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# Reduced vessel wall stretch after directional atherectomy prior to stent deployment. An intravascular ultrasound evaluation of the mechanisms of lumen enlargement

## Redukcja stopnia naprężenia ściany naczynia po zabiegu aterektomii kierunkowej z następczą implantacją stentu. Ultrasonograficzna ocena mechanizmów powiększenia światła naczynia

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**Abstract**

**Background:** *It has emerged from a number of prospective non-randomised trials that directional coronary atherectomy (DCA) before stenting reduces the risk of in-stent restenosis. The aims of the study were to determine the mechanism of lumen enlargement after stenting preceded by DCA by using 3-D intravascular ultrasound (IVUS), to compare this method with stenting after balloon predilation and to assess whether vessel stretching influences late restenosis.*

**Material and methods:** *A total of 20 patients treated with DCA followed by stenting (Group 1) and 30 patients who had undergone stenting preceded by balloon angioplasty (Group 2) were studied with serial IVUS examinations. Volumetric pre-intervention and post-stenting assessments of the external elastic membrane (EEM), lumen and the plaque cross-sectional area were performed on the entire stent length and the proximal and distal reference segments. The EEM stretch index was calculated as the difference between the EEM post stent and the pre-intervention EEM. Axial plaque shift (APS) was calculated as the mean change in plaque volume measured in both the reference segments. During the 6-month follow-up period angiography was performed on all the patients.*

**Results:** *Although there were no differences in the composition of the 2 groups, the increase in EEM area was significantly smaller in Group 1 than in Group 2 (3.05 ± 0.8 mm$^2$ vs. 4.28 ± ± 1.98 mm$^2$, respectively, $p < 0.001$). The EEM stretch index was significantly smaller in Group 1 than in Group 2 (0.28 ± 0.12 vs. 0.61 ± 0.29, respectively, $p < 0.001$). Axial plaque shift in the reference segments was significantly reduced in Group 1. Follow-up angiography revealed in-stent restenosis in 10.0% of Group 1 vs. 23.3% of Group 2, $p$ = NS.*

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**Conclusion:** *Intravascular ultrasound has shown that plaque removal by means of DCA prior to stent implantation reduces vessel stretch and plaque shift at the stent margins. This mechanism appears to slow down the in-stent restenosis process.* (Folia Cardiol. 2004; 11: 903–912)

**directional atherectomy, stent, intravascular ultrasound**

## Introduction

The mechanisms of lumen enlargement after stenting have already been defined [1–3]. Stent implantation leads to lumen enlargement through 3 different mechanisms: vessel expansion, axial plaque redistribution and plaque compression/embolisation [1]. Vessel expansion is the most important mechanism leading to an increase in lumen area regardless of the stenting technique (direct stenting or stenting preceded by balloon angioplasty) [2].

The adjunctive use of plaque removal by directional coronary atherectomy (DCA) proved to be an efficient technique for the reduction of stent restenosis [4, 5]. However, the mechanism of lumen enlargement obtained with the synergistic approach of plaque ablation with DCA plus stenting has not yet been elucidated.

The aim of the present intravascular ultrasound (IVUS) study was to compare the mechanism of lumen enlargement obtained after stenting preceded by DCA and balloon-dilatation.

## Material and methods

### Patient selection

Between January 2000 and November 2001 more than 350 patients underwent coronary stenting in our institutions preceded either by balloon dilatations or directional coronary atherectomy. Out of this population 50 patients were included in the study as having fulfilled the following angiographic inclusion criteria: lesion length up to 16 mm at quantitative coronary angiography, no significant side branches originating in the segment to be stented, absence of calcifications on angiography and the use of intravascular ultrasound to achieve an optimal result.

The 20 patients who underwent stenting after DCA (Group 1) were compared with 30 patients who underwent stent implantation after balloon predilation (Group 2). The patients in each group were selected according to the above inclusion criteria. The MUSIC trial criteria [6] had to be fulfilled. The two groups were similar with regard to demographic, clinical, angiographic and ultrasonographic characteristics.

The following types of stent were implanted: in Group 1 — Multilink stents (Guidant Co., Santa Clara, CA) in 90.4% cases, S670 stents (Medtronic AVE, Santa Rosa, CA) in 9.6%; in Group 2 — Multilink stents 68.1% and JoFlex stents (JOMED Gmbh, Sweden) in 31.9%. Baseline and angiographic characteristics are presented in Tables 1 and 2.

