local Tissue Reaction	Osteolysis with suspected soft tissue lesion near the joint.

CT examination:

Multi-detector computed tomography was performed using Aquilion TSX-101A, Toshiba medical system, Japan.

Patient position: Supine; Keep feet and toes turned inward toward each other and taped together.

Scanogram: Coronal from iliac crests extends down below the end of the femoral stem prosthesis. Intravenous injection of contrast was performed if there were suspicion of infection (in cases with no contraindication for contrast administration).

Parameters:

The parameters were set to minimize metal artifacts: Collimation 3mm, Kilovolt 135kVp, Milliampere 250mAs and pitch 0.3.

MDCT analysis was performed by qualified consultants of Radiology and the higher suggestion was taken into consideration.

Table (2) summarizes the parameters to be analyzed in CT after hip arthroplasty.

Table (2): Analyzed Parameters in CT after hip arthroplasty.

Parameters	Abnormal Findings
Osteolysis (Aseptic loosening)	*Classified according to Pluot et al., **[10]** into:* (a) Normal or acceptable: 2mm radiolucent areas around components, small voids representing air bubbles in the mantle of cemented components, calcar resorption and stress shielding. (b) Possible loosening: Pedestal formation, bead shedding, and hardware or cement fractures. (c) Definite loosening: Femoral stem/acetabular cup that rotated or migrated.
Infection	- Periprothetic fluid collection with gas/fat stranding/enhancement on postcontrast films.
Heterotopic ossification	*According to Brooker's Classification (Bone bridging across the joint):* Grade 0: No heterotopic ossification. Grade 1: One or two foci of heterotopic ossification <1cm. Grade 2: Ossification or osteophytes occupying less than half of the space between the femur and the pelvis. Grade 3: Ossification or osteophytes occupying more than half of the space between the femur and the pelvis. Grade 4: Ossification bridges between the pelvis and femur, indicative of hip ankylosis.
Peri-prothetic Fracture	*Classified by Vancouver classification (according to its location) into:* Type A: The fracture involves the trochanteric region. Type B: The fracture is around or just distal to the femoral stem. Type C: The fracture is so far below the stem that the treatment is independent of the hip replacement.
Dislocation/Subluxation	- Abnormal separation of the joint. A partial dislocation was referred to as a subluxation.
Prosthetic acetabular protrusion	- Medial migration of the acetabulum cup past Kohler's line and into the pelvis.
Adverse Local Tissue Reaction	- Osteolysis with soft tissue lesion near the joint (pseudotumor).

US +/- Color Doppler examination:

The patients were examined using: LOGIQ P6, GE (General electric medical system) ultrasound machine which was equipped by: 3-5MHz Curved array transducer (used due to the deep location of the joint) and 9-15MHz Linear array transducer (used to visualize superficial structures). Examinations were performed by two radiologists experienced in musculoskeletal ultrasound.

The patient lied supine on the bed to evaluate the anterior aspect of the hip joint with the hips and knees extended with a mild degree of external

rotation of the hip. Longitudinal images were first obtained by placing the transducer in a sagittal oblique plane parallel to the femoral neck of the prosthesis. Then transverse images were taken by placing the probe perpendicular to the major axis of the implant covering the entire area of the hip, from the anterior superior iliac spine up to the middle portion of the thigh. The femoral artey, femoral vein and the pelvic insertion of the adductor muscles were also assessed.

Then, the patient turned to lie on the side opposite to the affected prosthesis to assess the peritrochanteric tissues with hip joint extended. Longitudinal and transverse images were obtained by moving the probe in cranio-caudal direction to scan the greater trochanter and from anterior to posterior to scan the gluteus tendons insertions.

Aspiration guided ultrasound of hip effusion: Was done in some cases to detect the causative organism of infection. The depth from the skin surface to the deepest portion of the fluid is measured then a needle with an appropriate length was selected. With the transducer positioned over the effusion, a marker was used to place a dot on the skin at the midpoint of each side of the transducer. The dots were connected to form a "+". Accuracy of the marking was checked by placing the transducer at the "+" in both transverse and longitudinal orientations. The marking should be directly over the center of the effusion, Fig. (1). Ultrasound analysis was performed by qualified physicians of Radiology.

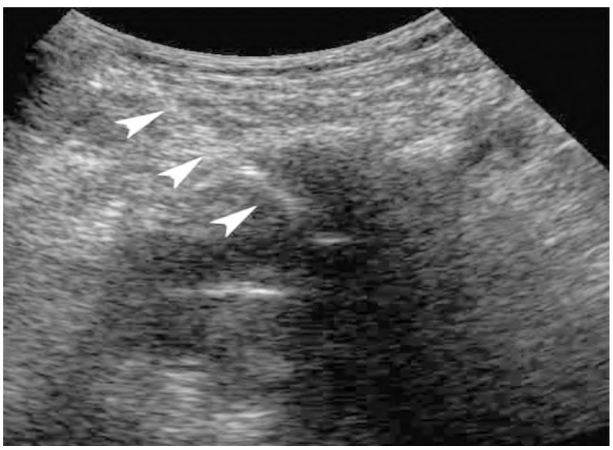

Fig. (1): US guided aspiration of the right hip joint effusion using an 18-gauge spinal needle (arrowheads) revealed purulent material **[11]**.

