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Cardiac MRI and Myocarditis in Covid-19 infected patients: our experience

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ABSTRACT

Purpose: To describe the cardiac magnetic resonance (CMR) radiological findings in patients with clinical suspicion of myocarditis due to infection of COVID-19.
Materials and Methods: During year 2021 we had CMR examinations in 90 patients , 58 males and 32 females, aged 21 to 80 years old, who had the indication of myocarditis due to Covid-19 infection. 45 patients had curtained disease of Covid-19, 24 patients had presented post Covid clinical symptoms, 5 patients with suspicious symptoms after vaccination and 8 patients with uncertain clinical criteria but high risk due to other diseases (eg respiratory problems, myositis etc).
Results: 38/90 (42.2%) had radiological findings in CMR study compatible to myocarditis. 3/90 (3,3%) had image findings of myocardiopathy and other 5/90 (5,5%) image findings of ischemic model. 6/90 (6.6%) had re- evaluation with CMR in order to control the progress of remodeling in myocardium due to Covid-19 myocarditis.
Conclusion: CMR is the golden standard in imaging myocardium in several diseases but especially in myocarditis. Radiological findings in myocarditis are common in Covid-19 and other etiologies.

KEY WORDS Cardiac Magnetic Resonance; Myocarditis; Covid-19 Infection

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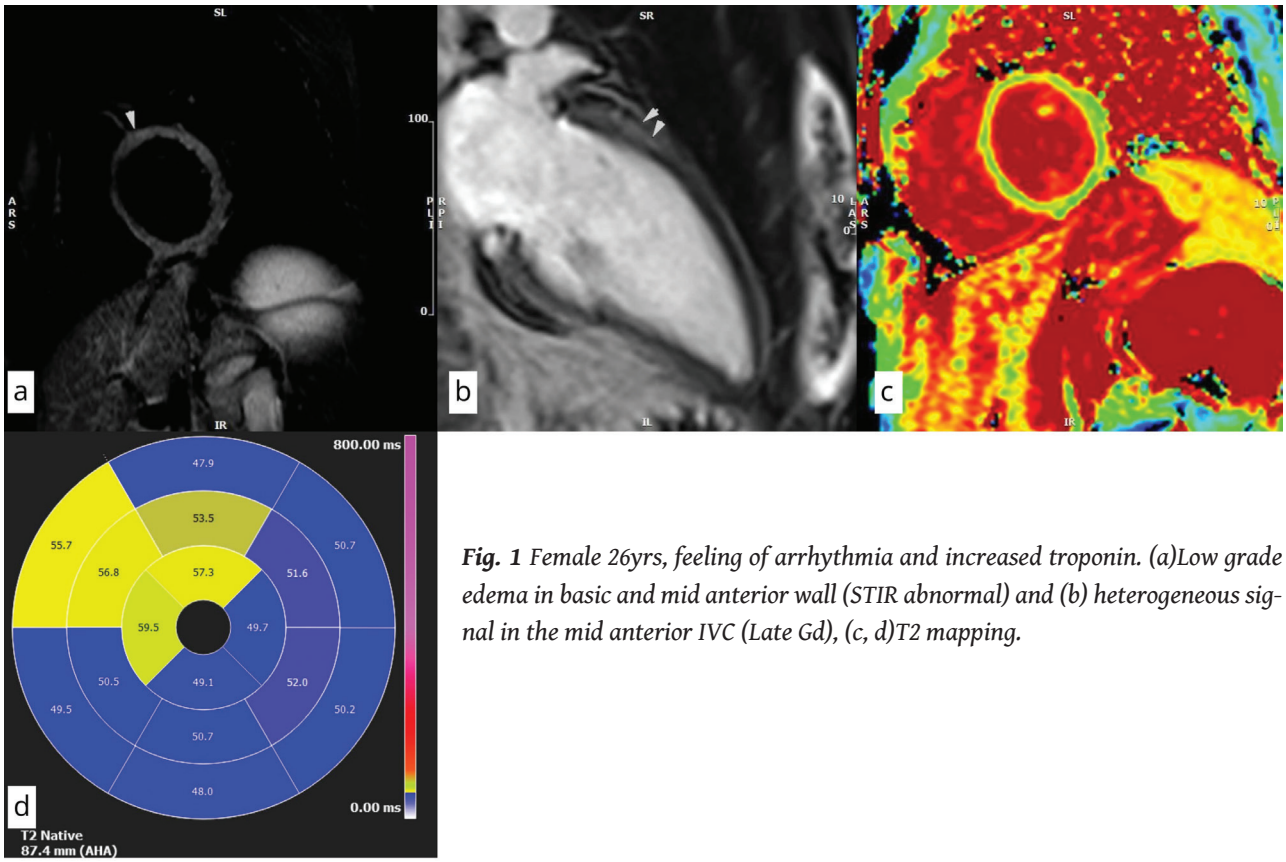