### Procedure and IVUS acquisition

All the patients underwent the procedure with femoral access, using guiding catheters of diameters ranging from 8 to 10 Fr in Group 1 and 6 to 7 Fr in Group 2. The patients were administered acetylsalicylic acid (300 mg/24 h) and 500 mg/24 h

**Table 1.** Patient population

**Tabela 1.** Populacja badana

| | Group 1 stenting with DCA (n = 20) | Group 2 stenting with predilation (n = 30) | p |
|---|---|---|---|
| Age (years) | 55.9 ± 11.6 | 56.0 ± 8.71 | NS |
| Male | 85.8% | 78.7% | NS |
| Diabetes | 9.5% | 11.0% | NS |
| Smoking | 47.6% | 49.0% | NS |
| Previous MI | 33.3% | 48.0% | NS |
| Vessel treated/Left anterior descending artery | 17 (85%) | 17 (57%) | NS |
| Left circumflex artery | 1 (5%) | 6 (20%) | NS |
| Right coronary artery | 2 (10%) | 7 (23%) | NS |

**Table 2.** Angiographic, IVUS and clinical characteristics for each of the groups studied
**Tabela 2.** Angiograficzna, ultrasonograficzna i kliniczna charakterystyka obu badanych grup

| | Group 1 stenting with DCA (n = 20) | Group 2 stenting with predilation (n = 30) | p |
|---|---|---|---|
| **Prior QCA measurements** | | | |
| MLD [mm] | 0.99 ± 0.26 | 1.10 ± 0.48 | NS |
| Ref. D. [mm] | 3.30 ± 0.37 | 3.24 ± 0.51 | NS |
| % DS | 73.1 ± 15.4% | 68.8 ± 11.7% | NS |
| Lesion length [mm] | 10.9 ± 2.4% | 9.7 ± 2.1 | NS |
| **QCA measurements post stenting** | | | |
| MLD [mm] | 3.59 ± 0.36 | 3.35 ± 0.52 | NS |
| Ref. D. [mm] | 3.52 ± 0.25 | 3.54 ± 0.58 | NS |
| % DS | 4.12 ± 2.41% | 5.47 ± 3.14% | NS |
| Stent size [mm] | 3.77 ± 0.39 | 3.79 ± 0.51 | NS |
| Stent length [mm] | 14.9 ± 1.4 | 13.5 ± 4.11 | NS |
| Max. balloon pressure (atm) | 14.4 ± 3.79 | 13.9 ± 2.5 | NS |
| DCA cuts | 9 ± 3 | – | – |
| **Plaque characteristics** | | | |
| Soft | 21% | 24% | NS |
| Mixed | 58% | 53% | NS |
| Hard | 21% | 23% | NS |

of ticlopidine 48 hours before the procedure. After the insertion of the arterial sheath each patient received heparin (70–100 IU/kg). An additional bolus was given to maintain an activated clotting time (ACT) > 250 s.

In Group 1 the DCA procedures were performed using a 7 Fr Simpson GTO AtheroCath in 14 cases and a Flexicut (Guidant, Santa Rosa, CA, USA) in 7 patients. The mean number of DCA cuts was 9 ± 3. The stenting procedure in Group 2 was carried out using the conventional predilation technique and post dilatation if necessary. The interventions were carried out with IVUS guidance and the MUSIC criteria of optimal stent expansion were applied [6]. Intravascular ultrasound criteria were used, however, to define the optimal result of directional atherectomy in Group 1. The residual plaque burden was less than 50%. In Group 2 the optimal result of balloon angioplasty was the achievement of more than 6.0 mm$^2$ of the lumen area without significant dissections.

The IVUS images were recorded after the administration of 200 $\mu$g of i.c. nitroglycerin with a commercially available mechanical system (Boston Scientific Co, Natwitch, MS, USA) using 30 or 40 MHz imaging catheters (Ultracross and Atlantis). After the target vessel had been wired, the ICUS catheter was advanced more than 3 cm distal to the lesion and pulled back at a speed of 0.5 mm/s until the guiding catheter was reached. The intravascular ultrasound examinations were performed before intervention, after the last DCA attempt (in Group 1) or the last balloon dilatation (in Group 2) and after stent implantation in both groups.

## Off-line QCA and IVUS analyses

Off-line quantitative coronary angiography (QCA) analyses were performed at the European Imaging Laboratory by 2 technicians who were unaware of the IVUS measurements. Angiographic measurements were performed with a computer-assisted system using an automated edge detection algorithm (MEDIS Co, Eindhoven, Netherlands) as previously described [7–9].

Quantitative 3-D IVUS reconstruction was performed using a semi-automated algorithm of contour detection (EchoScan, TomTec, Munich, Germany) [10]. On the basis of reproducible arterial landmarks such as side-branches, calcium deposits and the aortocoronary junction, the same arterial segments were identified at each step of the interventional procedure; A) prior to intervention, B) post DCA or post balloon angioplasty, C) post stenting and final dilation. The arterial segment analysed by IVUS encompassed the stented segments and 5 mm of the proximal and distal reference segments.

Data from the 3-D reconstruction was presented as means and included minimal lumen area (LA), total vessel area bordered by the external elastic membrane (EEM) and plaque area (PA). The last of these was measured as plaque + media area in all procedures recorded both in the stented segment and the reference segments. The differences in mean lumen area, plaque area and EEM area between the procedural steps were calculated.

