Comparison of Contrast ECHO Imaging Modalities for Left Ventricular Endocardial Border Detection and Wall Motion Analysis Using Levovist¶

LV ENDOKARDİAL SINIRLARININ BELİRLENMESİ VE DUVAR HAREKETLERİNİN İNCELENMESİNDE KONTRAST MADDE OLARAK LEVOVİST KULLANILARAK İKİ DEĞİŞİK GÖRÜNTÜLEME METODUNUN KARŞILAŞTIRILMASI

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Summary

Second harmonic (HI) and power harmonic imaging (PHI) modalities have been combined with contrast agents for LV endocardial border detection(EBD).Our objective was to compare these methods with fundamental imaging (FUND) in EBD and wall motion (WM) analysis.

EBD and WM was assessed from apical 4 and 2 chamber views in 24 patient using ATL HDI 3000 and Acuson XP 128 machines. FUND and HI imaging at baseline was compared to HI and PHI after Levovist (LEVO) injection at various concentrations (10 ml of 300 mg/ml and 400 mg/ml) Twelve segments were analyzed and scored by 2 different readers. A scoring system 0-3 was used for EBD and a 1-4 score was used for WM. Overall p value and mean+standard error of visual ratings for different imaging modalities are provided.

HI+LEVO and PHI+LEVO were significantly better than FUND or HI alone for EBD.EBD did not differ significantly between HI+LEVO and PHI+LEVO. Best improvement was for apical septum and lateral walls.There were no differences for WM among different imaging modalities.

EBD is significantly improved after Levovist administration with HI or PHI compared with FUND or HI imaging alone.PHI gave similar results to HI for EBD. The LV segments most markedly improved with HI and PHI are apical septum and lateral walls.

Key Words: Contrast echocardiography, Harmonic imaging

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Özet

Harmonik (H) ve" power" harmonik (PH) görüntüleme teknikleri endokardial sınırları (ES) belirlemede kontrast ajanlarla birlikte kullanılmıþtır. Çalıþmanın amacı bu metodları klasik görüntüleme metodu ile karþılaþtırmaktır. ES ve duvar hareketleri (DH) 24 hastada ATL HDI 3000 ve Acuson 128 XP makinaları kullanılarak apikal 4 ve 2 boþluktan incelendi. Bazal görüntüler klasik ve H metodlar ile alındıktan sonra galaktozlu bir kontrast madde olan Levovist verilerek H ve PH ile tekrarlandı. ES ve DH analizleri 12 segment üzerinden 2 bağımsız okuyucu tarafından değerlendirildi. Skorlama endokard sınırları için (0=yok.1=hafif, 2=orta ve 3=iyi) þeklindeydi.

Sınırları belirlemede H görüntüleme bazale göre daha üstün,kontrast madde ile birlikte H ve PH birbirlerine göre farklı olmayıp bazale göre daha üstün bulundular.

Sonuçta: Levovist ile H veya PH bazal veya yalnız H görüntülemeye göre ES belirlemede daha üstündü. PH ve H sonuçları birbirine benzer bulundu. H veya PH ile görüntü kalitesi en iyi artan segmentler apikal septum ve lateral duvarlardı.

Anahtar Kelimeler: Kontrast eko, Harmonik görüntüleme

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Recently usage of i.v.contrast agents to identify LV endocardial border has become a popular method. Harmonic imaging(HI) and power harmonic imaging (PHI) are two imaging modalities which increase the efficacy of visualization of contrast agents.

Harmonic imaging

The principle of harmonic imaging is that when microbubbles are insonated they begin to resonate and generate harmonics of the transmitted

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frequency.Harmonic mode attenuates tissue signals and enhances flow signals (3). Harmonic imaging can be performed with 2D and with Doppler signals. Sensitivity for microbubbles is much higher using the Doppler mode.When harmonic imaging is combined with Doppler it is called power harmonic imaging (PHI) (4).

Power Doppler Harmonic imaging

Backscatter signal power is color coded. When it is combined with Doppler signature of the myocardium the former eliminates most of the tissue signal and preserves the signals from blood flow. The signal from the contrast agent can be visualized in color overlaid in a high resolution conventional 2D image, thus demonstrating increased deliniation of the endocardium and better sensitivity to small changes in backscatter (3). Additional enhancement of images may be obtained when it is used with intermittant imaging. This is important for myocardial contrast effect. Also it is proposed that endocardial border deliniation is better with this method.

Although there are some studies comparing HI or PHI to fundamental imaging there are a few to compare these two methods together. The aim of this study was to compare these two tecniques with each other and fundamental imaging for endocardial border definition and wall motion analysis.

Material and methods

Patient Group

24 patients(18M and 6 F) with ischemic heart disease and segmental LV dysfunction were included in the study.Average age was 60+11 yrs., mean LVEF was 45+14%, while in 13 patients (54%) EF was <50%.

Echocardiography

All examinations were performed either with HDI 3000 or Acuson machine with a 2.5 mHz transthoracic transducer. Standard apical 4 chamber and 2 chamber view images were obtained in each patient by fundamental,harmonic and after the contrast material injection by HI and PHI. Wall motion analysis :12 segments were analyzed and scored by 2 independently blinded readers off tape.The following scoring system was used:

1:normal,2:hypokinesis,3:akinesis,4:dyskinesis, 5:aneurysmal.

Qualitative scoring system 0-3 was used for endocardial border detection where 0:none, 1:minimal, 2:adequate, 3:good.

Contrast Agent

Levovist (SHU 508 A) is a first generation contrast agent composed of galactose and small amount of fatty acid that releases air bubbles when combined with sterile water. It causes LV opacification after venous injection in all patients with normal pulmonary artery pressure (1). Bubbles measure 2-8 mm in diameter, with 95% of the bubbles being<6 mm (2). It was prepared as a solution of 300 and 400 mg and hand injected into an antecubital vein as a 10 mg bolus.

