Intravascular Ultrasound-Guided Recanalization of a Coronary Chronic Total Occlusion Located in a Stent Implanted Subintimally: A Case Report

Jean-Francois SURMELY, MD
Takahiko SUZUKI, MD, FJCC

Abstract

Successful percutaneous recanalization of coronary chronic total occlusion(CTO)results in improved survival, as well as enhanced left ventricular function, reduction of angina, and improved exercise tolerance. The procedural success rate has increased over time, but CTO recanalization does still fail in about 20% of cases. Different strategies and specific devices for CTOs have been developed with various degrees of success. We report the case of CTO after a first unsuccessful treatment attempt during which subintimal wire positioning without reentry into the distal lumen, and stent implantation were done. At the second revascularization, intravascular ultrasound guidance allowed reentry of the distal true lumen through the stent, restoring normal flow.

J Cardiol 2006 Aug; 48(2): 95−100

Key Words

■Interventional cardiology ■Intravascular ultrasound ■Revascularization
■Coronary artery disease ■Coronary vessels

INTRODUCTION

Percutaneous coronary intervention(PCI)of coronary chronic total occlusion(CTO)remains an important challenge in interventional cardiology. Even today, CTO is one of the major reasons why patients are referred for bypass surgery.[1,2] Guide wire crossing is the most important component of a successful PCI for CTO.[3] Reaching the distal true lumen is mandatory to reestablish antegrade flow in the distal coronary lumen. However, subintimal passage of the guide wire during recanalization is common and may result in inability to reach the distal true lumen. Coronary angiography is limited in its ability to guide the wire crossing in PCI for CTO. On the other hand, intravascular ultrasound (IVUS)can provide information about the exact location of the guide wires within a coronary artery, and discriminate the false lumen from the true lumen before guide wire crossing.[4−6]

We report the case of a CTO after a first unsuccessful treatment attempt during which subintimal wire positioning without reentry into the distal lumen, and stent implantation were done. At the second revascularization, IVUS guidance allowed reentery of the distal true lumen through the stent, restoring normal flow.

CASE REPORT

A 61-year-old female complained of chest pain on exertion. A cardiac check-up revealed dyslipidemia as the only cardiovascular risk factor, and a treadmill stress test was positive. The patient was referred to another hospital for coronary angiography which showed single vessel disease with chronic occlusion of the middle left anterior descending artery, and normal left ventricular function without regional wall motion abnormalities.

豊橋ハートセンター 循環器科: 〒441−8530 愛知県豊橋市大山町五分取21−1
Division of Cardiology, Toyohashi Heart Center, Aichi
Address for correspondence: SURMELY JF, MD, Division of Cardiology, Toyohashi Heart Center, Ooyama-cho Gobutori 21−1, Toyohashi, Aichi 441−8530; E-mail: j-f.surmely@heart-center.or.jp
Manuscript received January 24, 2006; revised February 22, 2006; accepted March 31, 2006