On the basis of serial IVUS assessments the EEM stretch index was calculated using the following formula: EEM = EEM post stenting – EEM pre-intervention/EEM pre-intervention.

Reference segment plaque shift was calculated for those stents with a length of 13 mm as the mean change in plaque volume measured in the segments 5 mm proximally and distally from the stent edges.

Qualitative plaque characteristics were defined as follows: soft (with an echodensity lower than that of the adventitia), hard/calcified (with an echodensity higher than that of the adventitia and producing an acoustic shadow of more than 90°) and mixed. Plaques with more than 45° of circumferential superficial calcium were excluded from the analysis.

### Follow-up assessment

Patients underwent clinical and angiographic follow-up studies between 5 and 6 months after the initial procedure. In-stent restenosis was considered if the percentage reduction in vessel diameter was > 50% at quantitative coronary angiography.

### Statistical analysis

Statistical analysis was performed using STATISTICA 5.1 software (Stat Soft Co.). Continuous variables are expressed as mean ± standard deviation (SD). A two-tailed *t* test was used for continuous variables. A linear regression was performed to compare the study data. A value of $p < 0.05$ was considered statistically significant.

## Results

The demographic, clinical, angiographic and IVUS characteristics and the procedural data were similar for the two groups.

Table 3 and Figure 1A show the results obtained after DCA in Group 1 and after balloon predilation in Group 2, both before stent positioning. The use of DCA led to a significantly smaller residual plaque burden in comparison with balloon angioplasty. Conversely, the EEM area was similar in the two groups. Figure 1A provides additional evidence that a greater reduction in plaque burden can be achieved using DCA. The optimal IVUS result of DCA in Group 1 has been achieved in 70% of cases to date and the optimal balloon angioplasty result in 60% of cases (p = NS, between groups)

After stent implantation (Tab. 3, Fig. 1B) the lumen area was larger in Group 1, although the difference was not statistically significant. A large increase in lumen area was achieved in Group 2 but this led to a further enlargement of the EEM area (Fig. 1B). Figure 1C depicts the changes obtained in vessel and lumen dimensions with a comparison of the pre-intervention and post-stenting (final) assessments. DCA led to a significantly greater

**Table 3.** Intravascular ultrasound measurements

**Tabela 3.** Pomiary ultrasonografii wewnątrzwieńcowej

| | Baseline | | Post DCA or balloon | | Post stenting | |
|---|---|---|---|---|---|---|
| **Proximal reference** | **Group 1** | **Group 2** | **Group. 1** | **Group 2** | **Group 1** | **Group 2** |
| Mean EEM [mm²] | 15.6 ± 3.8 | 15.5 ± 4.4 | 15.9 ± 4.1 | 16.4 ± 4.6 | 16.3 ± 4.2 | 16.8 ± 5.1 |
| Mean LA [mm²] | 10.0 ± 3.3 | 10.8 ± 4.6 | 10.0 ± 3.4 | 10.5 ± 4.1 | 9.9 ± 3.5 | 10.2 ± 3.4 |
| Mean PA [mm²] | 5.5 ± 1.2 | 4.7 ± 4.3 | 5.9 ± 3.7 | 5.9 ± 2.8 | 6.3 ± 1.6 | 6.6 ± 2.7 |
| Plaque burden (%) | 36.4 ± 12.2 | 32.5 ± 14.5 | 37.4 ± 12.2 | 35.9 ± 11.5 | 38.6 ± 13.4 | 39.0 ± 12.8 |
| **Lesion** | | | | | | |
| Mean EEM [mm²] | 14.3 ± 2.9 | 14.8 ± 5.1 | 16.6 ± 3.0 | 16.9 ± 5.7 | 17.4 ± 4.1 | 19.1 ± 5.2 |
| Mean LA [mm²] | 4.9 ± 0.7 | 4.5 ± 1.2 | 9.8 ± 1.7 | 7.7 ± 4.8 | 12.0 ± 3.0 | 10.8 ± 4.1 |
| Mean PA [mm²] | 9.4 ± 2.4 | 10.2 ± 4.2 | 6.7 ± 1.5* | 9.1 ± 3.6 | 5.2 ± 1.2* | 8.2 ± 4.8 |
| Plaque burden (%) | 65.5 ± 18.7 | 69.5 ± 16.4 | 40.7 ± 11.5* | 54.1 ± 9.4 | 29.9 ± 8.4* | 43.2 ± 10.5 |
| **Distal reference** | | | | | | |
| Mean EEM [mm²[ | 12.2 ± 3.2 | 12.1 ± 5.5 | 12.8 ± 3.1 | 12.2 ± 4.9 | 12.9 ± 3.3 | 13.1 ± 5.2 |
| Mean LA [mm²[ | 7.5 ± 1.7* | 6.0 ± 2.4 | 7.4 ± 0.2* | 5.9 ± 2.5 | 7.4 ± 1.8* | 5.7 ± 2.1 |
| Mean PA [mm²[ | 4.7 ± 1.9* | 6.1 ± 2.6 | 5.3 ± 2.0* | 6.3 ± 2.1 | 5.5 ± 2.1* | 7.3 ± 3.4 |
| Plaque burden (%) | 32.6 ± 11.4 | 50.4 ± 16.4 | 41.5 ± 11.8 | 51.9 ± 14.8 | 42.6 ± 18.4 | 56.1 ± 17.5 |