Table (3) summarizes the parameters to be analyzed on US after hip arthroplasty.

Table (3): Analyzed parameters in ultrasound after hip arthroplasty.

Parameters	Abnormal Findings
Effusion	- Hypoechoic or anechoic fluid that anteriorly displaces the joint pseudocapsule from the anterior cortex of the femoral neck (threshold of 10 mm has been suggested for the detection of hip effusion).
Infection	- Joint effusion which is turbid/loculated/ with internal echos. - Periprothetic fluid collection. - Cutaneous sinus tract.
Heterotopic ossification	- Hyperechoic ossifications with posterior acoustic shadowing.
Trochantric bursitis	- Hypo-or anechoic fluid collection which is located superficial to the greater trochanter.
Adverse Local Tissue Reaction (Pseudotumor)	- Anechoic or hypoechoic fluid collection with thick echogenic septations and marked synovial hypertrophy.
Vascular complications	- Color Doppler imaging, and pulsed Doppler ultrasound to assess femoral artery for pseudoaneurysm and femoral vein for deep venous thrombosis.

Statistics:

Data had been coded and entered using the statistical package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA), then data had been summarized using frequencies (number of cases) and relative frequencies (percentages). For comparing categorical data, Chi square (X^2) test was performed. Exact test was used instead when the expected frequency is less than 5 **[12]**. Standard diagnostic indices including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic efficacy were calculated as described by **[13]**. p-values less than 0.05 were considered as statistically significant.

Results

This study was carried out on ninety two patients (33 males & 59 females) referred to us from either the orthopedic or rheumatology outpatient clinics between August 2018 and February 2020, their age ranged from 23 to 80 years (mean age 57). Eight of them have bilateral hip prosthesis (6 females and 2 males). 35 of the examined hips were hemiarthroplasty and 65 were total hip arthroplasty.

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound were calculated for each complication.

1- *Effusion:*

Ultrasound was able to detect effusion in 86 out of the 92 examined hip prothesis Fig. (2A). Comparing its results to other modalities, clinical and +/- operative details 16 more hip prosthesis was diagnosed using ultrasound Fig. (2B) (Table 4A) and this was proved by comparing the results with MRI.

The sensitivity of ultrasound in detecting effusion was 100%, specificity was 27.27%, positive predictive value was 81.40%, negative predictive value was 100% and accuracy of ultrasound in diagnosing effusion was 82.61% Table (4B).

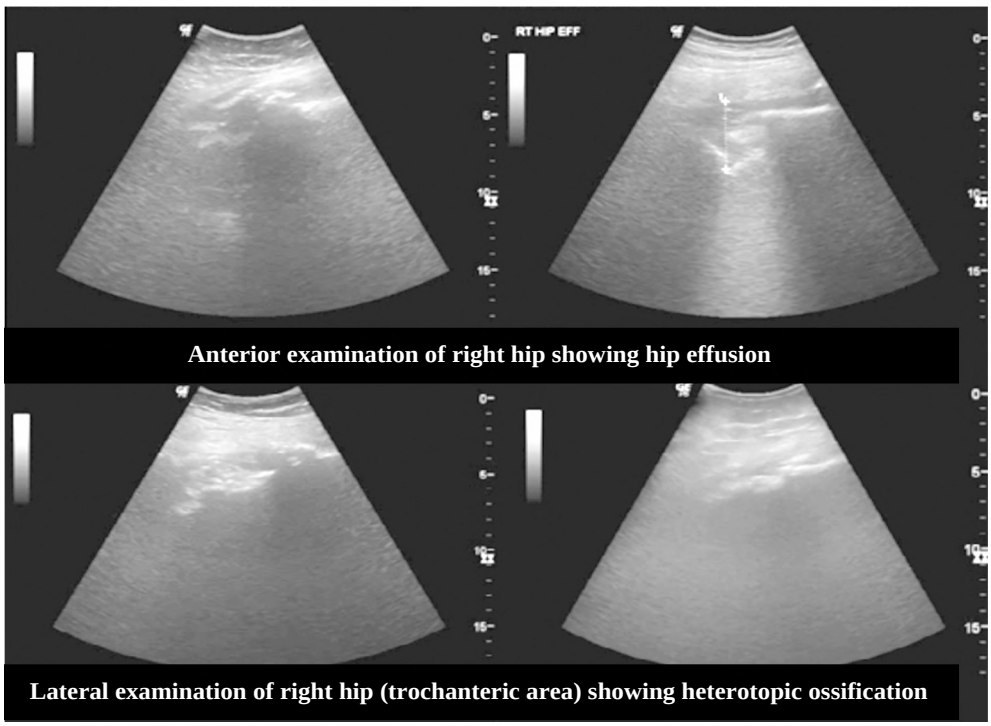

Fig. (2A): 52 years old female patient underwent right total hip replacement. Ultrasound showed RT hip effusion not detected by X-ray and CT and extensive RT heterotopic ossification.