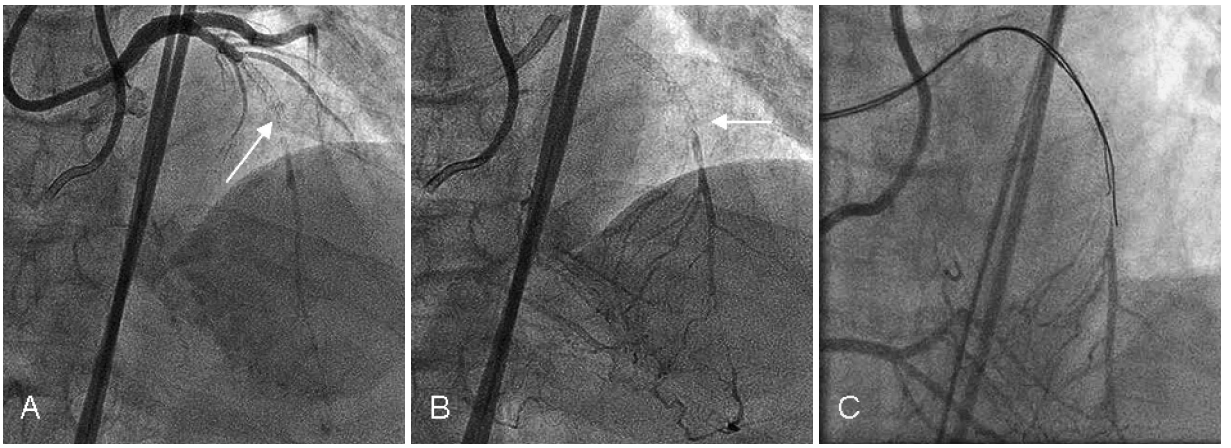

Fig. 1 Baseline angiography before the recanalization retry
A: Simultaneous contrast injection from the left and right coronary artery is shown in an epicranial view. The course of the opacified distal true lumen terminates under the implanted stent(*arrow*).
B: Contrast injection only from the right coronary artery is shown. The course of the opacified distal true lumen terminates under the implanted stent(*arrow*). This misalignment of the stent with the distal true lumen indicates subintimal location of the stent.
C: Crossing of the stent was achieved with the parallel technique, but it was not possible to reenter the distal true lumen.

The angiographic lesion characteristics were as follows: tapered stump, mild calcification, no bridging collaterals, lesion length of 20 mm, and good perfusion of the distal true lumen via collaterals. A recanalization attempt was unsuccessful. The wire entered the subintimal space just after the proximal CTO cap, but caused a long subintimal dissection as far as the distal left anterior descending artery which was probably not recognized. After balloon dilation(2.0 × 10 mm, 8 atm), stent implantation (Duraflex 3.0 × 25 mm, 16 atm; Goodman)was performed. The proximal 6 mm of the stent lay in the true lumen, and the remainder in the false lumen. The final angiographic results showed no reflow.

The patient was then referred to our hospital for further evaluation and treatment. Baseline electrocardiography showed a normal cardiac sinus rhythm, normal axis, normal intervals and no signs of ischemia. A repeat treadmill test(Bruce protocol, double product = 25,500)was again electrically positive. A second CTO recanalization was scheduled 6 months after the first attempt.

The baseline angiography showed occlusion of the mid left anterior descending artery beginning at the proximal end of the stent(**Fig. 1**). The femoral approach with an 8 French Judkins left 3.5 was chosen. Using the conventional wire technique with wires of incremental stiffness(Zeon 3 gram, Zeon; Miracle 6 gram, Asahi Intecc; Conquest pro 12 gram, Asahi Intecc), then the parallel wire technique, crossing the stent occlusion was achieved, but it was not possible to reenter the distal true lumen(**Fig. 1−C**).

The IVUS-guided technique was then tried. In stent pre-dilation(Ryujin plus 1.5 × 15 mm, Terumo; Aqua 2.5 × 15 mm, Cordis)was done to allow the positioning of the IVUS catheter(Atlantis SR pro 2, Boston Scientific). With IVUS, it was possible to identify the point at which the stent left the proximal true lumen and entered the false lumen, as well as to identify the true lumen aside the stent(**Fig. 2**). Using the Conquest pro 12 gram wire without support catheter, reentry through the stent in the distal true lumen was achieved(**Fig. 3**). Thereafter, dilation of the passage through the stent (Ryujin plus 1.5 × 15 mm, Terumo; Aqua 2.5 × 15 mm, Cordis; 15 atm)as well as dilation of the middle and distal left anterior descending artery was done, restoring distal flow(**Fig. 4**). Two Cypher stents(Cypher 3.0 × 33 mm, 22 atm; Cypher 2.5 × 23 mm, 20 atm, Cordis)were implanted with good final results(**Fig. 5**). Clinical follow-up was uneventful. The treadmill test(Bruce protocol, double product = 24,426)was done 6 weeks after the procedure and was subjectively and electrically negative.

