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Myocardial Performance Index and Carotid Intima Thickness as Predictors of Early Left Ventricular Dysfunction in Psoriatic Arthritis Patients

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ABSTRACT

Background: Myocardial performance index (MPI) is an echocardiographic/Doppler index measure the ratio of isovolumic time intervals to the ventricular ejection time. It is easy to determine, reproducible, neither affected by changes in heart rate, blood pressure, nor the degree of mitral regurgitation.

Objective: To detect subclinical cardiovascular disease (CVD) in individuals with psoriatic arthritis (PsA) through using the following means; the carotid intima media thickness (CIMT) and MPI .

Patients and Methods: The Disease Activity Index for Psoriatic Arthritis (DAPSA) score was used as the primary means of identification . We enrolled in our cross-sectional study 60 patients who met the inclusion criteria for PsA. In addition, we enrolled 30 participants as a control group (without PsA) who visited the Cardiology Department for an elective echocardiography. All participants were subjected to DAPSA score, echocardiography and CIMT, as well as DAPSA score calculation for patients ' group. **Results:** PsA patients' group mean age was 40.30 ± 4.52 years with no statistical significant difference from the control group. Their mean disease duration was 7.25 ± 3.5 years. According to the DAPSA score, all patients were active, with 60% exhibiting low disease activity. CIMT and the following echo parameters; global longitudinal strain (GLS), isovolumetric contraction time (IVCT), isovolumetric relaxation time (IVRT), MPI, early ejection velocity (EE'), and ejection time (ET) exhibited a significant positive correlation with DAPSA score, the disease duration, erythrocyte sedimentation rate (ESR) as well as C-reactive protein (CRP).

Conclusions: Early identification of subclinical cardiac affection in patients with PsA is imperative for optimizing treatment outcomes. This necessitates the utilization of various modalities such as CIMT, MPI, and GLS.

Keywords: Myocardial Performance Index, Carotid Intima Thickness, Early Left Ventricular Dysfunction, Psoriatic Arthritis.

INTRODUCTION

Psoriatic arthritis (PsA) is a sort of inflammation that is capable of causing severe joint destruction hence disability. Researchers have found that compared to general population, patients with PsA have a 43% increased risk of CVD with higher incidence (55%) of cardiovascular events [1]. Despite evidences of increased the cardiovascular risk in psoriasis or PsA patients, those with metabolic syndrome in particular, the elevated rate of cardiovascular morbidity and mortality in such patients could not be fully explaiened [2].

A number of modalities were developed to aid in the early detection of subclinical cardiac disease; the most significant of these modern modalities are the CIMT and the MPI [3]. CIMT is a noninvasive, reproducible, and widely recognized imaging modality that can detect the subclinical atherosclerosis. It is considered one of best in predicting the major adverse cardiovascular events (MACE) [4].

The MPI (Tei index) is an echocardiographic/Doppler index measure the ratio of isovolumic time intervals (isovolumic contraction time and isovolumic relaxation time) to the ventricular ejection time [5]. It is easy to determine, reproducible, neither affected by changes in heart rate (HR), blood pressure (BP), nor the degree of mitral regurgitation. It is also subjected to minimal inter- and intra-observer variation [6].

The following study aim was to detect the subclinical CV affection in PsA patients using CIMT and MPI.

PATIENTS AND METHODS

PsA patients in this cross-sectional study were enrolled from Tanta University Hospitals' outpatient clinic of the Rheumatology and Rehabilitation Department between January 2023 and June 2023, we enrolled 60 patients with clinical criteria of PsA. Additionally, we enrolled 30 controls (without PsA) who attended to the Cardiology Department for elective echocardiography study after excluding the exclusion criteria in each group.

Inclusion criteria:

- 60 patients, aged 34 to 44, diagnosed with PsA according to CASPAR criteria [7] were included in the current study. 30 healthy volunteers of similar age and sex were also included as a control group.

Exclusion criteria:

- Aged < 20 years.
- Patients with atrial fibrillation or flutter or any other significant rhythm disturbance.
- Left ventricle systolic dysfunction assessed by echocardiography (LVEF <55%).
- Reluctance to engage in the study.
- History of cardiac affection as ischemic heart disease, valvular heart disease or cardiomyopathy.

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- Pregnancy or lactation.
- Cardiac pacemaker implantation.
- Poor echocardiographic window.