Fig. (2B): X-ray and CT examination for the same case showed extensive right heterotopic ossification (Brooker grade 4: Apparent ankylosis across the hip joint) with no evidence of hip effusion detected by ultrasound.

Table (4A): The frequency of effusion detected by ultrasound versus other modalities, clinical and +/- operative details.

	Effusion by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Effusion by ultrasound:				
Positive	70	100.0	16	72.7
Negative	0	0.0	0	27.3

Table (4B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing effusion.

Statistics	Value	95% CI
Sensitivity	100.00%	94.87% to 100.00%
Specificity	27.27%	10.73% to 50.22%
Positive predictive value	81.40%	77.21% to 84.96%
Negative predictive value	100.00%	
Accuracy	82.61 %	73.30% to 89.72%

2- *Heterotopic ossification:*

Heterotopic ossifications were diagnosed by ultrasound in 14 of the examined hip prosthesis (Figs. 2A,3). 10 more cases were detected using other modalities, clinical and operative details as shown in Table (5A).

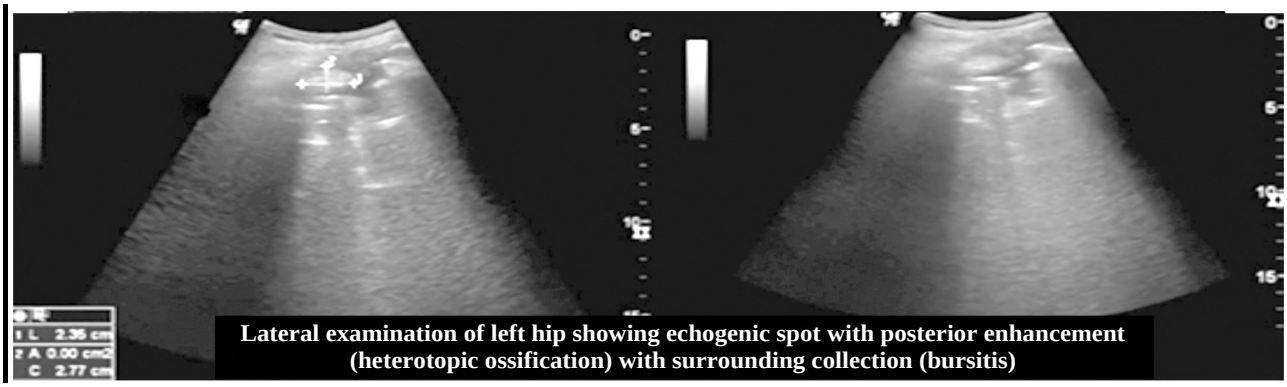

Fig. (3): 34 year old male who gave history of sickle cell anemia. He underwent left total hip replacement for a dislocated hip. Ultrasound showed calcific spot near the left greater trochanter with posterior enhancement (Grade 1 heterotopic ossification) and surrounding fluid collection (Bursitis).

Table (5A): The frequency of heterotopic ossification detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Heterotopic ossification by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Heterotopic ossification by ultrasound:				
Positive	14	58.3	0	0.0
Negative	10	41.7	68	100.0

Table (5B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing heterotopic ossification.

Statistics	Value	95% CI
Sensitivity	58.33%	36.64% to 77.89%
Specificity	100.00%	94.72% to 100.00%
Positive predictive value	100.00%	
Negative predictive value	87.18%	80.90% to 91.61%
Accuracy	89.13%	80.92% to 94.66%

The sensitivity, specificity, PPV, NPV and accuracy of ultrasound in detecting heterotopic ossification was (58.33%, 100%, 100%, 87.18% and 89.13%) respectively Table (5B).

3- *Infection:*

Infections were diagnosed by ultrasound in 14 of the examined hip prosthesis (Fig. 4A). This agreed with the results of other modalities, clinical and operative details, (Fig. 4B, Table 6A).

Table (6B) shows the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in detecting infection (100%, 100%, 100%, 100% and 100%) respectively.