Fig. 1 *Female 26yrs, feeling of arrhythmia and increased troponin. (a)Low grade edema in basic and mid anterior wall (STIR abnormal) and (b) heterogeneous signal in the mid anterior IVC (Late Gd), (c, d)T2 mapping.*

Introduction

During 2021 there was a significant increase in patients that had been infected by Covid-19 virus. The significant progress in the knowledge of Covid-19 has led to the conclusion that the specific virus, apart from its harmful effect of the pulmonary system, may also damage the small vessels and consequently, organs, such as the heart, could be quite vulnerable if effected. As a result, many patients that were affected by the virus, developed, either during the period of the illness or afterwards, cardiological symptoms. These patients should be further evaluated in order to exclude pathology of myocarditis. Study of choice for the evaluation of these patients is Magnetic Resonance (CMR-Cardiac Magnetic Resonance).CMR can be used to identify pathological findings, as well as to re-evaluate the patients periodically. The purpose of this study is to determine CMR findings and criteria in patients with clinical suspicion of myocarditis due to infection of COVID-19 and to determine the significance of the above method.

2. Materials and Methods

During 2021 a CMR study was performed in 90 patients with high clinical suspicion of myocarditis. Forty five (45) patients out of 90 (50%) had been confirmed for Covid-19 disease and were hospitalized. Twenty four (24) patients out of 90 (26.6%) showed mild symptoms, a positive PCR or Rapid test, they were not hospitalized and presented suspicious clinical signs (arrhythmia, tachycardia, fatigue, mild chest pain) subsequently to the disease (up to 60 days). Five (5) patients out of 90 (4.5%) had presented no history of disease, however they presented atypical symptoms after their vaccination. Eight (8) patients out of 90 (7.2%) were high risk patients due to other underlying diseases , with a positive PCR and unspecified clinical criteria (**Table 1**).

CMR took place in our radiology department, part of private sector , therefore the clinical information as well as the clinical and laboratory correlation of the patients is provided by the referring doctors (mostly cardiologists).The main characteristics of the patients include high levels of troponin (20/90), leycocytosis (45/90), high CRP levels (40/90), as well as clinical symptoms of tachycardia, fatigue, headache, arrhythmia and chest pain.

Cardiac MRI was performed in a SIEMENS MAGNETOM ESSENZA 1.5 T.

Table 1: Classification of patients in our study	
90 patients	
58 males	32 females
45 patients curtained disease of Covid-19	
24 patients with post Covid clinical symptoms	
5 patients with suspicious symptoms after vaccination	
8 patients with uncertain clinical criteria	

Table 2. Schematic presentation of results	
Results	
38/90 patients (42.2%)	Findings in CMR compatible to myocarditis • 38 patients with typical pathological lesion • 4 patients with intensed edema • 2 patients submotilities if the cardiac wall • 6 patients with small pericardial effusion
3/90 patients (3.3%)	Findings in CMR compatible to myocardiopathy
5/90 patients (5.5%)	Findings in CMR compatible to ischemic model

The appropriate hygiene protocols for the preparation of the examination room, the equipment and the patients were thoroughly followed and the patients were given the appropriate protection masks during the examination.

An intravenous contrast media was injected.

The study protocol was adjusted based on the revised criteria Lake Louise (2018). Additionally, ejection fraction was estimated in all patients and a cine sequence study was performed in order to inspect the motility of the myocardium and the ventricles.

Reports were performed from radiology and cardiology consultant with specialization in CMR.

Some of the above patients were re-evaluated in our medical center with a CMR study approx. 6 months after the first study, in order to determine further development of lesions in the myocardium.

3. Results:

38/90 (42.2%) presented imaging findings compatible to myocarditis, based on the CMR. More specifically, 4 out of 38 (10.5%) presented intense edema in the suppression sequences (**Fig. 1**). All 38 patients had pathological lesions in epicardial or midmyocardial wall localization (non-ischemic model) and affected times in T1 and T2 mapping (**Fig. 2 and Fig. 3**). 2 patients out of 38 (5.2%) showed sub motilities of the cardiac walls. 6 patients out of 38 (15.8%) additionally showed small pericardial effusion. The imaging characteristics of all the above patients showed no alteration in comparison to the characteristics of a typical myocarditis (regardless of previous clinical history).