There were ninety participants in all. They were divided according to the presence of PsA into two groups; Sixty PsA patients formed group 1, and thirty participants (controls) did not have PsA made up group 2.

The following was applied to each participant:

1- A thorough history is obtained.

2- Clinical examination that included clinical assessment (patients' pain, global assessments, tender, swollen joint counts, acute phase reactant and the DAPSA score [8] were used to measure PsA activity.

3- Laboratory investigation including ESR in mm / h using Westergren technique, CRP, total lipid profile, serum creatinine, blood urea, and complete blood picture.

Cardiovascular assessment:

4-Echocardiography examination:

- The echocardiography studies were performed according the American Society of Echocardiography guidelines [9]. All the echocardiographic acquisitions by the Vivid E9 ultrasound system (GE Vingmed Ultrasound, Horten, Norway) equipped with an M5S phased array transducer (2.5–5.0 MHz), then data were transferred to EchoPAC for offline analysis. Using Simpson's modified biplane method, the left ventricle end-systolic and end-diastolic volumes in addition to the ejection fraction (EF) were calculated. The left ventricular end diastolic function was assessed by utilization of the mitral inflow pulsed-wave (PW) Doppler (mitral E and A waves) with E/A ratio calculation as well as tissue Doppler imaging (TDI) of the mitral annulus and E/e ' ratio (Figure 1).

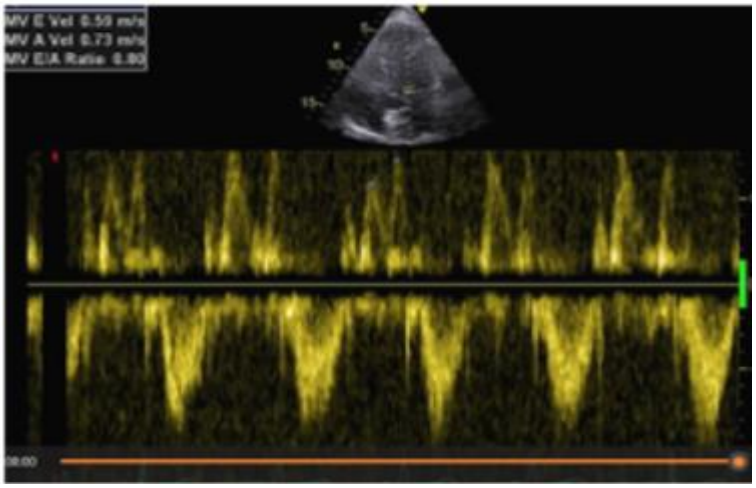

Figure (1): Assessment of LV diastolic function by conventional pulsed –Doppler.

- **Myocardial performance index (MPI):** The MPI was calculated subsequently after obtaining the following Doppler time intervals: the isovolumetric contraction time (IVCT), the IVRT and ejection time (ET). MPI was calculated using the equation (IVCT+IVRT) / ET (Figures 2, 3).

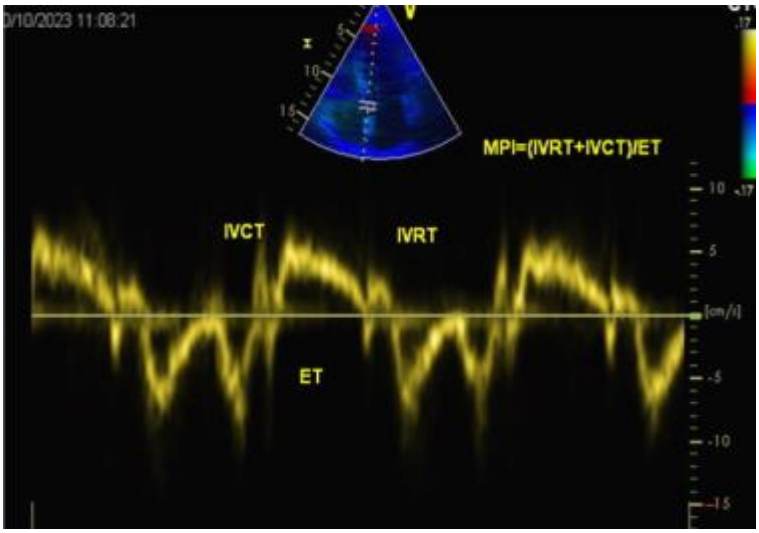

Figure (2): Calculation of tissue Doppler-derived left ventricular myocardial performance index.