*$p < 0.05$

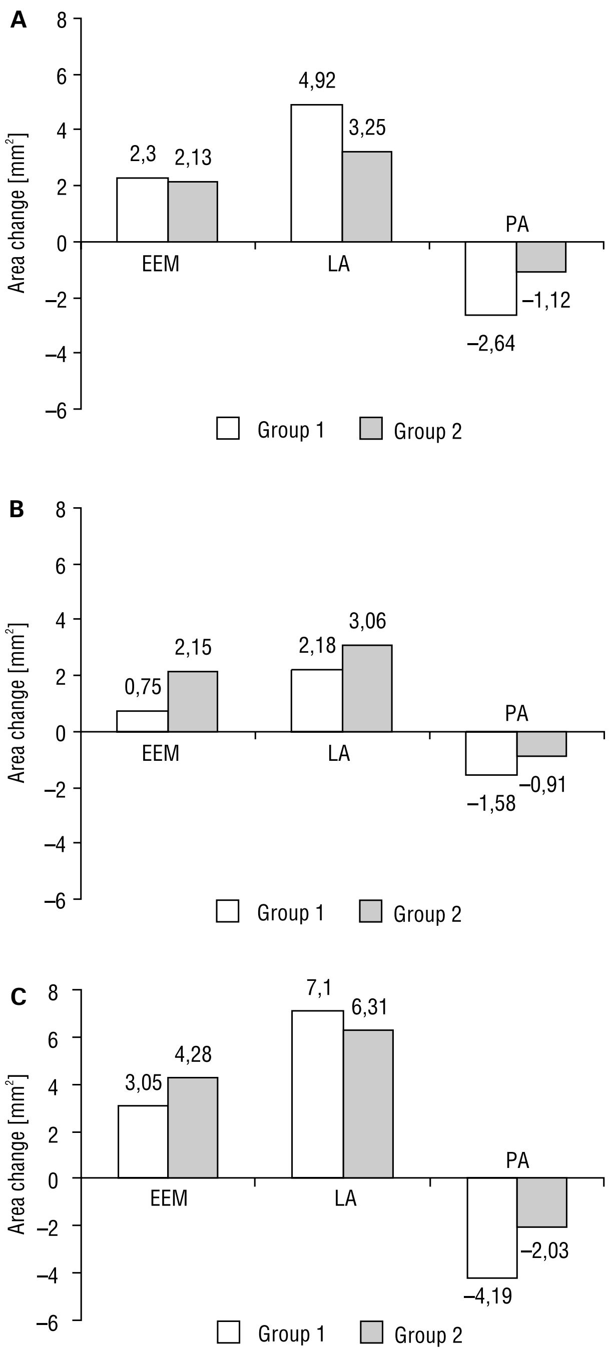


**Figure 1.** Changes in total EEM, lumen and plaque areas as calculated between baseline measurements and successive examination stages (DCA or balloon angioplasty) — **A**; between DCA or balloon angioplasty and assessment following stent implantation — **B**; **C** shows the changes from baseline measurements to the final results

**Rycina 1**. Zmiany całkowitego pola naczynia (EEM) światła i pola blaszki miażdżycowej obliczone jako zmiana pomiedzy pomiarem wyjściowym a kolejnym eteppem zabiegu (aterektomia lub angioplastyka) — **A**; oraz pomiędzy DCA lub angioplastyką a oceną po implantacji stentu — **B**; **C** — zmiany między pomiarami wyjściowymi a wynikiem końcowym

reduction in plaque burden and a significantly smaller increase in the EEM area. In addition, the lumen area tended to be larger in the group treated with DCA, although the difference was not statistically significant.

Intravascular ultrasound assessment revealed that in Group 1 after stenting 57% of lumen enlargement was obtained by means of plaque reduction and 43% was due to vessel wall expansion (vessel stretch), while in Group 2 32% of lumen enlargement was obtained by means of plaque reduction and 68% by vessel expansion. There were no significant differences between groups in this respect (p = NS) (Fig. 2).

The EEM stretch index was significantly smaller in Group 1 than in Group 2 (0.28 ± 0.12 *vs.* 0.61 ± ± 0.29, respectively, $p < 0.001$). A significant positive correlation between the EEM stretch index and the residual plaque burden after DCA or balloon angioplasty was found ($r = 0.7$, $p < 0.001$) (Fig. 3).