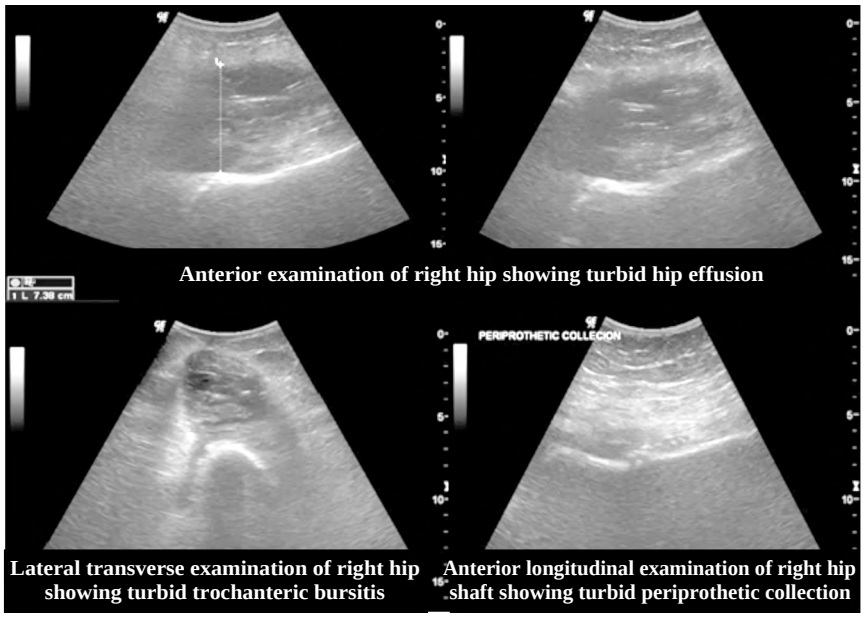

Fig. (4A): 64 years old female patient underwent right bipolar hemiprothesis. Ultrasound showed turbid periprothetic collection (anterior and lateral) and turbid trochantric bursitis.

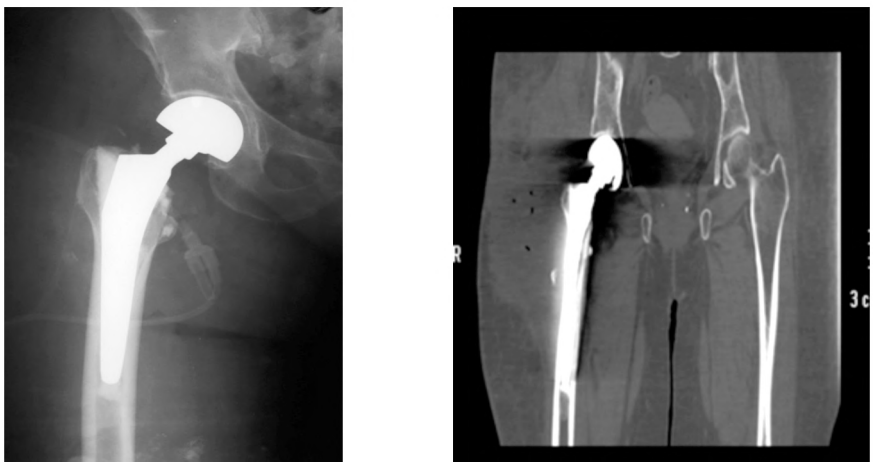

Fig. (4B): X-ray for the same patient was unremarkable. CT showed soft tissue collection with soft tissue gas and subcutaneous fat stranding; suggestive of infection. CT with contrast couldn't be done as the patient's renal function was impaired.

Table (6A): The frequency of infection detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Infection by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Infection by ultrasound:				
Positive	14	100.0	0	0.0
Negative	0	0.0	78	100.0

Table (6B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing infection.

Statistics	Value	95% CI
Sensitivity	100.00%	76.84% to 100.00%
Specificity	100.00%	95.38% to 100.00%
Positive predictive value	100.00%	
Negative predictive value	100.00%	
Accuracy	100.00%	96.07% to 100.00%

4- *Trochantric bursitis:*

Trochantric bursitis was seen in 24 of the examined hip prosthesis using ultrasound (Figs. 4A,5A). Comparing its results to other modalities, clinical and operative details 9 more patients were diagnosed as trochanteric bursitis using ultrasound (Figs. 4B,5B and Table 7A).

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in detecting trochanteric bursitis were (100%, 88.31%, 62.5%, 100% and 90.22%) respectively Table (7B).

5- *Adverse local tissue reaction (Metallosis +/- Pseudotumor):*

One of the examined hip prosthesis showed evidence of adverse local tissue reaction using ultrasound. 3 hips prosthesis with adverse local tissue reaction were missed by ultrasound (Table 8A).

Table (8B) shows the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing adverse local tissue reaction.

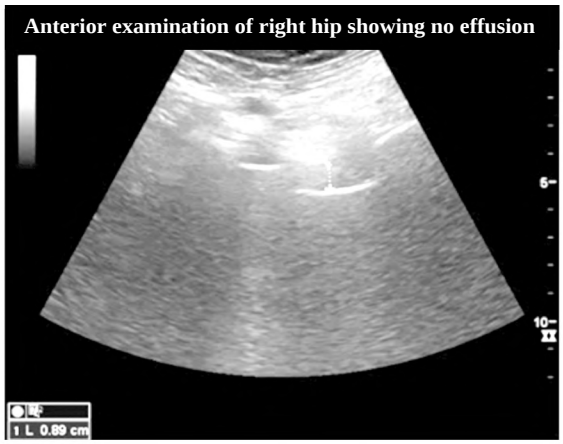

Fig. (5A): 54 years old female patient with history of fracture left femur neck which was treated with left bipolar hemiprothesis. After one year it was complicated (infection), revision surgery was done and replaced with total hip prosthesis. Now she is coming complaining of hip pain. Ultrasound showed Left hip trochanteric bursitis.

