

本文引用:季翔,张霞. 二维斑点追踪技术在类风湿关节炎患者心血管病变诊断中的应用研究进展[J]. 新乡医学院学报,2022,39(6):596-600. DOI:10.7683/xyxyxb.2022.06.020.

【综述】

二维斑点追踪技术在类风湿关节炎患者心血管病变诊断中的应用研究进展

季翔¹, 张霞²

(1. 盐城市大丰人民医院彩超室, 江苏 盐城 224000; 2. 皖南医学院第一附属医院超声医学科, 安徽 芜湖 241000)

摘要: 类风湿关节炎(RA)是一种慢性、全身性炎症性疾病,可并发心血管疾病,包括动脉粥样硬化、急性心肌梗死甚至心力衰竭等。心血管并发症是RA患者死亡的主要原因,准确评估RA患者心血管系统功能对于改善患者预后具有重要的意义。超声心动图具有无创、准确、便捷、经济、实时的特点,已广泛应用于心血管系统功能的评估,但RA患者的心血管并发症起病隐匿,常规超声心动图不能检测到RA患者心血管系统功能的细微变化。新近发展的二维斑点追踪技术(2D-STI)可通过测量心肌应变来反映心脏功能,具有更高的敏感性,已被用于早期评估RA患者心血管病变。本文就RA患者心血管损害机制和临床表现以及常规超声心动图和2D-STI对RA患者心血管病变预测的敏感性和可靠性进行综述,以期临床准确检测RA患者心血管系统功能提供参考。

关键词: 类风湿关节炎;心血管系统功能;超声心动图;二维斑点追踪技术

中图分类号: R593.22 **文献标志码:** A **文章编号:** 1004-7239(2022)06-0596-05

Research progress on the application of two-dimensional speckle tracking imaging technology in the diagnosis of cardiovascular lesions in patients with rheumatoid arthritis

Ji Xiang¹, ZHANG Xia²

(1. Department of Ultrasonography, Yancheng Dafeng People's Hospital, Yancheng 224000, Jiangsu Province, China; 2. Department of Ultrasonography, the First Affiliated Hospital of Wannan Medical College, Wuhu 241000, Anhui Province, China)

Abstract: Rheumatoid arthritis (RA) is a chronic and systemic inflammatory disease, which can be complicated with cardiovascular disease, including atherosclerosis, acute myocardial infarction and even heart failure. Cardiovascular complications are the main cause of death in RA patients, and accurate evaluation of cardiovascular function of RA patients has important significance in improving the prognosis of patients. Echocardiography has the advantages of noninvasive, accurate, convenient, economical and real time, which has been widely used in the evaluation of cardiovascular function. However, the onset of cardiovascular complications in RA patients is insidious, and routine echocardiography cannot find the subtle changes in cardiovascular function of RA patients. The newly developed two-dimensional speckle tracking imaging (2D-STI) can reflect cardiac function by measuring myocardial strain, which has higher sensitivity and has been used in the early evaluation of cardiovascular lesions in RA patients. This article reviews the mechanism and clinical manifestations of cardiovascular damage in RA patients, as well as the sensitivity and reliability of conventional echocardiography and 2D-STI in predicting cardiovascular lesions in RA patients, in order to provide reference for clinical accurate detection of cardiovascular function in RA patients.

Key words: rheumatoid arthritis; cardiovascular function; echocardiography; two-dimensional speckle tracking imaging technology

类风湿关节炎(rheumatoid arthritis, RA)是一种常见于女性的慢性全身性自身免疫性疾病^[1-3],其特征表现是炎症性滑膜炎^[4-6],可累及心脏、关节、肾

脏、肺、骨等多种器官和组织^[7-10],如果没有正确的诊断和治疗,该病可导致关节畸形甚至功能丧失^[11-12]。RA患者的寿命较健康人显著缩短^[13]。RA是心血管疾病发生的独立危险因素,RA患者心包炎、心肌病、动脉粥样硬化、心力衰竭和急性心肌梗死等心血管疾病的患病率高于健康人,严重影响患者的生活质量,是导致死亡的主要原因^[14-17]。超声心动图具有无创、简便、准确的特点,可以有效评