Figure 4 shows the longitudinal presentation of PA and LA measurements obtained in patients treated with 13 mm stents. Analyses were performed along the stented segment and in both reference segments. After stenting Group 1 had a smaller EEM volume and plaque volume than Group 2 (225 ± 45 $mm^3$ *vs.* 242 ± 54 $mm^3$ and 70 ± 21 *vs.* 84 ± 24 $mm^3$, respectively, $p < 0.05$), but similar lumen volumes (155 ± 46 $mm^3$ *vs.* 157 ± 34 $mm^3$, p = NS). In addition, the IVUS analysis performed in the distal reference segment revealed that lumen volume and EEM volume were significantly smaller in Group 2 than in Group 1 (33 ± 21 $mm^3$ *vs.* 45 ± 20 $mm^3$ and 66 ± 15 $mm^3$ *vs.* 70 ± 24 $mm^3$, respectively lumen and EEM volume, $p < 0.05$). In the proximal reference segments lumen and EEM volumes tended to be smaller in Group 2 than in Group 1, although the differences were not statistically significant (52 ± 16 $mm^3$ *vs.* 55 ± 21 $mm^3$ and 83 ± 28 $mm^3$ *vs.* 87 ± 32 $mm^3$, respectively, p = NS). Plaque shift into the reference segments was significantly smaller in Group 1 than in Group 2 (4.1 ± 1.7 $mm^3$ *vs.* 8.1 ± ± 2.1 $mm^3$ for proximal segments and 5.2 ± 1.2 $mm^3$ *vs.* 10.1 ± 1.9 $mm^3$ for distal segments).

In-stent restenosis was present at angiographic follow-up in 2 (10%) patients of Group 1 and 7 (23%) of Group 2 (p =NS). In the restenosis sub-group a significantly greater EEM increase index was found (0.92 ± 0.42 *vs.* 0.35 ± 0.19, respectively, $p < 0.001$) (Fig. 5).

## Discussion

The major findings of the present paper are the following: 1) the use of plaque removal by means of