Three (3) patients out of 90 (3.3%) showed no imaging findings compatible to myocarditis, nevertheless they showed imaging findings compatible to dilated (2/3) or hypertensive (1/3) myocarditis.

Five (5) out of 90 patients (5.5%) showed pathological findings compatible to ischemic model disease (subendocardial lesions). 3 out of 5 patients had a known medical history of ischemic myocardium and in 2 out of 5 patients the above lesions were stated as a differential diagnosis to that of myocarditis.

One (1) out of 90 patients (1.1%) had imaging findings compatible to myocarditis, with a complex medical history (previous infection to Covid 19 followed by vaccination against Covid 19 after the infection, presented by suspicious clinical findings of tachycardia 20 days after vaccination).

Six (6) out of 90 patients (6.6%) have undergone an imaging re-evaluation approx. 6 months after the first imaging and 3 out of 6 patients showed signs of replacement fibrosis whereas 3 out of six showed retreats of the imaging sings (male patients, athletes 8-25 y.o.) (Table 2).

4. Discussion

Myocarditis is the inflammation of the heart muscle, also known as ''myocardium''. It affects mostly young men with an average age of 42 but the symptoms are often mild and a wide range of cases remains undiagnosed.

In developed countries, the cause is mainly viral (Cox-

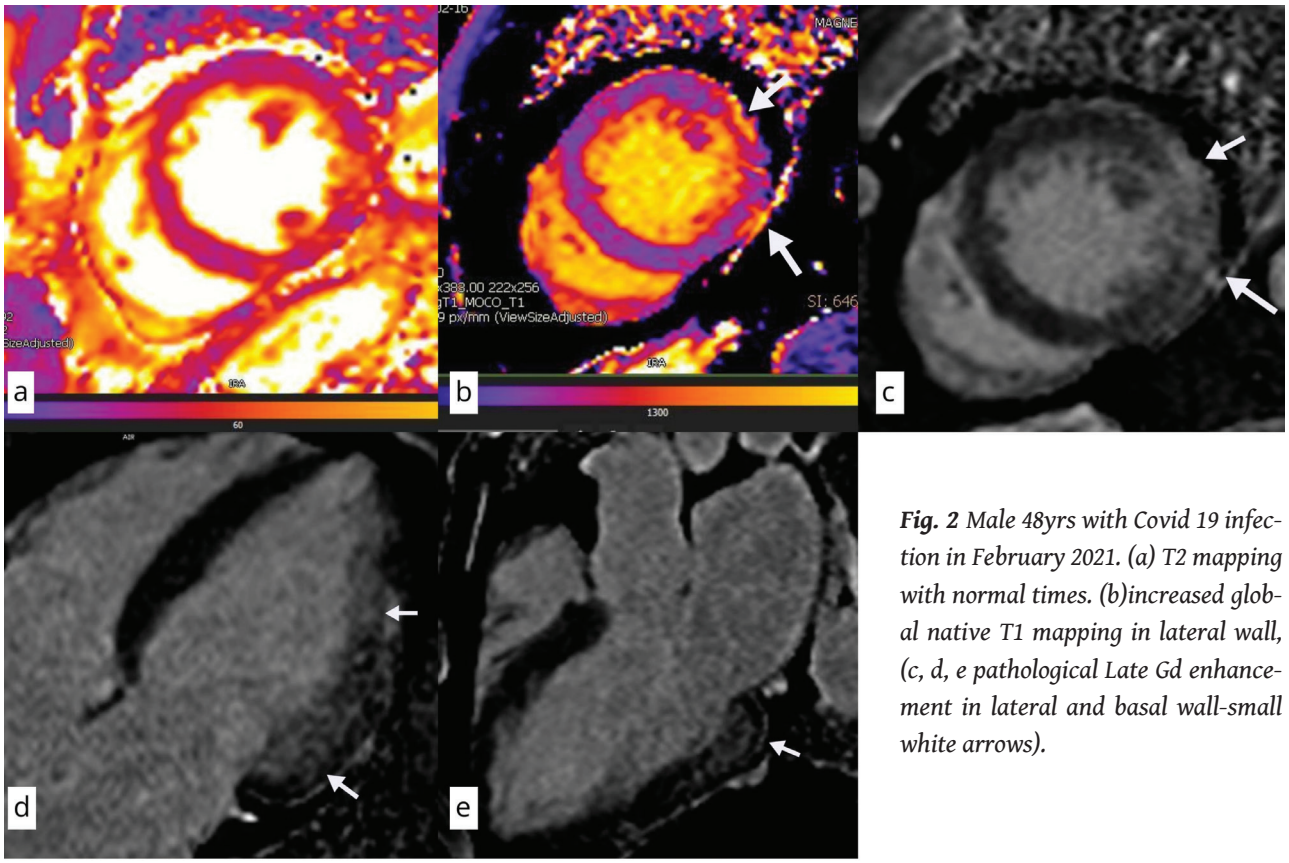

Fig. 2 *Male 48yrs with Covid 19 infection in February 2021. (a) T2 mapping with normal times. (b)increased global native T1 mapping in lateral wall, (c, d, e pathological Late Gd enhancement in lateral and basal wall-small white arrows).*

sackie B, Enteroviruses and Adenoviruses), unlike third world countries where bacterial infection and rheumatic carditis still prevail.

There are three mechanisms that lead to cardiac tissue damage:

1) direct viral damage at the myocardium