DOI:10.7683/xyxyxb.2022.06.020

收稿日期:2020-09-14

作者简介:季翔(1991-),男,江苏盐城人,硕士,住院医师,研究方向:心血管超声。

通信作者:张霞(1980-),女,安徽芜湖人,硕士,主任医师,硕士生导师,研究方向:心血管超声;E-mail:yjsusd@163.com。

估心血管系统的结构和功能,已广泛运用于临床。由于RA患者的心血管并发症起病隐匿,常规超声心动图检查难以早期准确发现心血管异常改变,导致RA患者心血管病变的早期诊断较为困难。二维斑点追踪技术(two-dimensional speckle tracking imaging, 2D-STI)是近年发展起来的一项新技术,该技术通过追踪二维超声图像内的斑点回声,准确地描绘心肌的运动轨迹,客观反映心脏功能^[18-19],该技术不依赖于声束方向和室壁运动方向间的角度关系,且重复性较高。2D-STI技术主要通过测量心肌的形变功能来早期、准确地反映RA患者房室收缩功能,为RA患者心脏病变早期诊治提供参考。本文就RA患者心血管损害机制和临床表现,以及常规超声心动图和2D-STI对RA患者心血管病变预测的敏感性和可靠性进行综述,以期临床准确检测RA患者心血管系统功能提供参考。

1 RA患者心血管损害机制及临床表现

RA患者心血管损害的发病机制复杂,长期系统性慢性炎症反应、自身免疫反应介导的免疫系统紊乱及药物的毒副作用可能导致RA患者心血管疾病的发展^[20-23]。

大量巨噬细胞、B细胞、T细胞等炎症细胞侵入类风湿关节炎患者滑膜后,可释放肿瘤坏死因子- α (tumor necrosis factor- α , TNF- α)、白细胞介素-6和干扰素- γ ,产生大量炎症物质,损伤关节和滑膜^[24],破坏血管内环境,使血管内皮功能失调,促进动脉粥样硬化的发生和发展;同时,炎症也促使RA患者出现亚临床心肌功能不全;此外,长期激素药物的作用也会损害RA患者的心脏功能。有超过2/3的RA患者心脏受累,临床表现为心脏内血栓形成、心包炎、心肌病、心律失常、心腔扩大、心脏瓣膜病等^[25-27]。

2 常规超声心动图在评价RA患者心血管病变中的作用

传统的二维经胸超声心动图(transsthoracic echocardiography, TTE)具有可靠、无创、经济、便携等优点,在RA的心功能评价中发挥了重要作用。RA患者的TTE表现为心室重构、左心室射血分数(left ventricular ejection fraction, LVEF)降低、左心房增大、心包积液、瓣膜病以及肺动脉高压等^[28-30]。然而,由于RA患者心脏受累的隐匿性,常规超声心动图不能检测到RA患者心血管系统功能的细微变化。因此,需要更有效的检测方法来评价RA患者心脏功能,为临床提供可靠帮助。

3 2D-STI的成像原理及参数

心肌由三层肌纤维组成,每层肌纤维有不同的排列和运动方式。通过评价心肌的应变和应变率可以有效反映心脏的局部及整体功能,对心肌形变功能的评价已成为当前研究的热点。应变参数主要包括纵向、径向和圆周应变等,纵向应变是指沿着心脏长轴方向的应变,圆周应变是指沿着心肌圆周方向的应变,径向应变是指沿着心肌短轴方向的应变,这些参数可以有效地反映心肌的形变功能。组织多普勒成像(tissue doppler imaging, TDI)和STI均可以测量心肌应变和应变率参数,然而,TDI技术对多普勒入射角非常敏感,而STI则无角度依赖性^[31-32],已逐渐取代了TDI技术。2D-STI通过追踪二维超声图像内的斑点回声来反映心肌的应变及应变率,从而更好地评价心脏整体和局部功能。目前,2D-STI大多以整体纵向应变(global longitudinal strain, GLS)作为评价心肌应变功能的首选指标^[33]。

4 2D-STI在评估RA患者心血管病变中的应用

准确评估RA患者的心血管系统功能具有重要的临床价值,2D-STI对RA患者心肌形变功能的准确评价具有重要临床意义,已成为当前研究的热点。GLS是2D-STI的主要参数,能够客观地反映心脏功能的亚临床改变,是评估RA患者心脏功能的有效指标。