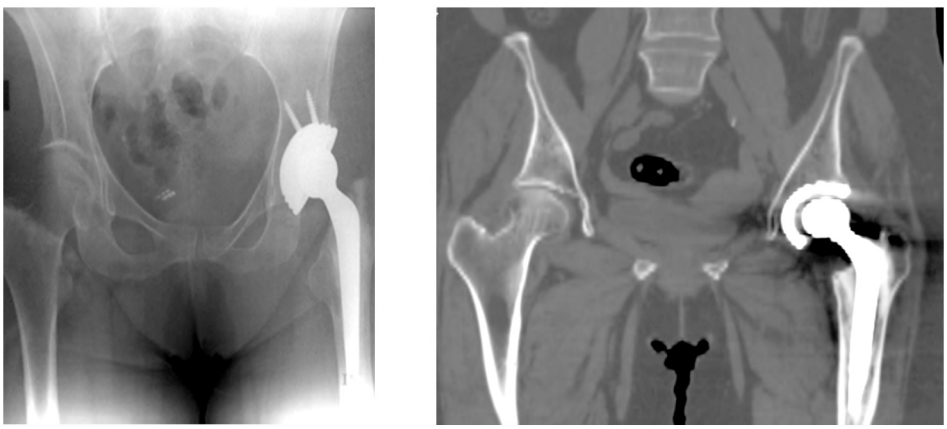

Fig. (5B): X-ray and CT for the same patient were unremarkable.

Table (7A): The frequency of trochanteric bursitis detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Trochanteric bursitis by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Trochanteric bursitis by ultrasound:				
Positive	15	100.0	9	11.7
Negative	0	0.0	68	88.3

Table (7B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing trochanteric bursitis.

Statistics	Value	95% CI
Sensitivity	100.00%	78.20% to 100.00%
Specificity	88.31%	78.97% to 94.51%
Positive predictive value	62.50%	47.42% to 75.49%
Negative predictive value	100.00%	
Accuracy	90.22%	82.24% to 95.43%

Table (8A): The frequency of adverse local tissue reaction detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Adverse local tissue reaction by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Adverse local tissue reaction by ultrasound:				
Positive	1	25.0	0	0.0
Negative	3	75.0	88	100.0

Table (8B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing adverse local tissue reaction.

Statistics	Value	95% CI
Sensitivity	25.00%	0.63% to 80.59%
Specificity	100.00%	95.89% to 100.00%
Positive predictive value	100.00%	
Negative predictive value	96.70%	94.34% to 98.10%
Accuracy	96.74%	90.77% to 99.32%

6- Vascular complications:

Two of the examined hip prosthesis showed evidence of deep venous thrombosis (Fig. 6). These 2 cases were missed by other modalities, clinical and +/- operative details (Table 9).

The specificity of ultrasound in detecting deep venous thrombosis was 97.83% and the NPV was 100%.

7- Dislocation/Subluxation:

Dislocations/Subluxations were diagnosed in 2 of the examined hip prosthesis by ultrasound (Fig. 7). 12 more hips prosthesis showing dislocation were missed by ultrasound (Table 10A).

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in detecting dislocation were as follows (14.29%, 100%, 100%, 86.67% and 86.96%) Table (10B).

8- Osteolysis (aseptic loosening) / Fracture / Prosthetic acetabular protrusion:

Using ultrasound no cases were diagnosed having aseptic loosening, fracture or prosthetic acetabular protrusion.

Tables (11,12,13) show the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in detecting aseptic loosening, fracture or prosthetic acetabular protrusion.