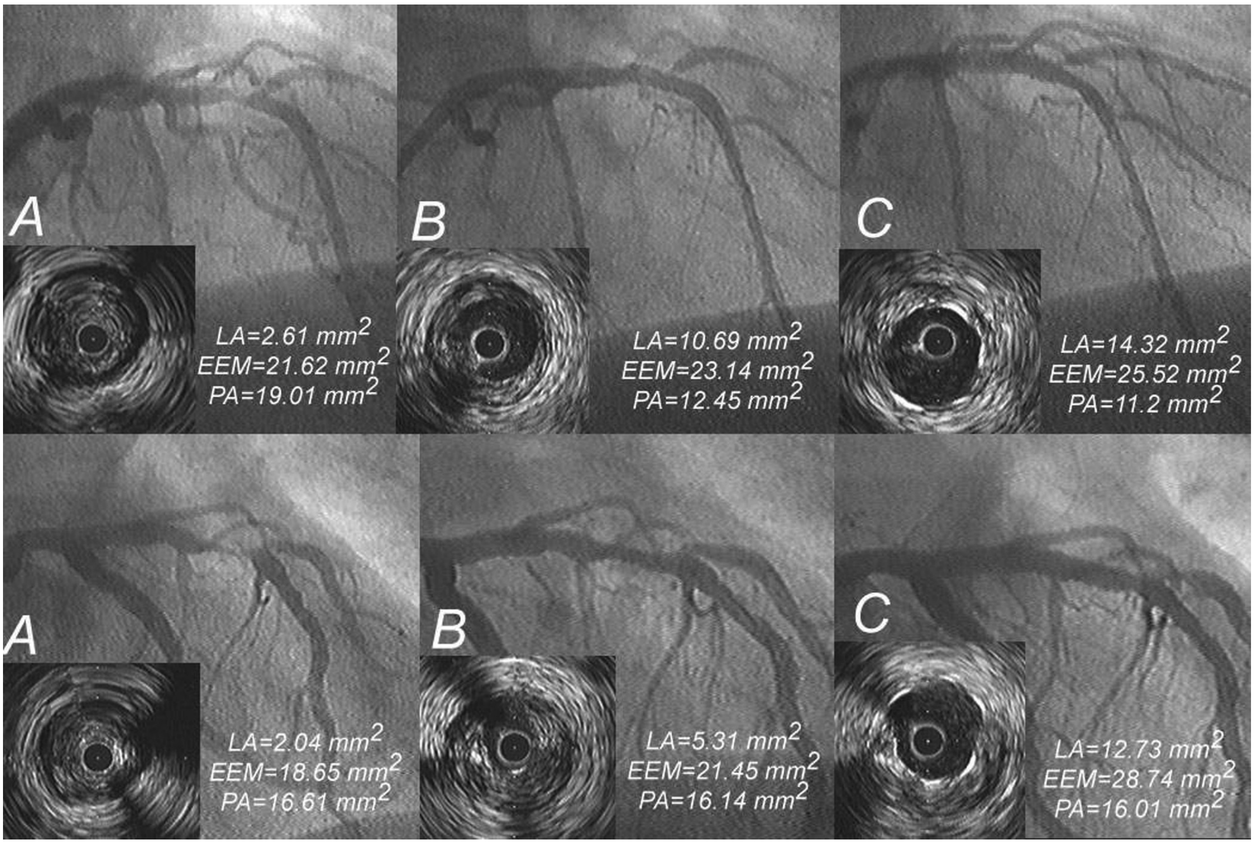


**Figure 2.** A example of the procedures performed in Group 1 (upper line) and Group 2 (lower line) showing angiographic and intravascular ultrasound assessment at each stage of the procedure. Note the greater EEM increase in Group 2

**Rycina 2.** Przykład pokazujący angiograficzny i ultrasonograficzny wynik zabiegu wykonanego w obydwu grupach (Grupa 1 — górny panel, Grupa 2 — dolny panel). Zwraca uwagę większy przyrost całkowitego światła naczynia w Grupie 2

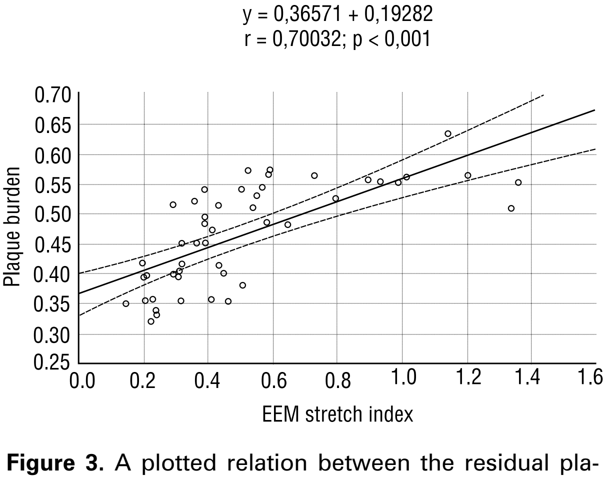


**Figure 3.** A plotted relation between the residual plaque burden obtained after DCA or balloon angioplasty with the EEM stretch index calculated between baseline assessment and the final stage (stenting)

**Rycina 3.** Wykres przedstawia zależności między rezydualną blaszką miażdżycową (po zabiegu DCA lub angioplastyki) a wskaźnikiem naprężenia ściany naczynia

DCA before stenting reduces the amount of vessel stretching 2) DCA plaque removal reduces plaque shift in the reference segments, thus improving lumen dimensions.

Oversized balloons or stents are the techniques mostly used to stimulate intimal hyperplasia in animal models, mimicking the restenotic process in man. Many experimental studies have confirmed that higher injury scores to the vessel wall, related to balloon size and applied pressure, predict more severe hyperplasia after angioplasty [11, 12] and these findings have been confirmed by clinical reports [13, 14]. Koyama et al. [15] in a serial (pre-intervention, post intervention and follow-up) IVUS study (28 patients with 457 consecutive cross--sectional areas analysed) using stepwise logistic regression analysis showed that the increase in EEM area (EEM area after stenting — EEM area pre-intervention) correlated with late intimal hyperplasia ($r = 0.57$). It was hypothesised that a possible me-

