# Perivalvular Abscesses due to *Staphylococcus aureus* Endocarditis Comparison with *Streptococcus viridans* Endocarditis and Incremental Value of Transesophageal Echocardiography

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**Abstract**

**Background :** Perivalvular abscesses are major complications of infective endocarditis (IE). The prevalence and best approach to detection of this complication in *Staphylococcus aureus* (SA) in comparison to *Streptococcus viridans* (SV) IE is unclear.

**Method:** Among 243 consecutive episodes of IE diagnosed using the Duke criteria, who underwent either transthoracic (TTE) or transesophageal echocardiography (TEE) at the Mayo Clinic between 1988 and 1993, there were 64 cases of SV and 61 of SA IE. Comparison of TTE and TEE detection of abscesses were restricted to patients with either surgical or autopsy examination and both TTE and TEE were performed.

**Results:** Prosthetic valve and valve repair were significantly higher in SA compared to SV IE (46 *vs* 23%, P = 0.008). The prevalence of abscesses was higher in SA compared to SV IE (42 *vs* 14%, P = 0.08). 1 (10%) of abscess detected by TTE in SA compared to 1 (50%) in SV IE and 6 (60%) by TEE in SA and 1 (50%) in SV IE. Incremental value of TEE *vs* TTE was higher in SA 5/24 (21%) than in SV IE 0/14 (0%) P = 0.067. Hospital mortality was significantly higher in SA than SV IE (13 *vs* 2%, P = 0.013)

**Conclusion:** Patients diagnosed with IE and those with SA 1) presented more often with prosthetic valve IE, 2) developed more perivalvular abscesses, and 3) had a higher in hospital mortality than those with SV. Incremental value of TEE was higher in SA than in SV IE, 4) therefore, had a stringent requirement for initial and repeated TEE to detect this ominous complication of IE.

**Key word :** Infective Endocarditis, *Staphylococcus aureus* Endocarditis, *Streptococcus viridans* Endocarditis, Transesophageal Echocardiography

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Without accurate diagnosis and treatment, infective endocarditis is a fatal illness, and remains a disease with high morbidity and mortality(1,2). The clinical diagnosis is crucial but difficult to establish, due to variable clinical manifestations. The clinical course depends on numerous factors, including the causative organisms, age, and underlying heart disease. Although acute endocarditis is usually due to *Staphylococcus aureus*,(3,4) both *Staphylococcus aureus* and *Streptococcus* groups can cause either fuminant or indolent conditions in different patients. Perivalvular abscesses are major complications, which increase the expected morbidity and mortality rate of patients.

Recent studies have shown that transesophageal echocardiographic study, compared to conventional transthoracic echocardiography, has increased the diagnostic accuracy in detection of vegetations and abscesses(5-7).

The purpose of this study was to determine the prevalence of perivalvular abscesses due to *Staphylococcus aureus* in comparison to *Streptococcus viridans* infective endocarditis and the incremental value of transesophageal echocardiography in detection of this complication.

## METHOD

We examined a total of 220 patients with 243 episodes of infective endocarditis, between 1988 and 1993 at the Mayo Clinic. The medical records at discharge were reviewed and diagnosis was made on the basis of; 1) the diagnosis at discharge, 2) blind reevaluation of echocardiographic tapes, 3) surgical or autopsy findings. Each diagnostic case was evaluated for categorizing the likelihood of infective endocarditis by the Duke criteria(8).

### Echocardiographic Examination

Transthoracic two-dimensional echocardiography was performed in 236/243 (90.1%) of the episodes as previously described(9). The patients were submitted for transesophageal echocardiography in 189/243 (77.8%) episodes within the fifth day of hospitalization. Transesophageal echocardiography was performed in the presence of 1) inadequate transthoracic study, 2) undetected vegetations by transthoracic study. The heart was scanned in the standard position as described previously(10).

### Echocardiographic Criteria

**Characterization of vegetation:** Vegetation was defined as a discrete mass lesion, sessile or pedunculated, adherent to the surface of the leaflet of the cardiac valve or prosthetic valve or ring with independent motion from the valve itself or endocardial surfaces. Once identified, valvular vegetations were further characterized on the basis of four physical properties (size, mobility, extent and consistency) as previously described(11).