Statistical Analysis

Endocardial border and wall motion analyses were expressed as mean and standard deviation. For reliability measurement generalizability coefficient was measured. A p value <0.05 was considered statistically significant.

Results

24 patients were analysed for endocardial border and wall motion (Table 1). All patients had ischemic heart disease, while 16 had hypertension and 5 had AVR additionally. The total number of analyzed segments was 576. The average wall motion analysis score was 1.29+0.04 in fundamental and 1.28 +0.04 in harmonic imaging.On the other hand when Levovist was added it was 1.31+0.04 in harmonic imaging and 1.33+0.04 in PHI.There were no differences for WM imaging in different imaging modalities (Table 2). Average score for endocardial border detection was 1.31+0.07 for FUND, while it was 2.05 +0.07 for HI.HI+LEVO

Table 1. Patient characteristics

Total number	24
Gender (male,n)	18(75%)
Age(y)	60+11
Left ventricular function	
Normal(LVEF>50%)	11(45.8%)
Impaired (LVEF<50%)	13(54%)

Table 2. Endocardial border and wall motion analysis

	EBD	Wall Motion
FUND	1.31+0.07	1.29+0.04
HI	2.05+0.07	1.28+0.04
HI+LEVO	2.46+0.07	1.31+0.04
PHI+LEVO	2.47+0.07	1.33+0.04

FUND<HI,FUND<HI+LEVO,FUND<PHI+LEVO($p<0.001$)

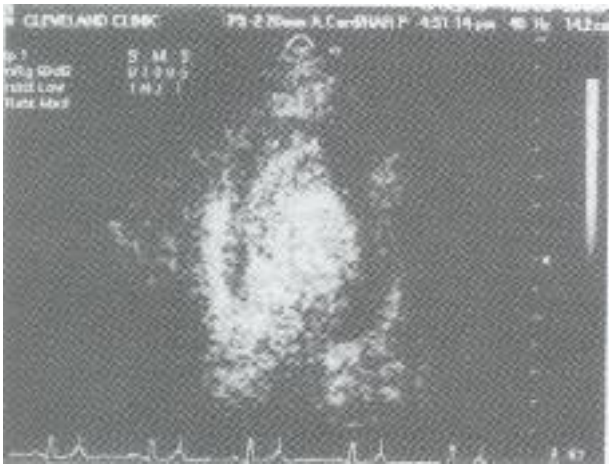

Figure 1.

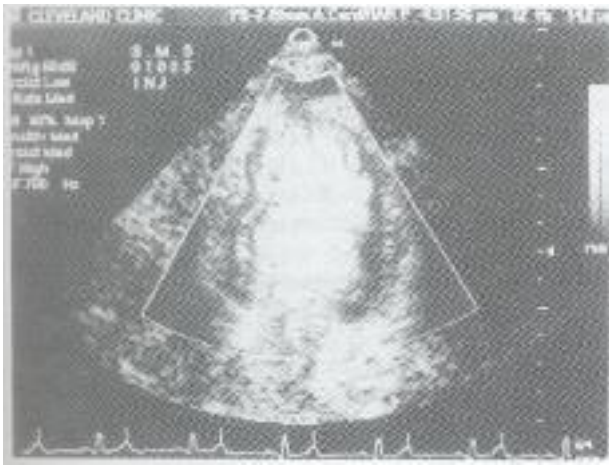

Figure 2.

and PHI+LEVO were significantly better than FUND or HI alone for EBD. It was 2.46+0.07 for HI+LEVO and 2.47+0.07 for PHI+LEVO.EBD did not differ significantly between HI+LEVO and PHI+LEVO (Table 2). The generalizability coefficient measuring reliability for EBD and WM was 0.91.The best improvement was observed in the EBD of apical septum and lateral walls (Figure 1 and 2). Contrast agent was well tolerated in all patients and no adverse reactions were seen.

Discussion

Both harmonic imaging and harmonic imaging during power Doppler have been shown to enhance the effects of contrast agents. This study compares these two imaging modalities in combination with Levovist.

Harmonic imaging technique is based upon the resonance behavior of the microbubbles.Current protocols use transient imaging (5). On the other hand, in harmonic Power Doppler technique stimulated acustic emission can be recorded.These signals originate from dissolving microbubbles which result in high amplitute signals (5). It is proposed that in comparison to HI,in HIPD provides better detection of the myocardium from the LV cavity.In addition HIPD with transient imaging is a very sensitive method for the assessment of myocardial perfusion (6).

We have shown in our study that both second HI and PHI enhances endocardial border detection compared with fundamental imaging,especially visualizing lateral and apical septal segments. Imaging is further enhanced by addition of contrast agent (Levovist). When compared to each other,we found no difference between these two methods similar to Masoni'study (7) where they used Echogen which is a second generation contrast agent.

On the other hand In Yeleti's study PHI with contrast was compared to PHI without contrast and better endocardial visualization was obtained with contrast agent (8).

It is postulated that there are three possible explanations for HI enhancement of endocardial border detection:reduction in near field haze,reduction in side lobes and nonlinear tissue backscatter (9-12).

Conclusions

Although harmonic Doppler and PHI have been shown to enhance the effects of several con-

trast agents there are a few reports comparing the usefulness of HI to PHI (5,7). This study demonstrates the feasibility of these methods in image enhancement using Levovist as the contrast agent. EBD is significantly improved after Levovist administration with HI or PHI compared with FUND or HI imaging alone.PHI gave similar results to HI with contrast for EBD.

The LV segments most markedly improved with HI and PHI were apical septum and lateral walls. There were no differences for WMA using these modalities.

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