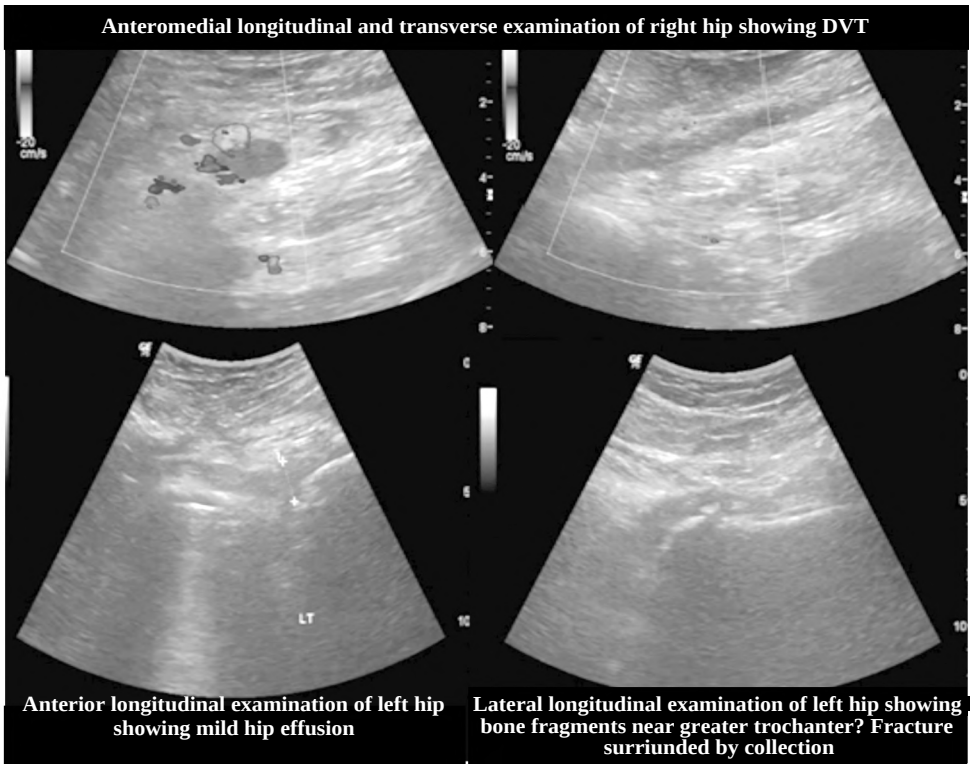

Fig. (6): 54 years old female patient gave history of right total hip replacement 3 years ago followed by left total hip replacement 1 year ago. Ultrasound showed right sided DVT (thrombus seen in the common femoral and superficial femoral veins), right hip joint dislocation with fluid collection around the shaft and in the acetabulum, left hip joint effusion and bone fragments at the site of the left greater trochanter are seen suspecting fracture surrounded by collection.

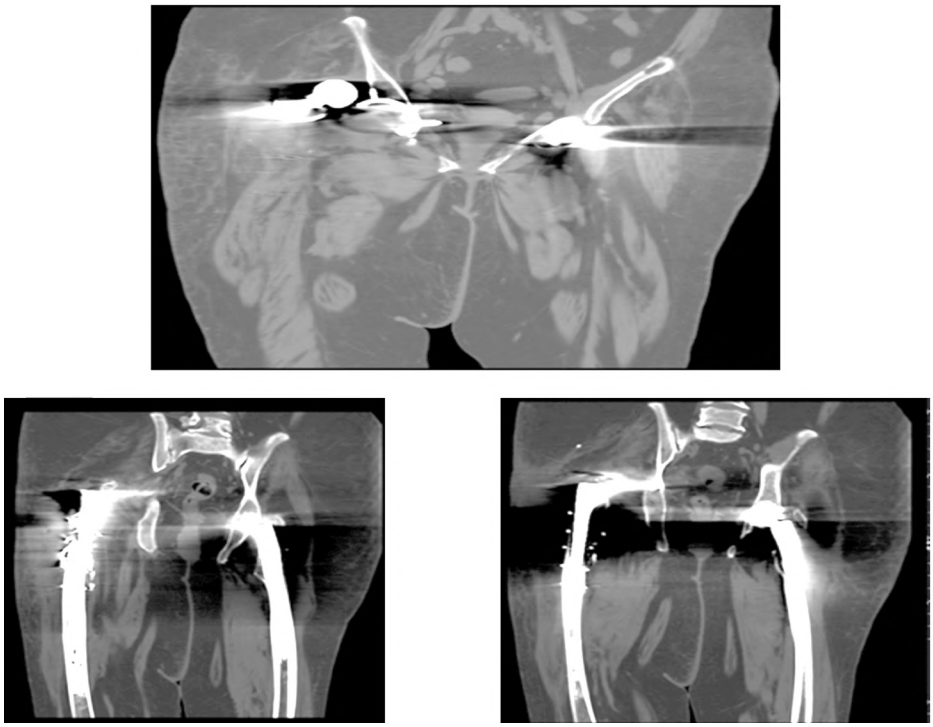

Fig. (7): CT showed Right hip joint dislocation, left greater trochanter fracture with surrounding collection (Type A), bilateral sacroilitis, cement extrusion and few air bubbles in the cement mantle (acceptable finding).

Table (9): The frequency of vascular complications detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Vascular complications by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Vascular complications by ultrasound:				
Positive	0	0.0	2	2.2
Negative	0	0.0	90	97.8

Table (10A): The frequency of dislocation/sublaxation detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Dislocation/sublaxation by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Dislocation/sublaxation by ultrasound:				
Positive	2	14.3	0	0.0
Negative	12	85.7	78	100.0

Table (10B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing dislocation / sublaxation.

Statistics	Value	95% CI
Sensitivity	14.29%	1.78% to 42.81%
Specificity	100.00%	95.38% to 100.00%
Positive predictive value	100.00%	
Negative predictive value	86.67%	84.00% to 88.95%
Accuracy	86.96%	78.32% to 93.07%

Table (11A): The frequency of osteolysis (aseptic loosening) detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Osteolysis (aseptic loosening) by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Osteolysis (aseptic loosening) by ultrasound:				
Positive	0	0.0	0	0.0
Negative	26	100.0	66	100.0

Table (11B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing osteolysis (aseptic loosening).

Statistics	Value	95% CI
Sensitivity	0.00%	0.00% to 13.23%
Specificity	100.00%	94.56% to 100.00%
Positive predictive value		
Negative predictive value	71.74%	71.74% to 71.74%
Accuracy	71.74%	61.39% to 80.64%

Table (12A): The frequency of fracture detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Fracture by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Fracture by ultrasound:				
Positive	0	0.0	0	0.0
Negative	20	100.0	72	100.0

Table (12B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing fracture.