**Characterization of abscess:** Direct inspection during surgery or autopsy, an abscess was defined as a region of necrosis containing purulent material and penetrating into the valvular annulus or adjacent myocardium structures(12). By echocardiography, an abscess was considered to be present when: a definite region of echolucent cavity within the valvular annulus or adjacent myocardium was found in the setting of valvular infection (13-16) (Fig. 1).

All echocardiograms were evaluated by two independent investigators without knowledge of the first evaluation. In case of disagreement, the observers re-evaluated the findings together and a consensus was reached.

### Statistical analysis

Data are expressed as mean ± SD. Group comparisons were performed with a standard *t* test or $\chi^2$ test when appropriate. A value of less than 0.05 was considered to be statistically significant.

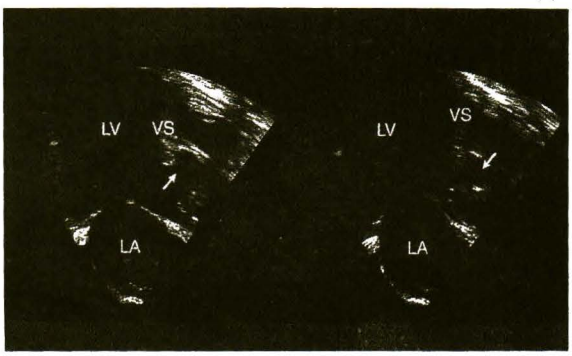


**Fig. 1. Transesophageal echocardiography of abscess cavity (*arrow*) expanding from the infected aortic valve to the ventricular septum (*vs*).**

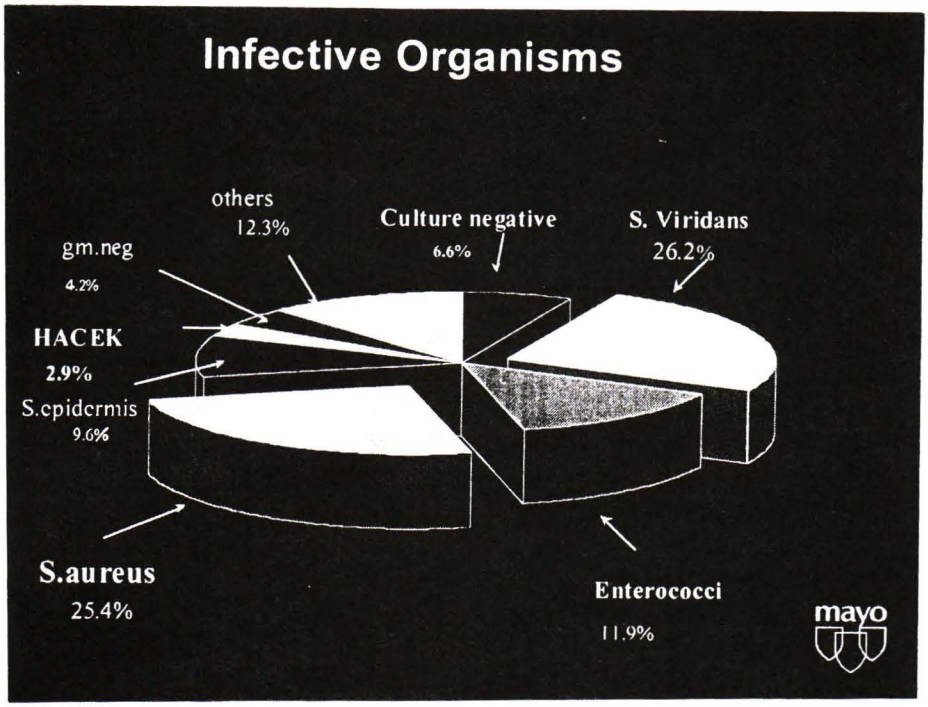


**Fig. 2. Blood cultures identified causative organisms in 243 episodes of infective endocarditis.**

## RESULTS

220 patients (66% male), mean age 61±19 with 243 episodes were diagnosed with infective endocarditis. Blood cultures identified the causative organisms in 243 episodes: 64 (26.2%) were infected by *Streptococcus viridans*, 61 (25.4%) by *Staphylococcus aureus*, 25 (9.6%) by *Staphylococcus epidermis*, 29 (11.9%) by Enterococci, 7 (2.8%) by HACEK group, 11 (4.5%) by Gram negative bacilli (Fig. 2). The most offending pathogens were *Streptococcus viridans* and *Staphylococcus aureus*.