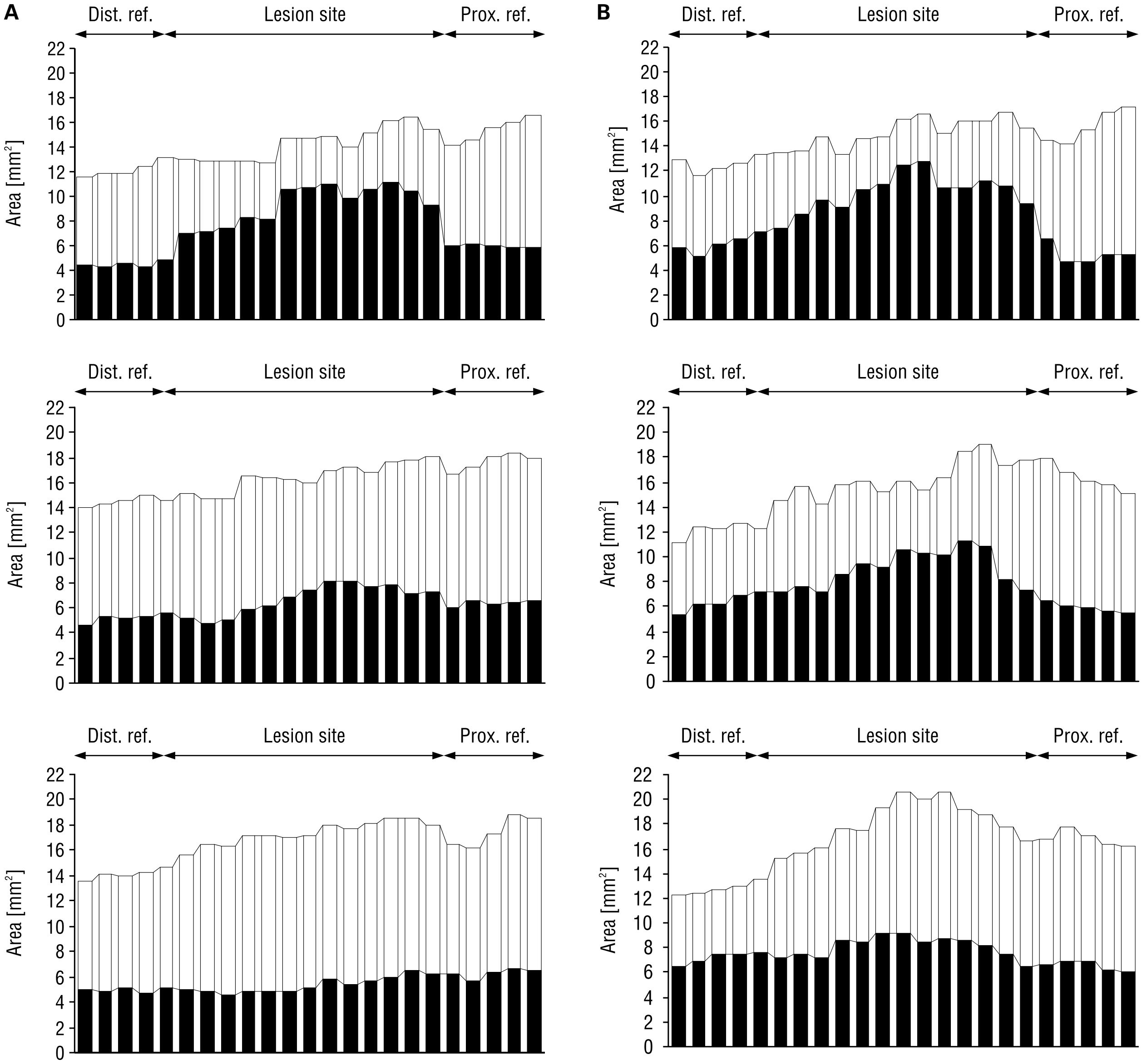


**Figure 4.** A longitudinal representation of plaque area (dark bars) and lumen area (light bars) at each stage of the procedure in Group 1 (**A**) and Group 2 (**B**)

**Rycina 4.** Podłużne przedstawienie pola blaszki miażdżycowej (ciemne słupki) i światła naczynia (jasne słupki) na każdym etepie zabiegu w Grupie 1 (**A**) oraz w Grupie 2 (**B**)

chanism would be that higher radial forces exerted on the vessel wall determined a more pronounced trauma that favours neointimal growth.

It was shown, also in an *in-vivo* setting, that the amount of neointimal formation correlated closely with the post-stenting residual plaque burden [7]. It is reasonable to speculate that, in the presence of a large residual plaque burden, stent implantation leads to a greater stretching of the vessel wall, enhancing vessel wall injury and favouring late neointima formation. Thus the coexistence of these two factors (vessel stretch and residual plaque burden) is likely to reduce the restenosis rate [7]. This hypothesis was also supported by the results of trials matching stenting with predilation and stenting after atherectomy [4, 5, 16], although recent data from the AMIGO trial [17] has not confirmed these earlier observations. The investigators have maintained that the poor late results of this trial were caused in 74% of cases by suboptimal results of the atherectomy. In explanation, they have pointed to the fact that the DCA-debulking technique is operator-dependent and can only be used effectively in selected lesions.

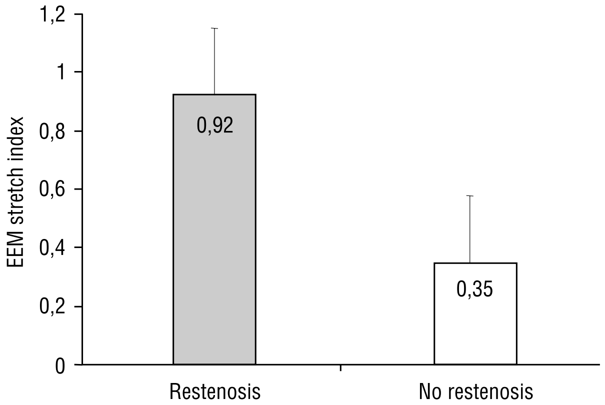


**Figure 5.** The mean values for the EEM stretch index in patients with and without restenosis

**Rycina 5.** Średnie wartości wskaźnika naprężenia światła naczynia u pacjentów z restenozą w stencie lub bez niej

In the population studied a higher success rate was achieved using DCA than in the AMIGO trial (70% *vs.* 26%) and therefore a trend towards a lower restenosis rate was observed.

