

혈관내초음파로 평가한 스텐트를 삽입한 관동맥의 형태학적 특징

정남식 · 홍범기 · 임세중 · 백성일 · 이문형
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= Abstract =

Morphological Characteristics of Intimal Hyperplasia in Stented Coronary Arteries Assessed with Intravascular Ultrasound

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Background : Intravascular ultrasound (IVUS) provides high resolution cross-sectional images of the vessels and permits the quantitative and qualitative assessment of coronary artery disease. Stent is a rigid endovascular lattice that effectively prevents elastic recoil at treated sites, but in-stent restenosis is a major limitation. The purpose of the current study is to assess the contribution of neointimal hyperplasia for in-stent restenosis and the distribution and morphological characteristics of neointimal hyperplasia in deployed stents.

Methods : Thirty patients (male 25 & female 5 ; 31 lesions) deployed with intracoronary stents underwent intravascular ultrasound imaging at follow-up at least 4 months after stenting ([mean \pm SD] 8.3 \pm 2.9 months).

Results :

1) In-stent restenosis occurred in 15 lesions out of 31 lesions at follow-up coronary angiography. There was no difference in clinical characteristics between the restenotic and the non-restenotic groups.

2) There was no difference in angiographic profiles between two groups. Deployed stents were as follows ; 16 Palmaz-Schatz (P-S) stents, 12 Gianturco-Roubin (G-R) stents, 2 Cordis stents, and 1 Microstent II. Average diameter of stents in the restenotic and the non-restenotic groups were 3.07 \pm 0.26mm and 3.16 \pm 0.30mm, respectively ($p = 0.38$).

3) There was no difference of stent cross-sectional areas (CSA) between the non-restenotic and the restenotic groups ($p = 0.476$), but luminal CSA of the restenotic group was significantly smaller than that of the non-restenotic group ($p = 0.006$).

4) In the restenotic group, there were no differences of the maximal and the minimal diameters of

stents, and the mean CSAs of stents among proximal, mid, and distal segments. But the mean CSA of neointimal hyperplasia at the mid segment was larger than that at the distal segment ($p < 0.05$). There was a tendency that the mean CSA of neointimal hyperplasia at the mid segment was larger than that at the proximal segment ($p = 0.187$). These findings were the same in the non-restenotic group.

5) In the restenotic group deployed with P-S stents, there were no differences of the maximal and the minimal diameters of stents, and the mean cross-sectional areas(CSA) of stents between each segment. But, the mean CSA of neointimal hyperplasia at the mid segment was larger than that at the distal segment ($p < 0.05$) and there was a tendency that the mean CSA of neointimal hyperplasia at the mid segment was larger than that at the proximal segment ($p = 0.354$).

6) In the morphology of neointimal hyperplasia of the restenotic group, eccentric form(77%) was more common than concentric form(22%). Neointimal hyperplasia occurred in focal or diffuse patterns(7 versus 8 cases).

Conclusions : In-stent restenosis resulted from neointimal hyperplasia which almost mainly occurred eccentrically at the mid segment of stents and in focal or diffuse patterns. Intravascular ultrasound imaging was a useful method for recognition of distribution and morphological characteristics of neointimal hyperplasia at follow-up of deployed stents.

KEY WORDS : Intravascular ultrasound · Stent restenosis · Neointimal hyperplasia.

서 론

1) (real - time)

2) 6)

3) 1,2) 가가 , 가

4) 7)

5) 가 (intravascular ultrasound, IVUS)가

6) modeling) 가 (coronary re - 가

7) 5) 8) 가

8) 9,10) (stent)

(balloon - expandable) Schatz BENESTENT
 11,12) 20 30% Hoffmann
 (neointimal hyperplasia) 13) Hoffmann
 Palmaz - Schatz

ican Heart Association(ACC/AHA)
 14)
 2) 관동맥 풍선성형술 및 스텐트 삽입술 (reference artery) 50% 70%
 de novo(elective stenting), (intimal dissection) 가
 (40%)
 Palmaz - Schatz stent TM(Johnson & Johnson Interventional Systems, Warren, NJ, U.S.A.), Gianturco - Roubin stent TM(Cook cardiology, A division of Cook Inc., Bloomington, IN, U.S.A.), Microstent II TM(Arterial Vascular Engineering Inc., Santa Rosa, CA, U.S.A.) Cordis stent TM(Cordis Co., Miami, FL, U.S.A.)
 20% 21 가