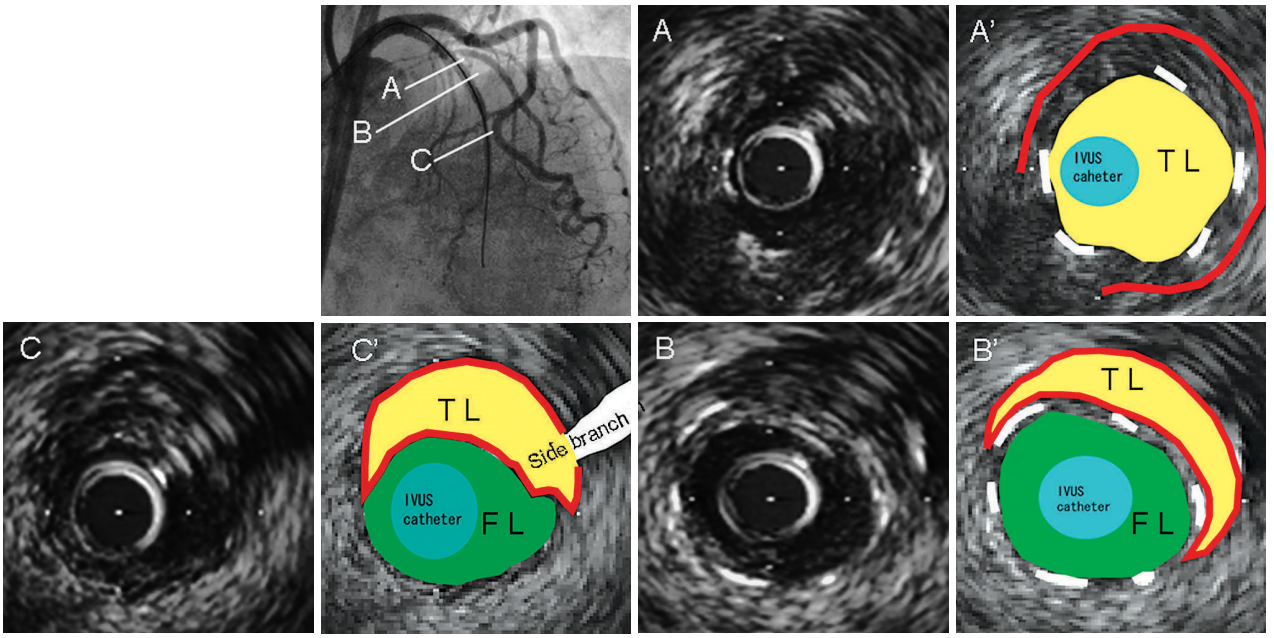

Fig. 2 Intravascular ultrasound recording after in-stent pre-dilation
The angiographic view (*upper left*, epicranial) shows the location of the corresponding IVUS frames.
A, *A'*: The proximal 6 mm of the implanted stent lies in the true lumen.
B, *B'*: The stent lies subintimally.
C, *C'*: Distal to the stent, we can see a side branch which is not connected with the false lumen where the IVUS catheter lies.
IVUS = intravascular ultrasound; TL = true lumen; FL = false lumen; red = external elastic membrane; yellow = true lumen; green = false lumen; blue = IVUS catheter.

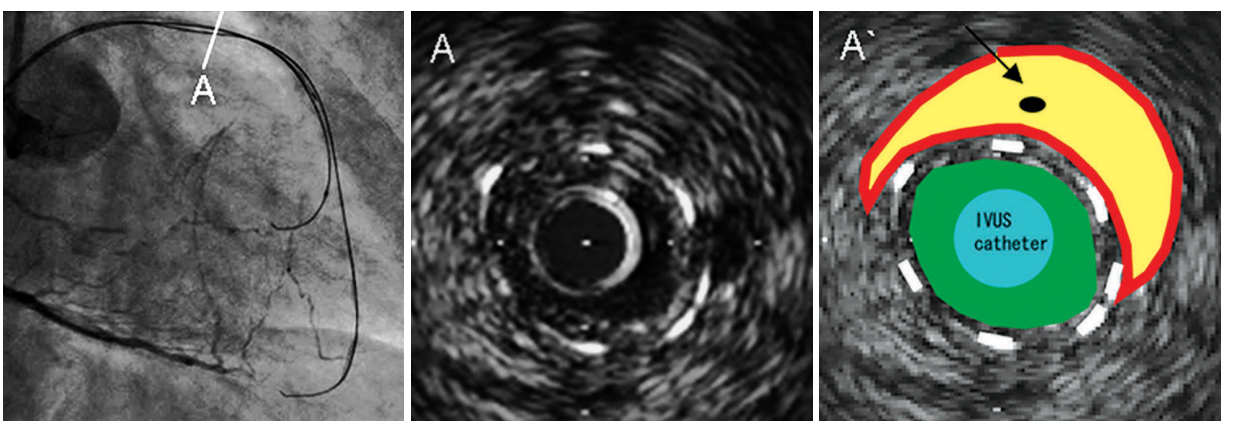

Fig. 3 Distal true lumen was reentered through the stent under IVUS guidance
The angiographic view (*left*, right anterior obligue 30/0) shows the first wire with the tip in a septal branch, with the IVUS catheter.
A, *A'*: The second wire lies in the distal true lumen. The IVUS frame shows the second wire (*arrow*) located in the true lumen.
Red = external elastic membrane; yellow = true lumen; green = false lumen; white = stent strut; black = second wire; blue = IVUS catheter. Oher abbreviation as in Fig. 2.