Statistics	Value	95% CI
Sensitivity	0.00%	0.00% to 16.84%
Specificity	100.00%	95.01% to 100.00%
Positive predictive value		
Negative predictive value	78.26%	78.26% to 78.26%
Accuracy	78.26%	68.44% to 86.19%

Table (13A): The frequency of prosthetic acetabular protrusion detected in the examined hip prosthesis by ultrasound versus other modalities, clinical and +/- operative details.

	Prosthetic acetabular protrusion by other modalities, clinical and +/- operative details			
	Positive		Negative	
	Count	%	Count	%
Prosthetic acetabular protrusion by ultrasound:				
Positive	0	0.0	0	0.0
Negative	3	100.0	89	100.0

Table (13B): The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound in diagnosing prosthetic acetabular protrusion.

Statistics	Value	95% CI
Sensitivity	0.00%	0.00% to 70.76%
Specificity	100.00%	95.94% to 100.00%
Positive predictive value		
Negative predictive value	96.74%	96.74% to 96.74%
Accuracy	96.74%	90.77% to 99.32%

Discussion

Hip arthroplasty is a very common orthopedic procedure for the treatment, and the improvement of the function in an arthritic hip. However, the majority of implants show complications by time [4]. Several imaging modalities are used to assess patients with hip arthroplasty to detect these complications [8].

Ultrasound is the best modality in evaluating joint effusion and extra-articular fluid collections [8]. 86 of the examined hip prosthesis diagnosed to have joint effusion by ultrasound. 16 cases were missed by other modalities, clinical and +/- operative details. Not all cases underwent operations; therefore there were missed cases in our comparison with ultrasound. The reported sensitivity of ultrasound to detect effusion is up to 92% [9], in our study its sensitivity were 100%.

Ultrasonography is also a reliable modality to detect infected hip arthroplasty with or without discharging sinus. Drainage of soft tissue fluid collections guided by ultrasound can be done as well. Patients who had large joint effusions (3.2mm) with extra-capsular soft tissue collections had 100% specificity for hip infection [3,9]. This agreed with our study, ultrasound showed 100% specificity in diagnosing infection compared to other modalities, clinical and operative details. Furthermore, in 4 cases CT with contrast were contraindicated due to high renal functions and ultrasound / ultrasound guided aspiration were useful for the diagnosis.

In this study, only 14 of the examined hip prosthesis were diagnosed by ultrasound to have heterotopic ossification (58.3% sensitivity) with 10 more examined hip prosthesis diagnosed by X-ray and CT. Long et al, stated that radiographs and CT are the used modalities to detect heterotopic ossifications [9].

By ultrasound, 24 of the examined prosthesis showed trochanteric bursitis (100% sensitivity). 9 of these cases were missed by other modalities, clinical and +/-operative details. This explained by that not all cases underwent operations. Sdao et al., stated that ultrasound is an ideal modality to evaluate the soft tissues surrounding the prosthesis including trochanteric bursitis [8].

Two cases were found to have DVT in our study as detected by US (However, these 2 cases were not suspected clinically and the patient's operations were postponed), It is therefore important to assess the femoral vein with venous compression, color Doppler imaging, and pulsed Doppler ultrasound when evaluating a patient with hip pain after arthroplasty in order to avoid missing a deep vein thrombosis [14].

In our study X-ray was our first modality of examination. Osteolysis (aseptic loosening), heterotopic ossification, fracture, dislocation, prosthetic acetabular protrusion and metallosis were the complications detected initially by X-ray. Adding CT in the evaluation of these patients increased the diagnostic performance compared to radiography.

Cloudy radiodensities (metallosis) in the periprosthetic tissues were seen in two of the examined hip prosthesis by X-ray. Unfortunately, Metallosis is missed by X-ray in over half of cases [15]. In our study CT was able to confirm the X-ray findings and was helpful in diagnosing two more cases. Ultrasound only diagnosed one case and our reported sensitivity was 25%. This can be explained by that metallosis cause periprothetic lucency with or without soft tissue mass (pseudotumor) and in our study only one case was associated with pseudotumor.

Osteolysis (aseptic loosening) was detected by X-ray in 24 of the examined hip prosthesis and was confirmed by CT examinations. Another two cases displayed subtle areas of lucencies on X-ray and was difficult to interpret; in these 2 cases CT were useful and confirmed osteolysis. CT is useful in the evaluation of subtle stress and insufficiency fractures that may not be detected by X-ray [16]. In our study 18 of the examined hip prosthesis showed fractures that were confirmed with CT examination. An additional two hip prosthesis subtle fractures were detected by CT and were missed by X-ray. Prosthetic acetabular protrusions were detected by both X-ray and CT in 3 cases. Ultrasonography is not ideally used in assessing the prosthesis and periprosthetic bone because of the inability of sound beams to penetrate metal or

bone [9]. This explain the limited role of ultrasound in detecting osteolysis, fractures & prosthetic acetabular.

14 cases were diagnosed to have dislocation/ subluxation by X-ray and CT, 2 of these cases (sensitivity 14.3%) were also diagnosed by US study, as the femoral head weren't found located in the acetabulum, however, US couldn't assess subtle cases or subluxation and couldn't be used for diagnosis.