연구 대상 및 방법

1. 대상 환자

1994 10 1996 2
 4 (8.3 ± 2.9)
 25 , 5 , 31)

2. 방 법

1) 관동맥조영술

Seldinger sheath 2,000 heparin 5 French(F)
 (diagnostic catheter)

3) 관동맥내 초음파

4 가
 50%
 30MHz 2.9F MicroView TM
 3.2F MicroRail™(Cardiovascular imaging systems, Inc. Sunnyvale, CA, U.S.A.)
 (coronary imaging catheter)

sheath heparin 8,000
 가 8F (guiding catheter)
 가 0.014 - 0.018 -
 in (ni -
 troglycerin) 200 µg
 monorail
 가 가

American College of Cardiology/Amer -

가
 (hand pull - back)
 super VHS videotape
 fluoroscopy

4) 관동맥내 초음파영상의 정량분석
 Computer assisted planimetry

(cross - sectional area, CSA)
 (Fig.)

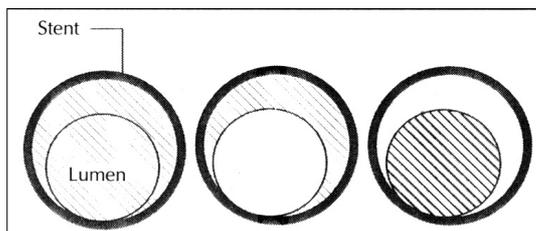


Fig. 1. Schematic intravascular ultrasound view of cross sectional structures of stented coronary arteries. The outer thick & inner thin circles represent stent struts(stent cross sectional area(CSA)) and perimeter of neointimal hyperplasia/blood interface(lumen CSA), respectively. The CSA of neointimal hyperplasia is calculated from the difference between stent CSA and lumen CSA.

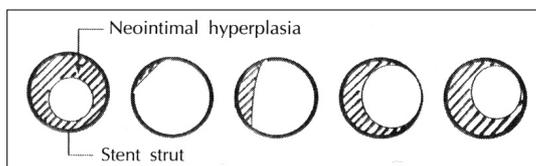


Fig. 2. Morphological characteristics of neointimal hyperplasia classified into concentric(C) and eccentric(E) forms. Eccentric forms are further classified into E1, E2, E3, and E4 according to the arc of neointimal hyperplasia in degree as follows ; E1 : less than 90° ; E2 : more than 90° and less than 180° ; E3 : more than 180° and less than 270° ; E4 : more than 270° and less than 360°

1).
 (conc -
 entric form)
 (eccentric form)
 90° (E1), 90°
 180° (E2), 180° 270° (E3)
 270° 360° (E4) (Fig.
 2).

(focal form)
 (diffuse form)

5) 통계분석

±
 WIN SPSS PC paired
 t - test Chisquare test
 p - value가 0.05 가

결 과

1. 스텐트 재협착 및 비재협착군의 임상적 특성과 관동맥조영 소견 및 스텐트 삽입에 대한 결과 분석

8.3 ± 2.9 (4.3 15.3)
 56.0 ± 9.8 (32
 76)
 (15 , 16)
 15

가 (Table 1).
 10.1 (0 19)
 1 ()
 (Palmaz - Schatz)
 11 (IRA, Infa -
 rct - related artery)

1 7 , 2 6 3
 2 , 1 2 , 2

6 () 3 2 .
 (target artery)
 (left anterior descending artery)
 11 (), (left circumflex artery) 1
 (right coronary artery) 3 ,
 10 ,
 1 5 . target
 89.4%
 86.9% 가 . ACC/

Table 1. Clinical characteristics in the restenotic versus the non-restenotic group