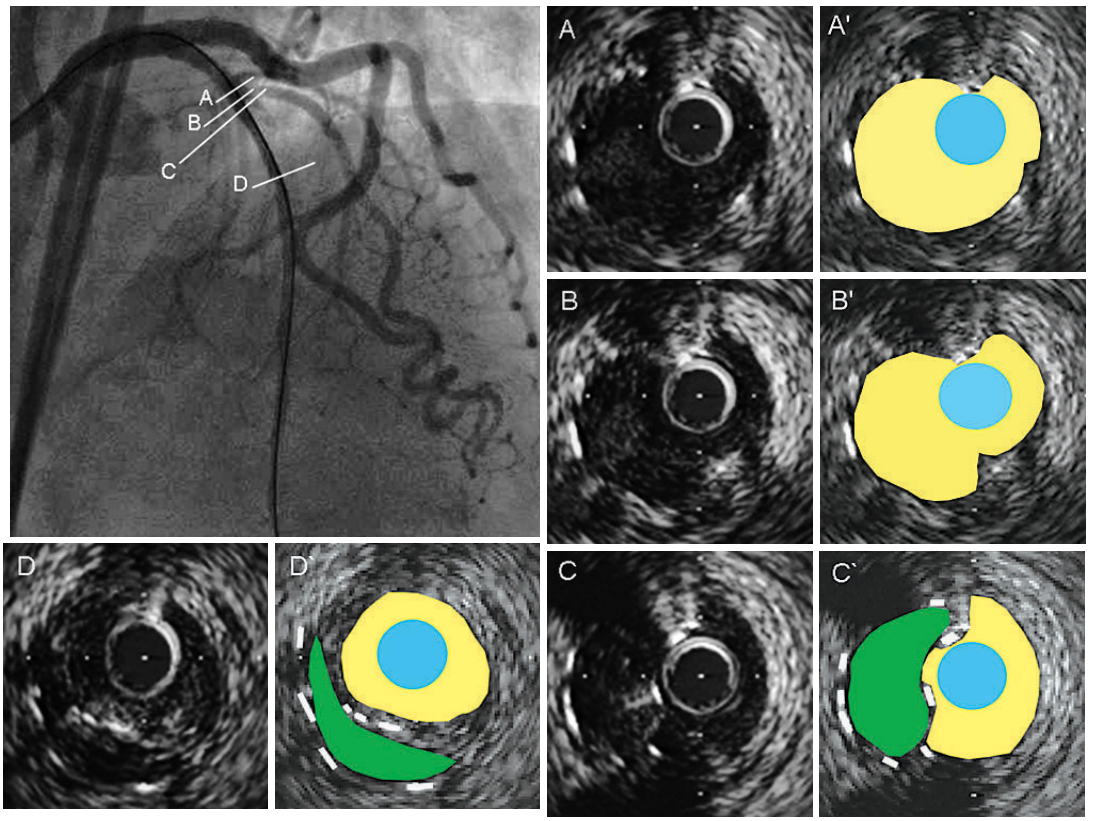

Fig. 4 Angiographic view (*upper left*, epicranial) and corresponding IVUS scan of the post balloon dilation of the passage through the stent in the distal true lumen

The angiogram shows the opacified true lumen separate from the stent and the four IVUS frames from proximal to distal illustrate the passage into the true lumen.

A, *A'* and *B*, *B'*: The IVUS catheter crosses through the stent struts.

C, *C'* and *D*, *D'*: The IVUS catheter lies in the true lumen, as demonstrated by the visualization of the surrounding vessel walls.

Yellow = true lumen; green = false lumen; white = stent strut; blue = IVUS catheter. Other abbreviation as in Fig. 2.