2) release of toxins that affect the myocardium (eg. Diphtheria)

3) destruction of the myocardium due to immunobiological mechanisms [1]

Regardless of the mechanism the result is still the same, a weakened myocardium that may affect the Ejection Fraction (EF) or the normal heart rhythm, thus leading to a heart failure and possible arrythmias.

Likely, the number of severe myocarditis is very limited and most patients are asymptomatic. If a patient develop any symptoms, that may include the following: chest pain, shortness of breath or difficulty in breathing, irregular heartbeat, edema in foot and ankle as well as signs of viral inflammation such as fever, fatigue, headache, muscle aches, sore throat or diarrhea.

The diagnosis is mostly clinical accompanied by an x ray, an ECG, a heart ultra sound and blood test for the determination of the level of troponin. In some cases CMR is necessary in order to confirm it.

Treatment depends on the cause and severity of the inflammation including corticosteroids, diuretics, b-blockers and ace inhibitors for the cardiac support, as well as abstention from any intense exercise. In some severe cases, a heart transplant or a pacemaker may be needed [2].

In the last two years, we all live in the Covid 19 reality. The ongoing study of the effects of the virus have led us in the recognition of the detrimental effect of the virus in the small vessels.

The huge increase of the patients affected from Covid 19 increases consequently the number of the patients that are affected in target organs such as the heart. Therefore, a percentage of these patients show a strong clinical suspicion to myocarditis. Some studies have also recognized significant correlation of myocardial injury and fatal outcome of COVID-19 [3, 4, 5].

Apart for the clinical and diagnostic-laboratory criteria, Cardiac MRI appears to be a significant tool in