	Restenosis	Non-restenosis
Age (years)	56.0 ± 9.8	54.6 ± 9.4
Sex (M : F)	14 : 1	11 : 4
Follow-up duration (months)	8.3 ± 2.9	8.0 ± 3.2
Type of ischemic heart disease (lesion)		
AMI with thrombolysis	1	3
AMI without thrombolysis	3	4
Recent MI		2
Angina pectoris, stable	3	2
Angina pectoris, unstable	8	5

AMI : Acute myocardial infarction

Table 2. Coronary angiographic findings in the restenotic versus the non-restenotic group before stent deployment

	Restenosis	Non-restenosis
Extent of coronary artery disease		
1 VD	7	7
2 VD	6	72
3 VD	2	
Target lesion for stent deployment		
LAD	11	10
LCX	1	1
RCA	3	5
Lesion characteristics ¹		
A	1	4
B1	7	5
B2	5	5
C	2	2

VD : Vessel disease

LAD : Left anterior descending artery

LCX : Left circumflex artery

RCA : Right coronary artery

1 : Classified by ACC/AHA Task Force criteria

AHA 1 A 4
 A
 (Table 2).
 ,
 bail - out 7 ,
 (elective)
 6 ,
 가 3 ,
 (elective) bail - out
 7 , 8
 (Table 3).

Palmaz - Schatz Gi -
 anturco - Roubin 가
 P - S 16 10 , G - R 12
 5 .
 3.0mm가 가
 3.07 ± 0.26mm
 3.16 ± 0.30mm
 가 (p=0.383). 가
 (adjuvant high pressure balloon inflation)

Table 3. Indications of coronary stenting

	Restenosis	Non-restenosis
Bail-out	7	7
Suboptimal result	8	6
Elective		3

Table 4. Types and diameters¹ of deployed stents in the restenotic versus the non-restenotic group

	Restenosis	Non-restenosis
Stent type		
Palmaz-Schatz	10	6
Gianturco-Roubin	5	7
Cordis		2
Micro II		1
Stent diameter ¹ (mm)		
2.5	1	
3.0	11	12
3.5	3	3
4.0		1
Mean	3.07 ± 0.26	3.16 ± 0.30

1 : Diameter at nominal balloon pressure of each stent

Table 7. Intravascular ultrasound analysis according to stent segments in the restenotic group deployed with Palmaz-Schatz stent

Stent segment	Diameter of stent ¹		Stent CSA ²	Lumen CSA	Neointimal hyperplasia CSA ³
	Maximal	Minimal			
Proximal	2.9 ± 0.3	2.7 ± 0.2	6.0 ± 1.1	4.1 ± 1.7	1.9 ± 1.8
Mid	2.8 ± 0.3	2.7 ± 0.3	6.0 ± 1.4	3.5 ± 1.4*	2.6 ± 1.5**
Distal	2.9 ± 0.3	2.7 ± 0.3	6.0 ± 1.3	5.2 ± 1.4*	0.8 ± 1.1**

1 : Diameter of stent(mm) 2 : CSA : Cross-sectional area(mm²) 3 : Neointimal hyperplasia CSA = Stent CSA-Lumen CSA
* : &, ** : p<0.05, in-stent mid versus distal segment

Table 8. Intravascular ultrasound analysis according to stent segments in the restenotic group deployed with Gianturco-Roubin stent

Stent segment	Diameter of stent ¹		Stent CSA ²	Lumen CSA	Neointimal hyperplasia CSA ³
	Maximal	CSA ²			
Proximal	3.1 ± 0.5	3.0 ± 0.4	6.9 ± 2.3	5.2 ± 2.3	1.7 ± 2.5
Mid	3.1 ± 0.2	2.9 ± 0.2	6.7 ± 1.0	2.6 ± 0.6	4.2 ± 1.1*
Distal	3.1 ± 0.5	3.0 ± 0.2	6.3 ± 0.8	5.1 ± 1.7	1.3 ± 2.5*

1 : Diameter of stent(mm) 2 : CSA : Cross-sectional area(mm²) 3 : Neointimal hyperplasia CSA = Stent CSA-Lumen CSA
* : p<0.05, in-stent mid versus distal segment

(, p=0.354 ; , p=0.003 ; , p=0.119).
(Table 7).