DISCUSSION

A successfully revascularized CTO confers a 10-year survival advantage compared to failed revascularization.[7] In the present case, a previous procedure had been unsuccessful and therefore coronary artery bypass grafting surgery or repeat PCI was an option. After discussion with the patient, the referring cardiologist opted for repeat PCI in a center specialized in the treatment of complex cases. After reviewing the coronary angiography and evaluating clinically the patient, we also selected PCI for this lesion as we thought the percutaneous procedure was still less invasive than surgery.

Despite the availability of a variety of guide wires and newer devices especially designed to cross CTO, the recanalization of CTO remains technically difficult with an overall success rate of about 80%.[7,8] Subintimal passage of the guide wire during recanalization is common and, if unrecognized, may lead to severe complications. Treating chronic total occlusion using subintimal tracking and reentry with subsequent stent implantation is feasible with a good end result.[9] The important characteristic of the subintimal tracking and reentry technique is that the subintimally implanted stent is a conduit leading from the proximal true lumen to the distal true lumen. In this case, a stent was implanted subintimally without reentry in the distal true lumen during first failed revascularization attempt.

The IVUS-guided technique have been shown to be safe and effective for helping reentering the distal true lumen after an initial wire enters a false

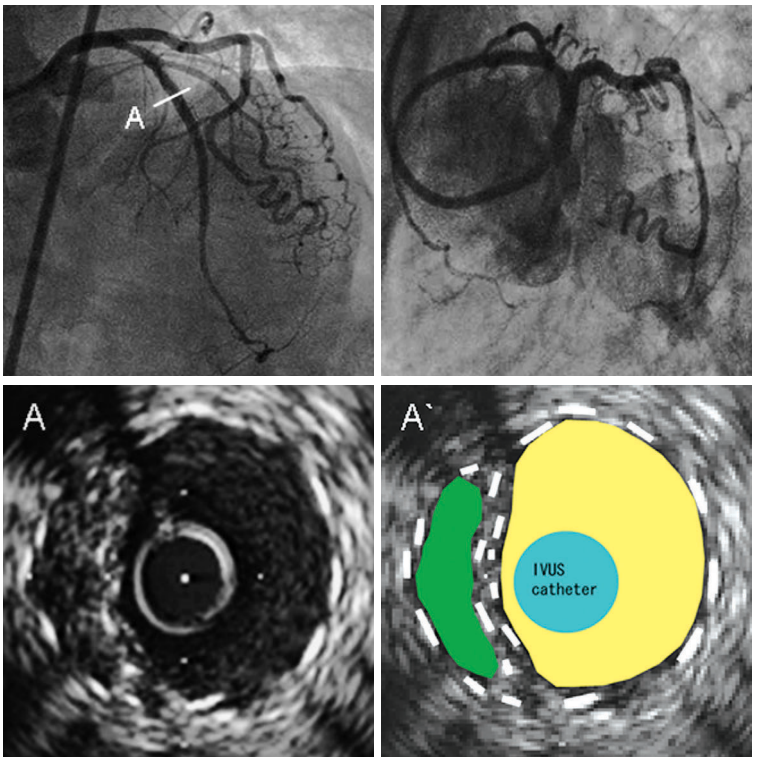

Fig. 5 Final angiographic results [epicranial (*upper left*) and spider (*upper right*) view]
A, A': The IVUS scan from inside the newly implanted stent show the compression of the previous stent implanted subintimally.
Yellow = true lumen ; green = false lumen ; white = stent strut ; blue = IVUS catheter. Other Abbreviation as in Fig. 2.

lumen. Although rare, the main potential complication is the risk of perforation due either to the manipulation of stiff wires or balloon pre-dilation in the false lumen. Such advanced technique should be therefore undertaken only by experienced interventionists skilled in pericardiocentesis and the management of cardiac tamponade.[4,6] In the present case, the false lumen was inside a stent, which means balloon pre-dilation and IVUS insertion was also performed inside the previously implanted stent. Therefore, the perforation risk in this setting was low.

The second procedure illustrates the utility of IVUS-guided technique for reentering the distal true lumen through a stent implanted subintimally. After unsuccessful reentry in the distal true lumen with the conventional wire technique and parallel wire technique, it was possible to locate the true lumen situated inside the stent with an IVUS catheter inserted in the stent, so guiding the manipulation of a second wire through the stent struts into the true lumen. The present case illustrates the use of the IVUS-guided technique for reentering the true lumen through an occluded stent located subintimally.