4.1 2D-STI评估RA患者左心室功能

左心室整体纵向应变(left ventricular global longitudinal strain, LVGLS)是评估RA患者左心室心肌形变功能的主要参数,左心室收缩主要是沿心肌纵轴方向的运动,心肌纵向收缩主要由心内膜纵向纤维完成,而心内膜下心肌对缺血更为敏感^[34-35],因此,左心室功能异常时,LVGLS较LVEF及其他应变参数变化更早^[36]。

2D-STI可以早期评估RA患者左心室亚临床功能障碍,监测不同病程患者的心血管系统功能。BAKTIR等^[37]采用2D-STI技术研究显示,随着病程的延长,RA患者左心室心肌形变功能降低,提示2D-STI技术可以有效监测不同病程RA患者左心室功能。CIOFFI等^[38]研究表明,无心血管病史的RA患者左心室形变功能降低,而且LVGLS和(或)LVGCS降低均可作为RA患者心血管不良事件的预测因子。研究发现,与健康对照组相比,RA患者的常规超声心动图参数无显著差异,而LVGLS显著降低提示2D-STI较常规超声心动图能早期有效发现RA患者的左心室功能异常^[39]。BENACKA等^[40]应

用2D-STI技术测量 RA 患者左心室心肌应变及应变率,结果发现,与正常对照组相比,未合并心血管疾病的 RA 患者径向、圆周和横向应变及应变率无显著变化,而 LVGLS 显著降低,提示通过 2D-STI 测量 LVGLS 能早期检测到 RA 患者的亚临床左心室功能变化。也可以通过 2D-STI 测量局部应变来评估 RA 患者左心室功能, SITIA 等^[41]运用 2D-STI 评估 RA 患者左心室各个节段的应变,与正常对照组比较发现,患者左心室收缩末期径向和纵向应变显著降低,而常规超声心动图参数无显著变化,提示 2D-STI 较常规超声心动图能更敏感地评估 RA 患者的左心室功能,为早期监测 RA 患者左心室功能受损提供了一种新的可靠方法。

2D-STI 可以准确评价药物治疗对 RA 患者左心室功能的影响。ATZENI 等^[42]运用 2D-STI 技术对 30 例 RA 患者用药前后的左心室功能进行评估,结果发现,经过 18 个月抗肿瘤坏死因子(anti-tumor necrosis factor, anti-TNF)药物治疗后,RA 患者的 LVGLS 显著升高,提示 2D-STI 技术可以有效监测药物治疗后 RA 患者左心室功能的变化。VIZZARDI 等^[43]运用 2D-STI 评估了 13 例 RA 患者在接受抗肿瘤坏死因子- α (anti-tumor necrosis factor- α , anti-TNF- α)治疗前和治疗后 12 个月的 LVGLS,结果发现,anti-TNF- α 治疗 12 个月后 RA 患者的左心室收缩功能无显著变化。运用 2D-STI 技术研究发现,长期 anti-TNF- α 治疗可改善 RA 患者的左心室形变功能,提示 2D-STI 可以为评估 RA 患者药物治疗后心血管系统功能的改变提供一种新的方法^[44-45]。一项研究通过 2D-STI 技术发现,与治疗前相比,经阿那白滞素治疗的 RA 患者左心室形变功能参数显著升高,而泼尼松龙治疗组左心室形变功能参数无显著变化,提示阿那白滞素可有效改善 RA 患者左心室功能,说明 2D-STI 技术可以评估不同药物对 RA 患者心血管病变的疗效,为临床治疗提供参考^[46]。

4.2 2D-STI 评价 RA 患者右心室功能 由于右心室壁较薄且解剖复杂,圆周及径向应变不能准确反映右心室收缩功能。而右心室心肌纤维通常呈纵向排列,右心室整体纵向应变(right ventricular global longitudinal strain, RVGLS)是评估 RA 患者右心室收缩功能相对可靠的参数^[33]。

2D-STI 可以早期评估 RA 患者右心室功能,发现右心室功能受损的因素。NASEEM 等^[47]运用 2D-STI 对 81 例活动期 RA 患者、39 例缓解期 RA 患者以及 40 例正常对照组受试者的心室功能进行评估,结果显示,与缓解期 RA 患者和正常对照组受试