(2) Gianturco - Roubin
Gianturco - Roubin(G - R)

5 (Table 4),
1 (an -
rysmal change)가

. 4 가
가
(, p=0.061 ; , p=0.090 ; , p=0.952).
가 ,

가
(, p=0.134 ; , p=0.038 ; , p=0.800). , G - R

Table 9. Morphological characteristics of neointimal hyperplasia according to stent segments in the restenotic group

Stent segment	C	E1	E2	E3	E4	N
Proximal	1		3	1	3	7
Mid	5		2	3	4	1
Distal			3	1		11

C : concentric form of neointimal hyperplasia
E : eccentric form of neointimal hyperplasia ;
classified by the arc of neointimal hyperplasia
in degree as follows ;
E1 : the arc of neointimal hyperplasia < 90 °
E2 : 90 ° the arc of neointimal hyperplasia < 180 °
E3 : 180 ° the arc of neointimal hyperplasia < 270 °
E4 : 270 ° the arc of neointimal hyperplasia < 360 °
N : No neointimal hyperplasia

Table 10. Patterns of neointimal hyperplasia in the restenotic group

Pattern ¹	Stent type		Total
	Palmaz-Schatz	Gianturco-Roubin	
Focal	4	3	7
Diffuse	6	2	8

1 : Number of in-stent segment(s) involved with neointimal hyperplasia ; one : focal pattern two : diffuse pattern

(Table 8).

3) 스텐트내 신생내막증식의 형태학적 특징

90 °
45
(15 3 /) 26

form) 6 (23%) (concentric form) 6.50 ± 1.44mm² vs 20 (77%) (eccentric form) 6.17 ± 1.08mm², p=0.476 (0.88 ± 1.03mm² vs 1.92 ± 1.12 mm², p=0.013) (Table 9).

focal pattern)가 7 (diffuse pattern)가 8 . Palmaz - Schatz (16 60%(6 /10) , Gianturco - Rouin 10 , 0.5 1.3mm²) , 60% (Table 10). recoil 가

고 안

가 (15,16) . 24,25) . 가 가

(contractile form) (synthetic form) (phenotypic modulation), Palmaz - Schatz (central articulation portion) . Palmaz - Schatz basic Fibroblast Growth Factor(bF - GF), Platelet - Derived Growth Factor(PDGF), Tr - ansforming Growth Factor - (TGF -), protease angiotensin II(AII) (growth factor) cytokine (coll - agen) 26,27) .

17 - 19) . 15 P - S 1 가 가 14 20) . 0.2mm

(axial) 0.1mm , (lateral) 0.25mm 가 21) . 가 가 coil Gianturco - Roubin 22,23) .

가 가 , (expansion) (apposit - ion) .

가 , Nakamura recoil . ,

가 , 4 re - coil . , (1mm/ 28) . sec) automatic pullback device가

(77%) , (7) , (8) . Palmaz - Sc - hatz 가 fluoroscope 가 . , 4 6 20 10 (Dussailant , 54) 가 . 27) .

가 (burden)가 , 연구배경 : (intravascular ultrasound, IVUS) anturco - Roubin 가 29) . Gi - (3) (2) , 가 .

(echo reflectance) 가 . (hard atheroma) (soft signal) (soft atheroma) 가 .

30) . 8 방 법 : 1994 10 1996 2

연구의 제한점 가 , 4 30 (25 , 5 , 31) . 결 과 : 가 가 1) 15 ,

16 , , 가 .

2) target (extent),
 target Palmaz -
 Schatz(P - S) 16 , Gianturco - Roubin(G - R) 12 ,
 Cordis 2 Microstent II 1 P - S G - R
 가 90% .
 3.07 ± 0.26mm 3.16 ± 0.30
 mm 가 (p = 0.38).
 3) 가 (p = 0.476)
 (p = 0.006).
 4) 가 .
 가
 (p < 0.05), (p = 0.187)
 ,
 5) Palmaz - Schatz 가
 ,
 (p < 0.05), (p = 0.354)
 6) (77%) (23%) ,
 7 8
 .
 결 론 :
 ,
 ,
 .

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