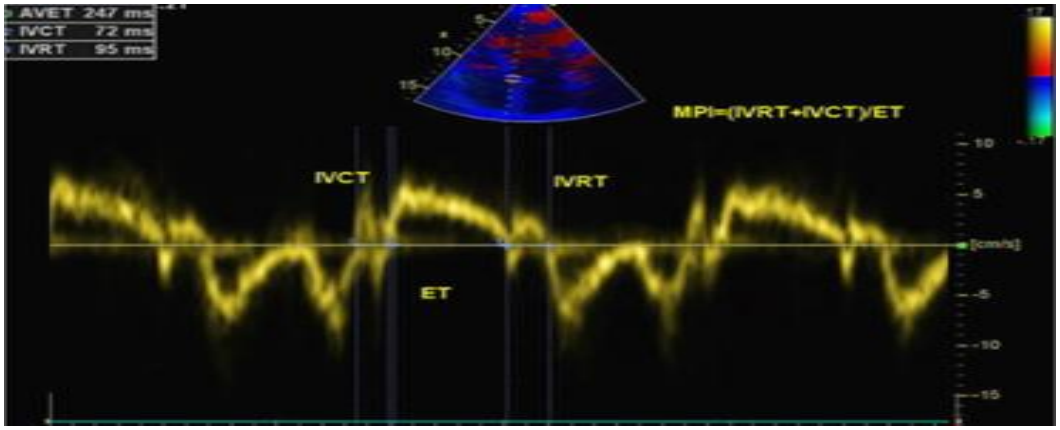

Figure (3): Measuring MPI using tissue Doppler imaging.

- **LV global longitudinal strain (LV-GLS):** The measurement of global longitudinal peak systolic strain was done offline. The endocardial margins were traced manually. They were shown as a color-coded sequence in each separate clip before being integrated into a bull's-eye graphic. Software estimated the regional average of the apical two-chamber, four-chamber, and three-chamber images of the 17 segments at an end-systolic frame[9]. GLS was calculated as the average of regional strains and then integrated in a bull's eye plot (Figure 4).

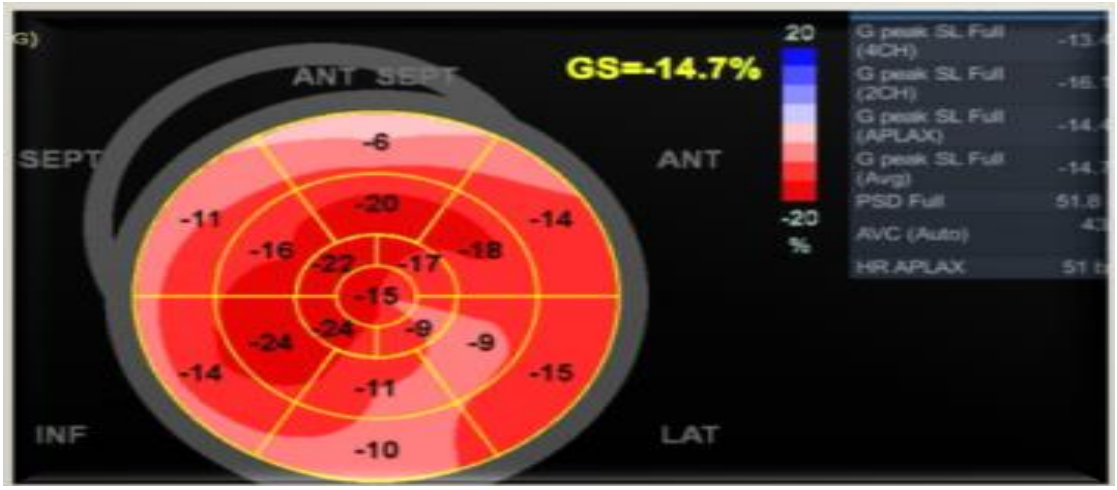

Figure (4): Bull's eye model of impaired global LV longitudinal strain using speckle tracking echo.

4- **Carotid intima – media wall thickness (CIMT) assessment**: the common carotid arteries were examined using a linear transducer (midfrequency: 10 MHz) of Samsung Medison (UGEO H60, Korea) device. The distance measured from the leading edge of the media–adventitia interface of the far wall to the lumen–intima interface's leading edge was defined as CIMT. The common carotid artery's CIMT was measured one to three centimetres proximal to the right and left carotid artery bifurcation. CIMT was measured on a 10-mm segment at the carotid artery's distal wall [10]. The threshold for increased CIMT was 0.9 mm. The definition of carotid plaque was CIMT ≥ 1.2 mm [11]. The recorded scans of the patients and controls were examined separately by two ultrasonographers (Figure 5).