者相比,活动期 RA 患者的 LVGLS 及 RVGLS 均显著降低;研究还发现,RA 患者双心室 GLS 与 RA 疾病活动度评分有显著相关性,提示 RA 患者的心室功能可能受到疾病活动的影响,活动期 RA 患者心室功能显著降低,GLS 可作为评估 RA 患者双心室功能的可靠参数。一项研究运用 2D-STI 评估了 59 例无心血管病史的 RA 患者及 59 例正常对照组受试者的心室应变功能,结果显示,与正常对照组相比,无心血管病史 RA 患者的 LVGLS 及 RVGLS 显著降低,提示 2D-STI 可早期准确发现 RA 患者的亚临床心室功能障碍^[48]。

4.3 2D-STI 评价 RA 患者左心房功能 由于左心房解剖结构复杂且心肌较薄,将左心房应变进行分段评价具有局限性,左心房整体纵向应变(left atrial global longitudinal strain, LAGLS)是评估 RA 患者左心房应变的主要参数之一,能准确客观地评估 RA 患者的左心房功能^[33]。

2D-STI 可以准确监测 RA 患者的左心房功能,判断药物治疗对患者左心房功能异常的改善效果。ETIN 等^[49]应用 2D-STI 对 38 例 RA 患者以及 30 例正常对照组受试者的左心房功能进行评估,结果显示,与正常对照组相比,RA 患者的 LAGLS 显著下降,而左心房常规超声心动图参数无显著变化,使用英夫利昔单抗治疗的 RA 患者的 LA 整体应变参数有所改善,提示 2D-STI 有助于 RA 患者左心房功能异常的早期诊断,且可以有效地监测药物治疗后 RA 患者左心房功能的变化。JI 等^[50]通过 2D-STI 观察 RA 患者的左心房应变功能,结果发现,RA 患者左心房功能与病程相关,随着病程的延长,RA 患者的左心房功能下降,提示 2D-STI 能有效监测不同病程 RA 患者的左心房功能,为临床早期干预提供参考。

5 2D-STI 评估心血管系统功能的局限性

目前通过 2D-STI 测量的心肌应变值尚存在一些局限性,如尚无统一的正常值标准;另外,该技术对超声图像质量要求较高,且只能在二维平面上进行斑点追踪,不能反映心脏的立体运动。

6 结语

2D-STI 在 RA 患者心血管功能评估中具有很大的潜力,可早期准确地评价 RA 患者的心血管系统功能;同时,通过 2D-STI 可以更好地了解 RA 患者心肌损伤的机制及病理生理。2D-STI 具有较高的准确性、敏感性和特异性,对 RA 患者心血管病变的临床诊断、治疗和预后具有重要意义。

参考文献:

- [1] WU Y Y, LI X F, WU S, *et al.* Role of the S100 protein family in rheumatoid arthritis[J]. *Arthritis Res Ther*, 2022, 24(1):35.
- [2] ESPOSITO A J, CHU S G, MADAN R, *et al.* Thoracic manifestations of rheumatoid arthritis[J]. *Clin Chest Med*, 2019, 40(3):545-560.
- [3] HASHIMOTO T, YOSHIDA K, HASHIRAMOTO A, *et al.* Cell-free DNA in rheumatoid arthritis[J]. *Int J Mol Sci*, 2021, 22(16):8941.
- [4] 帅波, 沈霖, 马陈, 等. 尪痹片联合甲氨蝶呤片对类风湿性关节炎患者血清 DKK-1 及关节滑膜侵蚀的影响[J]. 中国中医骨伤科杂志, 2020, 28(6):16-20.
- SHUAI B, SHEN L, MA C, *et al.* Effect of Wangbi pill combined with methotrexate on serum DKK-1 expression and synovial erosion in patients with rheumatoid arthritis[J]. *Chin J Trad Med*, 2020, 28(6):16-20.
- [5] LU X, HU R, PENG L, *et al.* Efficacy and safety of adalimumab biosimilars: current critical clinical data in rheumatoid arthritis[J]. *Front Immunol*, 2021, 12:638444.
- [6] BRONDELLO J M, DJOUAD F, JORGENSEN C. Where to stand with stromal cells and chronic synovitis in rheumatoid arthritis[J]. *Cells*, 2019, 8(10):1257.
- [7] 薛晓倩, 江洪耿, 许百洁, 等. 血清胱抑素 C 对类风湿关节炎心血管病变患者的影响[J]. 岭南心血管病杂志, 2019, 25(5):556-560.
- XUE X Q, JIANG H G, XU B J, *et al.* Effect of serum cystatin C in patients with rheumatoid arthritis and cardiovascular disease[J]. *South Chin J Cardio Dis*, 2019, 25(5):556-560.
- [8] CHENG L, WANG Y, WU R, *et al.* New insights from single-cell sequencing data: synovial fibroblasts and synovial macrophages in rheumatoid arthritis[J]. *Front Immunol*, 2021, 12:709178.
- [9] CROFT A P, CAMPOS J, JANSEN K, *et al.* Distinct fibroblast subsets drive inflammation and damage in arthritis[J]. *Nature*, 2019, 570(7760):246-251.
- [10] AZAM A T, ODEYINKA O, ALHASHIMI R, *et al.* Rheumatoid arthritis and associated lung diseases: a comprehensive review[J]. *Cureus*, 2022, 4(2):e22367.
- [11] SHAPIRO S C. Biomarkers in rheumatoid arthritis[J]. *Cureus*, 2021, 13(5):e15063.
- [12] ESPINOZA G, MALDONADO G, NARVAEZ J, *et al.* Beyond rheumatoid arthritis evaluation; what are we missing[J]. *Open Access Rheumatol*, 2021, 13:45-55.
- [13] 王静, 张明明, 薛书峰, 等. 类风湿关节炎合并冠心病患者的临床特点及预后分析[J]. 中国循证心血管医学杂志, 2019, 11(11):1354-1357.
- WANG J, ZHANG M M, XUE S F, *et al.* Clinical characteristics and prognosis analysis in patients with rheumatoid arthritis complicated by coronary heart disease[J]. *Chin J Evid Based Cardiovasc Med*, 2019, 11(11):1354-1357.
- [14] KUMAR K, SEETHARAM K, POONAM F, *et al.* The role of cardiac imaging in the evaluation of cardiac involvement in systemic diseases[J]. *Cureus*, 2021, 13(12):e20708.