### Clinical Characteristics Data

The clinical characteristics of *Streptococcus viridans* and *Staphylococcal aureus* endocarditis are shown in (Table 1). There were 64 patients (67% male, mean age 58±23 with *Streptococcus viridans* endocarditis and 61 patients (57% male, mean age 60±17) with *Staphylococcal aureus* endocarditis. There was no statistically significant differences in age and sex between the two groups. Prosthetic valves and valve repair were the underlying heart conditions and were significantly more increased in *Staphylococcal aureus*, than those with *Streptococcus viridans* endocarditis (46 *vs* 23%, p = 0.08). Native valves with structural abnormality were more significantly increased in *Streptococcus viridans*, than those with *Staphylococcal aureus* endocarditis (52 *vs* 31%, p = 0.02), mitral valve prolapse was significantly more increased in *Streptococcal viridans*, than those with *Staphylococcal aureus* endocarditis (27 *vs* 10%, p = 0.01).

### Overall perivalvular abscesses

The prevalence of abscesses between the two groups is shown in Table 2. Perivalvular abscesses were significantly more increased in *Staphylococcus aureus* compared to *Streptococcus viridans* endocarditis (31 *vs* 9%, p = 0.002).

### Anatomical findings

The anatomical evaluation during surgery or autopsy and both transthoracic and transesophageal echocardiography performed revealed a total of 24 patients with *Staphylococcus aureus* and 14 with *Streptococcus viridans* endocarditis.

Perivalvular abscesses in *Staphylococcus aureus* was higher than in *Streptococcus viridans* endocarditis (42 *vs* 14%, p = 0.08) as shown in Table 2.

**Transthoracic Echocardiography:** On transthoracic echocardiography only 1 of the 2 abscesses (50%) could be correctly identified in *Streptococcal viridans* and 1 of the 10 abscesses (10%) in *Staphylococcus aureus* endocarditis. No transthoracic echocardiographic resulted in a false positive diagnosis of abscess in both groups. Transthoracic echocardiography thus had a sensitivity of 50 per cent in *Streptococcal viridans*, and 10 per cent in *Staphylococcus aureus* in detecting abscesses associated with endocarditis; the most common location was abscess at the aortic root. (Table 2).

**Transesophageal Echocardiography:** Compared to the transthoracic approach, transesophageal echocardiography allowed a higher rate of detection of abscesses in *Staphylococcus aureus* than *Streptococcus viridans* endocarditis: 6 of the 10 abscesses (60%) correctly identified in *Staphylococcal aureus* and 1 of the 2 abscesses (50%) in *Streptococcus viridans* endocarditis. Abscesses were missed by the transthoracic but correctly identified by the transesophageal echocardiography. No patient had an abscess detected by TTE alone. Therefore, the incremental value of transesophageal echocardiography *versus* transthoracic echocardiography was higher in *Staphylococcus aureus* compared to *Streptococcus viridans* endocarditis (5 of 24 (21%) *versus* (0 of 14 (0%), p = 0.06)

### In-hospital Outcome

The complications of infective endocarditis between the two groups are shown in Table 3. There was a significantly lower ejection fraction in *Staphylococcus aureus* compared to *Streptococcus viridans* endocarditis (58±10 *vs* 61±9, p = 0.042). There was no significant difference between the two groups regarding CHF and heart block. In-hospital mortality was significantly higher in *Staphylococcus aureus* compared to *Streptococcus viridans* endocarditis (13% *vs* 2%, p = 0.013).