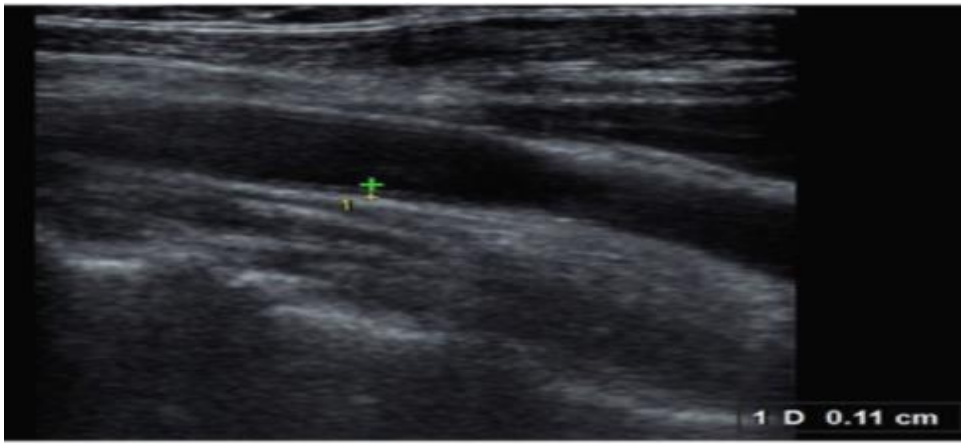

Figure (5): Transverse carotid duplex showed increased IMT (CIMT=11 mm).

Ethical approval:

This study follows the ethical principles defined in the Declaration of Helsinki and meets the ethical criteria established by the Tanta Faculty of Medicine. The study received approval from the institution's Ethical Board of Faculty of Medecine, Tanta University under the reference number (36219/12/2022). All patients had provided informed, written consent as required by the institutional review board. The privacy of patient data was protected by assigning a unique code number to each patient file, which included all necessary investigations.

Statistical analysis

We used SPSS version 26.0 for statistical analysis. Quantitative data were displayed as mean ± standard deviation (SD) and were compared using the unpaired Student's t-test. For appropriate cases, the frequency and percentage (%) of the qualitative variables were examined using the X^2-test. The threshold for statistical significance was set at P values less than 0.05.

RESULTS

Sixty PsA patients and thirty controls were enrolled in the current study. Neither age, sex, BMI nor diastolic BP showed statistical significant difference comparing patient to control group ; however, systolic BP recorded significant difference between both groups. (Table 1).

Table (1): Demographic and clinical data of both patients and control

	PsA patients (n=60)	Control (n=30)	p. value
Age	40.30 ± 4.52	40.10 ± 4.05	0.838
Sex (female/male)	45/15	20/10	0.81
BMI	28.37 ± 3.67	27.75 ± 4.21	0.476
Systolic	132.33 ± 7.89	125.00 ± 9.10	**0.001***
Diastolic	81.83 ± 6.17	80.43 ± 6.25	0.315

Data are presented as mean ± standard deviation or as frequency, PsA: psoriatic arthirits, BMI: body mass index, *: significant.

The mean duration of PsA patients was 7.25 ± 3.5 years. Eighteen patients were on conventional treatment (14 on methotrexate and 4 on leflunomide), 20 were on biological treatment (15 on anti-TNF and 5 on anti-IL 17), and 22 patients were on both conventional and biological treatment. According to DAPSA score, the mean of disease activity was 14.37 ± 4.44, with 60% of patients had low disease activity. Regarding the majority of the echo parameters and CIMT, there was a significant difference between the patient and control groups (Table 2).