In the present study an index of vessel stretching (an EEM stretch index) was adopted to document the relationship between vessel stretching and restenosis. A significantly higher vessel stretching index was found in the patients who developed restenosis. In addition, the EEM stretch index was significantly lower in patients undergoing stent implantation after DCA.

It is of note in our study that the stent area was not statistically greater in Group 1 than in Group 2. In fact, only optimised IVUS-guided procedures were adopted. The use of ultrasound-guided stent implantation led to a larger stent area at the cost of a greater vessel stretch. The finding that in stented lesions DCA is able to reduce vessel stretch in comparison with balloon angioplasty without significantly increasing the stent areas highlights the importance of a "gentle" approach based on stent deployment preceded by plaque debulking, which leads to reduced vessel stretch and, finally, a reduced restenosis rate.

An additional finding of the present paper is the reduction in plaque shift observed in the group treated with DCA. At the end of the procedure a smaller plaque burden and a higher lumen volume were obtained after DCA plus stenting and this also applied to the reference segments at the stent margins. This finding may provide additional evidence that DCA is a useful tool for reducing late restenosis at the stent margins. Hoffman et al. showed that focal stent edge restenosis can be related to a greater plaque burden at the stent margins [18] and it has recently been found that the amount of axial plaque shift is correlated with in-stent restenosis at follow-up [19]. The improvement in lumen dimensions and the reduction in plaque volume in the segments adjacent to the stent ends obtained using DCA should therefore translate into a lower restenosis rate at the stent margins.

### Limitations

Although the study is non-randomised, two homogenous groups were compared with similar clinical, angiographic and IVUS characteristics. DCA procedures were performed by adopting two generations of atherectomy devices, the most recent of which (Flexicut) is able to achieve more efficient plaque removal, including the removal calcified plaques (data in press). This may influence the ability of the devices to remove plaque and to affect vessel stretch.

## Conclusion

Intravascular ultrasound shows that plaque removal by means of DCA followed by stent deployment reduces vessel stretch and plaque shift at the stent margins. This mechanism appears to slow down the in-stent restenosis process.

### Streszczenie

**Wstęp:** *Z wielu prospektywnych, nierandomizowanych badań wynika, że aterektomia kierunkowa przed zabiegiem implantacji stentu (DCA + stent) zmniejsza ryzyko restenozy w stencie. Celem tej pracy jest ocena mechanizmów powiększenia światła naczynia po zabiegu implantacji stentu, poprzedzonym aterektomią kierunkową w ocenie ultrasonografii wewnątrzwieńcowej (IVUS), a także porównanie tej metody z implantacją stentu poprzedzoną predylatacją (BA + stent) i ocena, czy naprężenie ściany naczynia wpływa na proces restenozy.*

**Materiał i metody:** *U 20 pacjentów leczonych DCA + stent (Grupa 1) oraz 30 po zabiegu BA + stent wykonano seryjne badanie IVUS. Oceniano całkowite pole naczynia (EEM), pole* *światła oraz pole blaszki miażdżycowej przed zabiegiem i po nim, zarówno w obrębie implantowanego stentu, jak i w obu segmentach referencyjnych. Wskaźnik naprężenia ściany naczynia obliczono jako różnicę między całkowitym polem naczynia po zabiegu w stosunku do wartości przed zabiegiem. Osiowe przesunięcie blaszki (APS) obliczono jako zmianę objętości blaszki w obu segmentach referencyjnych. W okresie obserwacji (6 miesięcy) odległej u wszystkich pacjentów wykonano kontrolne koronarografie.*

**Wyniki:** *Przyrost całkowitego pola naczynia był istotnie mniejszy w Grupie 1 niż w Grupie 2 (3,05 ± 0,8 mm*$^2$ vs. *4,28 ± 1,98 mm*$^2$*, p < 0,001). Wartość wskaźnika naprężenia ściany naczynia byłą istotnie mniejsza w Grupie 1 niż w Grupie 2 (0.28 ± 0.12* vs. *0.61 ± 0.29, p < 0,001). Wartość APS była istotnie mniejsza w Grupie 1 w porównaniu z Grupą 2. U 10% pacjentów z Grupy 1 oraz 23,3% z Grupy 2 stwierdzono cechy restenozy w stencie (p = NS pomiędzy grupami).*

**Wnioski:** *Badanie IVUS pokazało, że usunięcie blaszki miażdżycowej za pomocą aterektomii kierunkowej przed implantacją stentu pozwala na zmniejszenie naprężenia ściany naczynia i redukuje przesunięcie osiowe blaszki w kierunku segmentów referencyjnych. Mechanizm ten wydaje się istotny w spowolnianiu indukcji procesu restenozy w stencie.* (Folia Cardiol. 2004; 11: 903–912)

**aterektomia kierunkowa, stent, ultrasonografia wewnątrzwieńcowa**

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