## DISCUSSION

Perivalvular abscess is a serious complication of infective endocarditis. Early diagnosis and appropriate therapy are essential. Before the era of two-dimensional echocardiography, perivalvular abscess was identified only at surgery or autopsy. Transthoracic echocardiography was shown to visualize vegetations as early as 1973[16] but the detection of perivalvular abscess by the transthoracic approach is difficult, especially the prosthetic valve. Abscesses were detected by two-dimensional

**Table 1. Clinical characteristics of *Streptococcus viridans* and *Staphylococcus aureus* endocarditis.**

| | *S. viridans* (n=64) | *S. aureus* (n=61) | P- Value |
|---|---|---|---|
| Age (y) | 58±23 | 60±17 | NS |
| Gender (%male) | 67 | 57 | NS |
| Prosthetic valve/ valve repair | 23 | 46 | 0.008 |
| Native valve | 52 | 31 | 0.021 |
| Mitral valve prolapse | 27 | 10 | 0.018 |

**Table 2. Detection of perivalvular abscesses by Transthoracic and Transesophageal Echocardiography and surgery/autopsy in both groups of endocarditis.**

| | S.Viridans (n=64) | S. Aureus (n=61) | P - Value |
|---|---|---|---|
| Overall n (%) | 6 (9) | 19 (31) | 0.002 |
| Prosthetic valve | n=15 | n=28 | |
| Abscesses n (%) | 4 (27) | 10 (36) | 0.546 |
| Native valve | n=49 | n=33 | |
| Abscesses n (%) | 2 (4) | 9 (27) | 0.003 |
| At Surgery/autopsy | n=14 | n=24 | |
| Abcesses by anatomy | 2 (14%) | 10 (42%) | 0.08 |
| Ring of aortic prosthetic valve | 1 | 4 | |
| Mitral prosthetic valve | 1 | 4 | |
| Aortic root of aortic valve | - | 1 | |
| Mitral valve (PML) | - | 1 | |
| Abscess by TTE | 1 (50%) | 1 (10%) | 0.17 |
| Abscess by TEE | 1 (50%) | 6 (60%) | 0.79 |

**Table 3. In-hospital outcome.**

| | *S. viridans* (n=64) | *S. aureus* (n=61) | P -Value |
|---|---|---|---|
| LVEF (%) | 61±9 | 58±10 | 0.042 |
| CHF (%) | 9 | 12 | 0.701 |
| Heart block (%) | 2 | 8 | 0.083 |
| In-hospital mortality (%) | 2 | 13 | 0.013 |

echocardiography most frequently involving the aortic valve ring more often than the other valves (13). However, mitral and tricuspid valve ring abscesses have also been described(17,18).

The early identification of perivalvular extension of infective endocarditis such as an abscess is particularly important, however, since in patients with such abscesses antibiotic therapy may not be able to penetrate the abscess effectively. It has been proposed that surgery before widespread tissue destruction has occurred may improve the outcome(19,20).

**Role of transthoracic and transesophageal echocardiography in identifying perivalvular abscesses**

Our results confirm the use of transthoracic and transesophageal echocardiography in detecting perivalvular abscesses. In fact, all cases diagnosed were confirmed by surgery or autopsy. However, two-dimensional transthoracic echocardiography has a relatively low capability to visualize such complications of infective endocarditis especially in *Staphylococcus aureus* endocarditis which has a high prevalence of prosthetic valve endocarditis, owing to poor image resolution. The role of transesophageal echocardiography has been documented during the past few years, and indications are further evolving and expanding. The introduction of transesophageal echocardiography has greatly improved sensitivity and specificity in the detection of perivalvular abscesses of 87 per cent and 95 per cent respectively(13). Our study shows that, the transesophageal has higher sensitivity in detection of perivalvular abscesses than the transthoracic echocardiography. The incremental value of transesophageal is remarkably higher in *Staphylococcus aureus* than in *Streptococcal viridans* endocarditis.