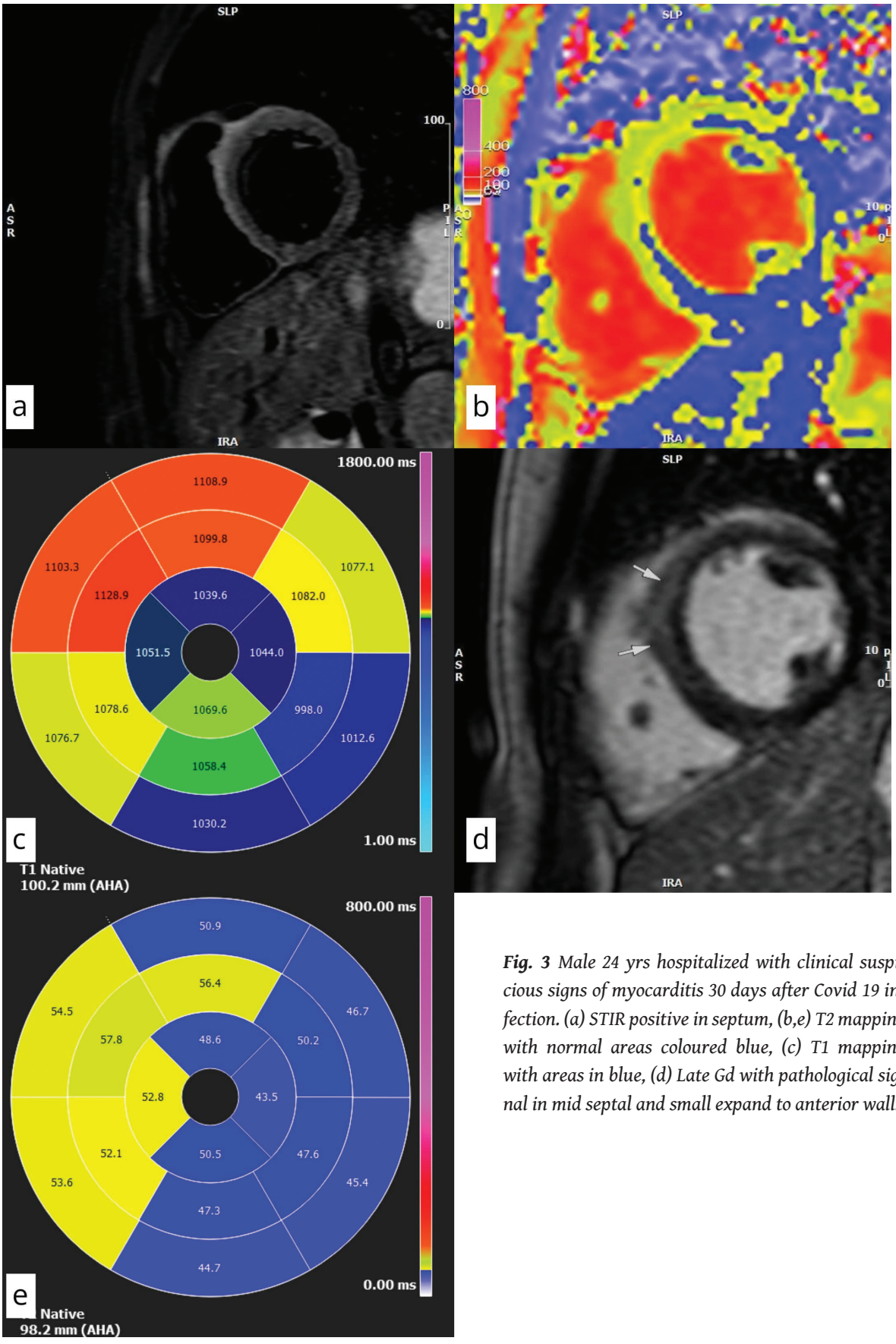

Fig. 3 *Male 24 yrs hospitalized with clinical suspicious signs of myocarditis 30 days after Covid 19 infection. (a) STIR positive in septum, (b,e) T2 mapping with normal areas coloured blue, (c) T1 mapping with areas in blue, (d) Late Gd with pathological signal in mid septal and small expand to anterior wall.*

the diagnosis, severity assessment and follow up of the above patients [6]. The specificity of CMR can be increased significant if we combine findings compatible of myocardial edema in STIR sequences with other markers of inflammatory myocardial injury, especially with the assistance of t2-based criteria [7].

The significance of the method has been fortified in the last five years, due to its ability to identify and distinct sufficiently the myocardial lesion to ischemic and non-ischemic. As cardiovascular involvement is associated with poor prognosis is more than important to have an effective imaging method, in order to have an early attention and appropriate treatment for this group of patients [8]. Thus, a large amount of patients, even showing a slight suspicion of myocarditis, could undergo a CMR and can have a clear image of the myocardium and a significant help in the rest of the clinical and laboratory findings whereas its appropriate and promptly therapeutical treatment. Furthermore, it constitutes a powerful tool regarding the imaging re-evaluation, offering a subjective specification of the evolution of the lesions and the myocardium. Of course is very important to include in our discussion and patients that present symptom after covid infection .This patient group will be the case of persistence and focused study [9, 10].

It should be noted that myocarditis due to Covid 19 infection has no imaging alteration in comparison to the other types of myocarditis. However, this does not in any way reduce the significance of this imaging method in the diagnosis of myocarditis when there is high clinical suspicion, especially in a Covid 19 effected population. It will be the topic of further studies in the near future.

5. Conclusion

CMR is the gold standard for the research of myocarditis, especially for patients that have a clinical history of Covid 19 infection. Imaging characteristics are common within the sum of patients that suffer from myocarditis. With Cardiac MRI the ordinal re-evaluation of these patients is easy and repeatable. **R**

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Conflict of interest

The authors declared no conflicts of interest.

Ethical approved

The Scientific Council of VIOIATRIKI GROUP has approved the specific study and waived patient consent form.

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