要　　約

慢性完全閉塞病変偽腔に植え込まれたステント不成功例での血管内エコーガイドによる再疎通

Jean-Francois SURMELY　　鈴木　孝彦

慢性冠動脈閉塞症の経皮的再疎通の成功は，改善された生存率（強化された左室機能，狭心症の減少と高められた運動耐性と同様に）に帰着する．手順の成功率は時の経過とともに高くなったが，いまだ20％の慢性冠動脈閉塞症再疎通の試みが不成功に終わっている．慢性冠動脈閉塞症へのさまざまな治療と特定のデバイスは，成功時の過程において開発されてきた．我々は，慢性冠動脈閉塞症病変で偽腔内へステント植え込みがなされ，再疎通が得られなかった不成功例に対して，血管

内エコーガイド下でステントストラットを通し，ステントによって圧迫されたガイドワイヤーを遠位真腔に再入し，通常の血流を回復した．

J Cardiol 2006 Aug; 48(2): 95−100

References

1) Bourassa MG, Roubin GS, Detre KM, Sopko G, Krone RJ, Attabuto MJ, Bjerregaad P, Bolling S, Herman MV, Frye R: Bypass Angioplasty Revascularization Investigation: Patient screening, selection, and recruitment. Am J Cardiol 1995; **75**: 3C−8C
2) King SB Ⅲ, Lembo NJ, Weintraub WS, Kosinski AS, Barnhart HX, Kutner MH, Alazraki NP, Guyton RA, Zhao XQ: A randomized trial comparing coronary angioplasty with coronary bypass surgery: Emory Angioplasty versus Surgery Trial(EAST). N Engl J Med 1994; **331**: 1044−1050
3) Kinoshita I, Katoh O, Nariyama J, Otsuji S, Tateyama H, Kobayashi T, Shibata N, Ishihara T, Ohsawa N: Coronary angioplasty of chronic total occlusions with bridging collateral vessels: Immediate and follow-up outcome from a large single-center experience. J Am Coll Cardiol 1995; **26**: 409−415
4) Ito S, Suzuki T, Ito T, Katoh O, Ojio S, Sato H, Ehara M, Suzuki T, Kawase Y, Myoishi M, Kurokawa R, Ishihara Y, Suzuki Y, Sato K, Toyama J, Fukutomi T, Itoh M: Novel technique using intravascular ultrasound-guided guidewire cross in coronary intervention for uncrossable chronic total occlusions. Circ J 2004; **68**: 1088−1092
5) Kimura BJ, Tsimikas S, Bhargava V, DeMaria AN, Penny WF: Subintimal wire position during angioplasty of a chronic total coronary occlusion: Detection and subsequent procedural guidance by intravascular ultrasound. Cathet Cardiovasc Diagn 1995; **35**: 262−265
6) Matsubara T, Murata A, Kanyama H, Ogino A: IVUS-guided wiring technique: Promising approach for the chronic total occlusion. Catheter Cardiovasc Interv 2004; **61**: 381−386
7) Suero JA, Marso SP, Jones PG, Laster SB, Huber KC, Giorgi LV, Johnson WL, Rutherford BD: Procedural outcomes and long-term survival among patients undergoing percutaneous coronary intervention of a chronic total occlusion in native coronary arteries: A 20-year experience. J Am Coll Cardiol 2001; **38**: 409−414
8) Olivari Z, Rubartelli P, Piscione F, Ettori F, Fontanelli A, Salemme L, Giachero C, Di Mario C, Gabrielli G, Spedicato L, Bedogni F, for the TOAST-GISE Investigators: Immediate results and one-year clinical outcome after percutaneous coronary interventions in chronic total occlusions: Data from a multicenter, prospective, observational study(TOAST-GISE). J Am Coll Cardiol 2003; **41**: 1672−1678
9) Colombo A, Mikhail GW, Michev I, Iakovou I, Airoldi F, Chieffo A, Rogacka R, Carlino M, Montorfano M, Sangiorgi GM, Corvaja N, Stankovic G: Treating chronic total occlusions using subintimal tracking and reentry: The STAR technique. Catheter Cardiovasc Interv 2005; **64**: 407−411; discussion 412