- [15] 杨金萍, 桂明. 肠道微生物在类风湿关节炎机制中的作用及对心血管风险的影响[J]. 中国免疫学杂志, 2021, 37(1):124-128.
- YANG J P, GUI M. Role of enteric microbiota in pathogenesis of rheumatoid arthritis on cardiovascular risk[J]. *Chin J Immunol*, 2021, 37(1):124-128.
- [16] RODRIGUES P, FERREIRA B, FONSECA T, *et al.* Subclinical ventricular dysfunction in rheumatoid arthritis[J]. *Int J Cardiovasc Imaging*, 2021, 37(3):847-859.
- [17] BARTOLONI E, ANGELI F, MARCUCCI E, *et al.* Unattended compared to traditional blood pressure measurement in patients with rheumatoid arthritis: a randomised cross-over study[J]. *Ann Med*, 2021, 53(1):2050-2059.
- [18] BAI C, MENG F, FENG P, *et al.* Application effect and evaluation of two-dimensional speckle tracking imaging on myocardial damage in patients with malignant lymphoma treated with anthracyclines[J]. *Evid Based Complement Alternat Med*, 2021, 2021:6355047.
- [19] XING X, LI D, CHEN S, *et al.* Evaluation of left ventricular systolic function in patients with different types of ischemic heart disease by two-dimensional speckle tracking imaging[J]. *J Cardiothorac Surg*, 2020, 15(1):325.
- [20] 苏瑞娟, 黄彦宏, 陈彩霞, 等. 类风湿关节炎患者右心功能超声心动图评估及其与病程、病情的关系[J]. 山东医药, 2019, 59(26):1-4.
- SU R J, HUANG Y H, CHEN C X, *et al.* Echocardiographic evaluation of right ventricular function in patients with rheumatoid arthritis and the relationship with illness duration and condition[J]. *Shandong Med J*, 2019, 59(26):1-4.
- [21] YANG C, LI D, TENG D, *et al.* Epigenetic regulation in the pathogenesis of rheumatoid arthritis[J]. *Front Immunol*, 2022, 13:859400.
- [22] KOBAYASHI M, FERREIRA M B, COSTA R Q, *et al.* Circulating biomarkers and cardiac structure and function in rheumatoid arthritis[J]. *Front Cardiovasc Med*, 2021, 8:754784.
- [23] NOROUZI S, JAVINANI A, AMINORROAYA A, *et al.* Anti-modified citrullinated vimentin antibody: a novel biomarker associated with cardiac systolic dysfunction in patients with rheumatoid arthritis[J]. *BMC Cardiovasc Disord*, 2020, 20(1):390.
- [24] ZHAO T, YANG Q, XI Y, *et al.* Ferroptosis in rheumatoid arthritis: a potential therapeutic strategy[J]. *Front Immunol*, 2022, 13:779585.
- [25] TOKONAMI A, OHTA R, TANAKA Y, *et al.* Pericarditis with cardiac tamponade mimicking yellow nail syndrome in a patient with rheumatoid arthritis and a paucity of joint symptoms[J]. *Cureus*, 2022, 14(1):e21523.
- [26] PATEL K H K, JONES T N, SATTLER S, *et al.* Proarrhythmic electrophysiological and structural remodeling in rheumatoid arthritis[J]. *Am J Physiol Heart Circ Physiol*, 2020, 319(5):H1008-H1020.