Table (2): Cardiac assessment of patients and control

	PsA patients	Control	p. value
LVEDV	127.80 ± 9.32	128.37 ± 8.90	0.783
LVESV	42.95 ± 2.12	42.75 ± 2.37	0.686
RVEDD	2.57 ± 0.25	2.54 ± 0.23	0.556
DT	212.13 ± 37.43	192.00 ± 25.38	**0.009***
E	0.69 ± 0.05	0.77 ± 0.04	**0.001***
A	0.47 ± 0.06	0.38 ± 0.05	**0.001***
E/A ratio	1.43 ± 0.20	2.02 ± 0.23	**0.001***
EF%	59.97 ± 3.86	60.00 ± 3.91	0.969
EE dash	8.25 ± 1.10	6.62 ± 0.65	**0.001***
IVRT	86.80 ± 7.83	74.30 ± 4.32	**0.001***
IVCT	76.87 ± 3.42	77.73 ± 3.46	0.262
ET	267.63 ± 11.12	283.30 ± 9.84	**0.001***
MPI	0.61 ± 0.04	0.53 ± 0.02	**0.001***
GLS	-16.37 ± 1.44	-20.20 ± 1.30	**0.001***
CIMT	7.40 ± 1.17	6.42 ± 1.37	**0.001***

Data are presented as mean ± standard, LVEDV: lef ventricular end -diastolic volume, LVESV : left ventricular end-systolic volume, RVEDD: right ventricular end -diastolic diameter, DT: decelartion time, E: early ejection velocity, A: atrial contraction peak velocity, EF: ejection fraction, IVRT : isovolumetric relaxation time, IVCT: isovolumetric contaction time, ET: ejection time, MPI : myocardial performance index, GLS: global longitudinal strain and CIMT: carotid intimal media thickness, *: significant.

CIMT had a significant positive correlation with DAPSA score, duration of disease, ESR, CRP, and some echo parameters (GLS, IVRT, IVCT, EE' and ET) (Table 3).

Table (3): Correlation of CIMT with different parameters

	CIMT	
	r	P value
MPI	0.667	**0.001***
GLS	0.741	**0.001***
Duration in years	0.643	**0.001***
DAPSA	0.742	**0.001***
ESR	0.510	**0.001***
CRP	0.643	**0.001***
LVEDV	-0.065	0.620
LVESV	0.158	0.228
RVEDD	0.323	**0.010***
DT	-0.111	0.396
E	-0.249	0.055
A	-0.270	0.058
E/A ratio	0.037	0.782
EF%	0.125	0.268
EE dash	0.384	**0.002***
IVRT	0.687	**0.001***
IVCT	0.511	**0.001***
ET	0.430	**0.001***

*: significant.

MPI had a significant positive correlation with duration of disease, DAPSA score, ESR, CRP, CIMT and some echo parameters (GLS, IVRT and IVCT) (Table 4).

Table (4): MPI and different parameters correlations

	MPI	
	r	P value
CIMT	0.667	**0.001***
GLS	0.477	**0.001***
Duration in years	0.374	**0.003***
DAPSA	0.620	**0.001***
ESR	0.319	**0.013***
CRP	0.536	**0.001***
LVEDV	0.149	0.257
LVESV	-0.061	0.642
RVEDD	0.139	0.288
DT	0.147	0.263
E	-0.105	0.424
A	-0.083	0.530
E/A ratio	-0.179	0.171
EF%	0.057	0.666
EE dash	0.107	0.415
IVRT	0.726	**0.001***
IVCT	0.534	**0.001***
ET	0.219	0.093

*: significant.

GLS showed a significant positive correlation with the duration of disease, DAPSA score, ESR, CRP, CIMT, and some echo parameters (MPI, IVCT and IVRT) (Table 5).

Table (5): Correlation between GLS and different parameters

	GLS	
	r	P value
	0.741	**0.001***
MPI	0.477	**0.001***
Duration in years	0.528	**0.001***
DAPSA	0.531	**0.001***
ESR	0.481	**0.001***
CRP	0.512	**0.001***
LVEDV	-0.132	0.314
LVESV	0.133	0.312
RVEDD	0.426	**0.001***
DT	-0.187	0.153
E	-0.227	0.081
A	-0.250	0.054
E/A ratio	0.046	0.725
EF%	0.057	0.664
EE dash	0.064	0.626
IVRT	0.629	**0.001***
IVCT	0.286	**0.027***
ET	0.195	0.124

*: significant.

DISCUSSION

About 1% to 4% of the population suffer from PsA, making it one of the most prevalent immune-mediated chronic inflammatory illnesses [9]. Atherosclerosis and joint degeneration are both driven by the same immunological mediators [10]. Continuous stimulation of the immune system results in endothelial dysfunction, impaired vascular healing, the development of atherosclerotic plaque, and ultimately a development of CVD through the release of proatherogenic and inflammatory mediators [11]. Long-term morbidity and mortality in those patients may be reduced by the early identification of mild heart damage as well as the therapeutic intervention during this preclinical stage [12].