**Other findings**

In some cases, transesophageal echocardiography can not detected perivalvular abscesses. The reasons for negative transesophageal echocardiography: 1) early performed transesophageal echocardiography, 2) location of abscesses in the myocardium (myocardial abscesses), in calcified mitral annulus (very uncommon, many calcification-generated artifacts), in mitral peri-prosthetic, 3) small perivalvular abscess less than 5 mm.

**Limitation of the study**

Due to the fact that only patients with infective endocarditis, documented during surgery or autopsy, were included in the study, this group represented as the positive 'gold standard' could be viewed as a limitation and patients who had echocardiographic examinations but did not undergo surgery or autopsy were not included. However, the selection criteria in this study provided the only way to avoid uncertainty about whether abscesses had been correctly identified.

Referral bias is a well-recognized problem in descriptions of disease and the clinical spectrum of infective endocarditis might be distorted by referral.

The results should be interpreted in regard to the retrospective nature of the study. We had to rely on clinical information obtained by physicians other than that directly involved in the study.

**Clinical Implications**

This study documents that, in *Staphylococcus aureus* endocarditis compared to *Streptococcal viridans* endocarditis, 1) transesophageal echocardiography demonstrated superiority over the transthoracic approach in the visualization of perivalvular abscesses and an aggressive approach should be beneficial, 2) a careful examination of the mitral annular region should be done before declaring a negative result of transesophageal echocardiographic examination, 3) repeated transesophageal echocardiographic examination to detect ongoing abscesses formation, and undergo early surgery.

## SUMMARY

Among the patients diagnosed with infective endocarditis, in comparison with *Staphylococcus aureus* and *Streptococcal viridans* endocarditis, *Staphylococcus aureus* endocarditis, 1) presented more often with prosthetic valve endocarditis, 2) developed more perivalvular abscesses, 3) had a higher in-hospital mortality, 4) had a higher incremental value of transesophageal echocardiography in detection of abscesses than those with *Streptococcal viridans* endocarditis.

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# การศึกษาภาวะ Perivalvular abscesses ที่เกิดจาก *Staphylococcus aureus* เปรียบเทียบกับ *Streptococcus viridans* endocarditis และคุณค่าที่เพิ่มขึ้นเมื่อใช้เครื่องตรวจหัวใจชนิดคลื่นเสียงสะท้อนความถี่สูงผ่านทางหลอดอาหาร

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ผู้ทำการวิจัยได้ศึกษาโรค Infective endocarditis จำนวน 243 เหตุการณ์ที่ได้รับการวินิจฉัยโดยใช้ Duke criteria และได้รับการตรวจด้วย TTE หรือ TEE ตั้งแต่เดือนมกราคม 2531 ถึง ธันวาคม 2536 ที่เมโยคลินิก มีผู้ป่วย *Staphylococcus aureus* 61 ราย, *Streptococcus viridans* 64 ราย การเปรียบเทียบจำกัด เฉพาะในผู้ป่วยที่ได้รับการผ่าตัดหรือตรวจศพและมีการตรวจทั้ง TTE และ TEE เท่านั้น พบว่า *Staphylococcus endocarditis* จะมี prosthetic valve endocarditis สูงกว่าอย่างมีนัยสำคัญ (46 *vs* 23%, P = 0.01), มีความชุกของ perivalvular abscesses มากกว่า (42 *vs* 14%, P = 0.08) และมีอัตราการเสียชีวิตในโรงพยาบาลสูงกว่าอย่างมีนัยสำคัญ (13 *vs* 2%, P = 0.01) คุณค่าที่เพิ่มขึ้นเมื่อตรวจด้วย TEE ในกลุ่ม *Staphylococcus aureus* มีมากกว่า *Streptococcus viridans* endocarditis (21 *vs* 0%, P = 0.07).

การศึกษาครั้งนี้สรุปได้ว่าควรใช้การตรวจชนิด TEE ตั้งแต่แรกรับสำหรับ *Staphylococcus aureus* endocarditis และติดตามต่อไปเพื่อค้นหาภาวะแทรกซ้อนดังกล่าว

**คำสำคัญ :** Infective Endocarditis, *Staphylococcus aureus* Endocarditis, *Streptococcus viridans* Endocarditis, Transesophageal Echocardiography

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