- [27] MORI K, YAGI M, OE K, *et al.* Pericarditis-complicated takotsubo cardiomyopathy in a patient with rheumatoid arthritis [J]. *Cardiovasc Diagn Ther*, 2018, 8(4):520-524.
- [28] KUMAR P, KALPANA F, KHAMUANI M K, *et al.* Frequency of cardiovascular manifestation in patients with rheumatoid arthritis [J]. *Cureus*, 2021, 13(4):e14631.
- [29] M S, GAURI L. Study of cardiovascular involvement in rheumatoid arthritis and it's correlation with severity of disease [J]. *J Assoc Physicians India*, 2022, 70(4):11-12
- [30] SAHA S, SINGH R, MIR I A, *et al.* Epicardial fat thickness: a cardiometabolic risk marker in rheumatoid arthritis [J]. *Cureus*, 2022, 14(1):e21397.
- [31] HUANG X, LIU Y, GUAN B, *et al.* Comprehensive assessment of the left ventricular systolic function in the elderly with acute myocardial infarction using echocardiography [J]. *Int J Gen Med*, 2022, 15:1437-1445.
- [32] YANG G, XU Q, HOU C, *et al.* Evaluation of carotid artery elasticity in early stage of kawasaki disease by two-dimensional speckle tracking imaging; a pilot study [J]. *J Ultrasound Med*, 2022, 41(1):79-87.
- [33] BADANO L P, KOLIAS T J, MURARU D, *et al.* Standardization of left atrial, right ventricular, and right atrial deformation imaging using two-dimensional speckle tracking echocardiography: a consensus document of the EACVI/ASE/Industry Task Force to standardize deformation imaging [J]. *Eur Heart J Cardiovasc Imaging*, 2018, 19(6):591-600.
- [34] 周金玲, 王凤, 白晖, 等. 三维斑点追踪成像评价肥厚型心肌病患者左室扭转功能 [J]. *临床超声医学杂志*, 2019, 21(10):739-742.
- ZHOU J L, WANG F, BAI H, *et al.* Assessment of left ventricular twist function by three-dimensional speckle tracking imaging in patients with hypertrophic cardiomyopathy [J]. *J Clin Ultrasound Med*, 2019, 21(10):739-742.
- [35] 蔡迪, 马媛媛, 郭瑞强. 斑点追踪成像技术评价移植心脏左室收缩及舒张功能 [J]. *临床超声医学杂志*, 2019, 21(8):607-609.
- CAI D, MA Y Y, GUO R Q. Evaluation of left ventricular systolic and diastolic function in transplanted hearts by speckle tracking imaging [J]. *J Clin Ultrasound Med*, 2019, 21(8):607-609.
- [36] 蒋瑶, 牟霜, 谭开彬. 二维斑点追踪成像评价乳腺癌曲妥珠单抗化疗亚临床心脏毒性的价值 [J]. *临床超声医学杂志*, 2020, 22(1):33-37.
- JIANG Y, MOU S, TAN K B. Evaluation of subclinical cardiotoxicity associated with trastuzumab chemotherapy in patients with breast cancer by two-dimensional speckle tracking imaging [J]. *J Clin Ultrasound Med*, 2020, 22(1):33-37.
- [37] BAKTIR A O, SARLI B, CEBICCI M A, *et al.* Preclinical impairment of myocardial function in rheumatoid arthritis patients. Detection of myocardial strain by speckle tracking echocardiography [J]. *Herz*, 2015, 40(4):669-674.
- [38] CIOFFI G, VIAPIANA O, OGNIBENI F, *et al.* Prognostic role of subclinical left ventricular systolic dysfunction evaluated by speckle-tracking echocardiography in rheumatoid arthritis [J]. *J Am Soc Echocardiogr*, 2017, 30(6):602-611.
- [39] HANVIVADHANAKUL P, BUAKHAMSRI A. Disease activity is associated with LV dysfunction in rheumatoid arthritis patients without clinical cardiovascular disease [J]. *Adv Rheumatol*, 2019, 59(1):56.
- [40] BENACKA O, BENACKA J, BLAZICEK P, *et al.* Speckle tracking can detect subclinical myocardial dysfunction in rheumatoid arthritis patients [J]. *Bratisl Lek Listy*, 2017, 118(1):28-33.
- [41] SITIA S, TOMASONI L, CICALA S, *et al.* Detection of preclinical impairment of myocardial function in rheumatoid arthritis patients with short disease duration by speckle tracking echocardiography [J]. *Int J Cardiol*, 2012, 160(1):8-14.
- [42] ATZENI F, GIANTURCO L, BOCCASSINI L, *et al.* Noninvasive imaging methods for evaluating cardiovascular involvement in patients with rheumatoid arthritis before and after anti-TNF drug treatment [J]. *Future Sci OA*, 2019, 5(6):FSO396.
- [43] VIZZARDI E, CAVAZZANA I, FRANCESCHINI F, *et al.* Left ventricular function in rheumatoid arthritis during anti-TNF- α treatment: a speckle tracking prospective echocardiographic study [J]. *Monaldi Arch Chest Dis*, 2016, 84(1/2):716.
- [44] AYYILDIZ Y O, VURAL M G, EFE T H, *et al.* Effect of long-term TNF- α inhibition with infliximab on left ventricular torsion in patients with rheumatoid arthritis [J]. *Hellenic J Cardiol*, 2015, 56(5):406-413.
- [45] AY B, VURAL M G, ERTEM A G, *et al.* Chronic inhibition of tumor necrosis factor- α with infliximab improves myocardial deformation in parallel with aortic elasticity in rheumatoid arthritis [J]. *Turk Kardiyol Dern Ars*, 2015, 43(2):138-148.
- [46] IKONOMIDIS I, TZORTZIS S, LEKAKIS J, *et al.* Lowering interleukin-1 activity with anakinra improves myocardial deformation in rheumatoid arthritis [J]. *Heart*, 2009, 95(18):1502-1507.
- [47] NASEEM M, SAMIR S, IBRAHIM I K, *et al.* 2-D speckle-tracking assessment of left and right ventricular function in rheumatoid arthritis patients with and without disease activity [J]. *J Saudi Heart Assoc*, 2019, 31(1):41-49.
- [48] FINE N M, CROWSON C S, LIN G, *et al.* Evaluation of myocardial function in patients with rheumatoid arthritis using strain imaging by speckle-tracking echocardiography [J]. *Ann Rheum Dis*, 2014, 73(10):1833-1839.
- [49] ETIN S, MUSTAFA G, KESKIN G, *et al.* Infliximab, an anti-TNF- α agent, improves left atrial abnormalities in patients with rheumatoid arthritis: preliminary results [J]. *Cardiovasc J Afr*, 2014, 25(4):168-175.
- [50] JI X, ZHANG X, LI G. A preliminary study on the evaluation of left atrial function of rheumatoid arthritis by two dimensional speckle tracking imaging [J]. *Sci Rep*, 2021, 11(1):21537.