In this current study, all our patients were active; 60% had low disease activity, while 40% of patients had moderate disease activity with a range from 7.0 to 24.0.

The obtained findings align with the conclusions of **Palmou-Fontana *et al.*'s study [13],** which indicated that the most of PsA patients were categorized as having mild to moderate disease activity. The DAPSA is a disease-specific quantitative tool that holds practical utility in clinical contexts, particularly in the management of peripheral joint disorders [14].

Regarding cardiac assessment, our study discovered subclinical CV affection in PsA patients. There were 25 patients (41.6%) with subclinical atherosclerosis, 12 patients (20%) with diastolic dysfunction and 6 patients (10%) with valvular thickening (mitral valve). By encouraging cardiac fibrosis, contributing to atherosclerosis, and hastening necrosis and apoptosis, inflammation has been linked in

several studies to an earlier development of CVD. The large arteries may functionally stiffen as a result of decreased nitric oxide bioavailability combined with increased activity of opposing mediators like endothelin 1, whereas the larger vessels may structurally stiffen as a result of increased proliferation of smooth muscle cells and the synthesis of collagen and other structural proteins [15,16].

The present study demonstrated a notable positive association between CIMT and various parameters, including the DAPSA score, disease duration, ESR, CRP, and most echocardiographic parameters. These findings partially align with those of **Palmou-Fontana *et al.*** [13] who observed a significant correlation between CIMT and inflammatory markers as well as the disease duration, however they reported an insignificant correlation with echocardiographic parameters.

Moreover, among PsA patients, there were no significant associations found between the increases in CIMT and the increases in arthritis duration, DAPSA, CRP, and ESR. Studies by **Talari *et al.*** [17] **and Tecer *et al.*** [18] revealed similar findings, emphasizing the lack of a significant association between inflammatory markers, DAPSA, and CIMT.

One possible explanation for the discrepancy is that individuals with PsA who participated in the research had the condition for a shorter time than those who participated in the previously cited trials. In addition, the sample size of the study has been varied [19]. Nevertheless, the findings of the present study cannot rule out the possibility of a link between PsA disease and atherosclerosis. Alternative indicator, like flow-mediated vasodilation might be more accurate than CIMT at identifying atherosclerosis in PsA disease; but wasn't assessed in the current study [20].

PsA affects cardiac function, as evidenced by the current study's statistically significant difference in MPI (Tei index), with higher Tei index values in the PsA group compared to the control group. Additionally, our research showed a favorable relationship between the MPI and the years of disease, ESR, and CRP.

Çevik *et al.* [21], who studied the cardiac function in children with psoriasis, showed similar results regarding MPI values. The MPI values were significantly affected in patients' group compared to control group. Those findings emphasize the early and great effect of psoriasis as an inflammatory disease on cardiac function without regard to the impact of conventional cardiovascular risk factors.

In the current study, a statistically significant difference was recorded comparing the GLS of the PsA group to the control group, p-value < 0.001, with GLS in the PsA group below the standard cut-off value denoting the subclinical systolic cardiac affection[22].

The current study's findings were consistent with those of **Pletikosic *et al.*** [23] who confirmed with their studies the increased prevalence of subclinical myocardial dysfunction without CV risk factors in PsA patients and the effect of the biomarkers level and disease activity on the degree of the myocardial dysfunction.

There is a significant positive link in the current study between the GLS and the length of the illness. DAPSA score, and inflammatory markers (ESR and CRP), with a p-value <0.001.

Those results agreed with **Makavos *et al.*** [24] study, which found that the duration of psoriatic illness was correlated with decreased cardiac deformation as measured by GLS. The results of this study imply that chronic inflammation may directly impair myocardial function, which in turn affects prognosis. To further emphasize the significance of GLS as a risk stratification marker and, by extension, an improvement in the capacity to alter CV risk in psoriasis patients, their research also revealed that GLS has changed after 6 months of therapy with biological agents.

Limitations of the study:

1.A greater number of patients is required to obtain reliable outcomes.

2.The study population might not accurately reflect the general population because it was selected from a single center.

CONCLUSION

Early identification of subclinical cardiac involvement in patients with PsA is imperative for optimizing treatment outcomes. This necessitates the utilization of various modalities such as CIMT, MPI, and GLS.

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- **Conflict of interest:** Nil.
- **Acknowledgement:** Nil.

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