Conclusion:

We concluded that ultrasound has a valuable added role in assessing patients with hip arthroplasty especially in cases with soft tissue abnormality as effusion, infection, sinus tracts, DVT & trochanteric bursitis.

References

1- FRITZ J., LURIE B., MILLER T. and POTTER H.: MR Imaging of Hip Arthroplasty Implants. Radiographics, 34: 106-132, 2014.

2- PIVEC R., JOHNSON A.J., MEARS S.C. and MONT M.A.: Hip arthroplasty. Lancet, 380: 1768-1777, 2012.

3- DOUIS H., DUNLOP D.J., PEARSON A.M. and O'HARA J.N.: The role of ultrasound in the assessment of postoperative complications following hip arthroplasty. Skeletal Radiol., 41: 1035-1046, 2012.

4- AWEN O., CHEN L. and RESNIK C.: Imaging Evaluation of Complications of Hip Arthroplasty: Review of Current Concepts and Imaging Findings. Canadian Association of Radiologists Journal, 64: 306-313, 2013.

5- WATT I., BOLDRIK S., LANGELAAN E. and SMITHUIS R.: Arthroplasty: Normal and Abnormal Imaging Findings. Radiology Assistant, 2006.

6- MUSHTAG N., TO K., GOODING C. and KHAN W.: Radiological Imaging Evaluation of the Failing Total Hip Replacement. Frontiers in Surgery, 6: 35, 2019.

7- TRENTON D.R., NATHAN A.M., ANDREW P., KENNETH A.B. and ROBERT H.C.: CT of the hip prosthesis: Appearance of components, fixation, and complications. Radiographics, 32: 1089-1107, 2012.

8- SDAO S., ORLANDI D., ALIPRANDI A., LACELLI F., SCONFIENZA L.M., RANDELLI F., et al.: The role of ultrasonography in the assessment of peri-prosthetic hip complications. J. Ultrasound, 18: 245-50, 2015.

9- LONG S.S., SURREY D. and NAZARIAN L.N.: Common sonographic findings in the painful hip after hip arthroplasty. J. Ultrasound Med., 31: 301-312, 2012.

10- PLUOT E., DAVIS E.T., REVELL M., DAVIS A.M. and JAMES S.L.S.: Hip Arthroplasty. Part 1: Prosthesis terminology and classification. Clin. Radiol., 64: 954-960, 2009.

11- LONG S. S., SURREY D. and NAZARIAN L.N.: Common Sonographic Findings in the painful Hip after Hip Arthroplasty. J. Ultrasound Med., 31: 301-312, 2012.

12- CHAN Y.H.: Biostatistics 103: Qualitative Data-Tests of Independence. Singapore Med. J., 44 (10): 498-503, 2003.

13- GALEN R.S.: Predictive values and efficiency of laboratory testing. Pediat. J. Clin. North Am., 27: 861-69, 1980.

14- XING K.H., MORRISON G., LIM W., DOUKETIS J., ODUEYUNGBO A. and CROWTHER M.: Has the incidence of deep vein thrombosis in patients undergoing total hip/knee arthroplasty changed over time? Asystematic review of randomized controlled trials. Thromb. Res., 123: 24-34, 2008.

15- KAKARLA S.: Heterotopic ossification of muscles and soft tissuesPictorial Atlas. J. Med. Sci. Res., 5 (3): 88-97, 2017.

16- HARGUNANI R., MADANI H., KHOO M., FOTIADOU A., PRESSNEY I., CALLEJA M. and O'DONNELL P.: Imaging of the Painful Hip Arthroplasty. Canadian Association of Radiologists Journal, 67: 345-355, 2016.

القيمة المضافة للموجات فوق الصوتية في الكشف عن المضاعفات المرتبطة برأب مفصل الفخذ

الهدف من هذه الدراسة هو الإبلاغ عن القيمة المضافة للموجات فوق الصوتية فى تقييم المضاعفات المرتبطة بالطرف الاصطناعى بعد رأب مفصل الفخذ ومقارنة النتائج بالأشعة السينية والتصوير المقطعى (CT) والفحص السريرى والنتائج المختبرية والنتيجة العملية.

٩٢ المرضى الذين يعانون من زرع مفصل الفخذ خضعوا لأخذ التاريخ، والفحص المحلى، والدراسات المختبرية، والأشعة السينية، والتصوير المقطعى +/- العملية ومقارنة النتائج إلى الموجات فوق الصوتية عالية الدقة مع دوبلر اللون. تم حساب الحساسية والتحديد والقيمة التنبؤية الإيجابية والقيمة التنبؤية السلبية ودقة الموجات فوق الصوتية للكشف عن كل المضاعفات.

أظهرت دراستنا أن الموجات فوق الصوتية هى أداة تصوير مفيدة للغاية فى الكشف عن مضاعفات الأنسجة الرخوة وفى التوجيه لشفط الإبر من ناحية أخرى، لديها دور محدود فى الكشف عن المضاعفات العظمية وتخفيف الكسور والخلع.