Transmyocardial laser revascularization with the holmium:YAG laser:
loss of symptomatic improvement after 2 years

J. Schneidera,*, A. Diegelera, R. Krakora, T. Walthera, R. Klugeb, F.W. Mohra

aDepartment of Cardiac Surgery, Herzzentrum, University of Leipzig, Russenstrasse 19, 04289 Leipzig, Germany
bDepartment of Nuclear Medicine, University of Leipzig, Russenstrasse 19, 04289 Leipzig, Germany

Received 19 November 1999; received in revised form 22 November 2000; accepted 11 December 2000

Abstract

Objective: Whether transmyocardial laser revascularization (TMLR) provides a long-term benefit in terms of relief of angina, improvement of exercise tolerance, left ventricular function, and myocardial perfusion. Methods: Forty-one patients underwent TMLR using a holmium:YAG-laser, 14 as TMLR alone (group A), 27 with additional aortocoronary bypass grafting (group B). Follow-up was obtained at 6, 12, 18, 24, and 36 months in this prospective study. Results: In group A patients CCS-class improved up to 18 months postoperatively, after 24 and 36 months postoperatively there was absence of a positive effect of TMLR: the CCS-class decreased to 2.4 as compared to 3.5 preoperatively. After combined CABG and TMLR (group B) there was a significant decrease in angina at all times. The CCS-functional class in these patients was 1.7 at 36 months as compared to 3.5 preoperatively. There was no significant change in exercise tolerance as compared to preoperatively. Left ventricular ejection fraction did not improve in either of the groups. Thallium scintigraphy indicated no improvement in myocardial perfusion in laser treated areas. The perioperative mortality was 0%, the late mortality rate was 36% in group A and 11% in group B. Conclusions: In our experience, in the vast majority of patients who are subjected to TMLR alone the benefit of reduction or relief of angina and improvement in quality of life is only temporary. In addition there is no improvement in objective clinical parameters. We believe that TMLR should only be used in patients with severe angina refractory to medical treatment and requiring a symptomatic therapy.

Keywords: Transmyocardial revascularization; Laser surgery; Holmium; Coronary disease; Myocardium

1. Introduction

Coincident with a combination of medical, percutaneous, or operative therapies there is an decreasing number of symptomatic patients with suitable target vessels in areas of ischemic and viable myocardium. Attempts to revascularize ischemic myocardium by direct methods predate the advent of CABG and PTCA. Vineberg introduced implantation of the internal mammary artery into the myocardium as a means of revascularization [1]. The concept of transmyocardial laser revascularization (TMLR) is based on the pioneering work of Massimo and Boffi [2] who inserted tubes from the left ventricle into the myocardium. Sen and others [3] used acupuncture to create transmyocardial channels. Mirhoseini and Cayton [4] applied laser energy to form transmyocardial channels that would allow ventricular blood to perfuse ischemic myocardium directly. Advancements in laser technology have stimulated a surge of interest in TMLR, which involves the creation of channels in the myocardium with laser techniques with the objective to relieve angina. The efficacy of laser-based TMLR was thought to be contingent to the degree of channel patency; however, an increasing body of evidence in animal studies suggests that TMLR may be effective by inducing angiogenesis [5,6] or nerval ablation [7]. Although encouraging initial results have been attained in clinical trials with the CO2, the holmium:YAG [8], and, more recently, the low energy, fiberoptic, excimer laser [9,10], the long-term benefit of TMLR remains largely unproven. In this report we focus on the intermediate and long-term effectiveness of TMLR in a cohort of patients with disabling angina refractory to medical therapy and not sufficiently treatable by conventional means of revascularization. We examined the relief of angina and improvement of exercise tolerance, ventricular function, and myocardial perfusion and mortality.

* Corresponding author. Tel.: +49-341-865-1421; fax: +49-341-865-1452.
E-mail address: schneider@medizin.uni-leipzig.de (J. Schneider).
2. Materials and methods

Between March 1996 and February 1999, 41 patients were treated with TMLR using the holmium:YAG laser (CardioGenesis™ Corporation, Santa Clara, CA). Inclusion criteria for patients in the prospective study were angina pectoris class III or IV according to the Canadian Cardiovascular Society (CCS), refractory to medical therapy of at least two anti-anginal medications on a maximal tolerable dose. Inclusion criteria for TMLR as the sole therapy was the presence of areas of reversible ischemia at rest and under stress conditions as demonstrated by radionuclide myocardial perfusion scan (dipyridamole-thallium) that were ineligible for percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass grafting (CABG).

For another group of patients, who received a combination of TMLR and CABG, inclusion criteria was the additional presence of viable areas of myocardium, identified by radionuclide perfusion scan, in which CABG was technically feasible.

Patients with a poor left ventricular function (ejection fraction <25%), patients with instable angina and patients which a history of myocardial infarction within the last 6 months were excluded from the study. According to these criteria 14 patients were subjected to the sole therapy (group A) and 27 patients to a combined therapy of TMLR and CABG (group B). Table 1 summarizes the patients’ data. In both groups the mean preoperative CCS-class was 3.5. A previous myocardial infarction was documented in a relatively high percentage of patients in each group: 57% in group A and 77% in group B. Previous procedures consisted of PTCA: 23 and 22%, respectively, and CABG: 71 and 41%, respectively.

2.1. Laser source and operation

The holmium:YAG laser delivers a beam with a wave length of 2100 nm. The laser is triggered to fire on the R wave of the electrocardiogram (ECG), when the ventricle is distended to the maximum with blood and is electrically quiescent. The laser beam is pulsed as a triple burst with a duration of 350 μs/pulse and is delivered with an energy of 2 J/pulse. Tissue ablation is performed by a direct contact of the lens at the tip of the probe with the surrounding tissue. Blood emerges at the epicardial surface if the channel traverses the myocardium. The channels were about 1 mm in diameter and were distributed at about one per cm².

The operative strategy was decided by analysis of the results of coronary angiogram and perfusion scans. Primarily a revascularization with CABG-graft was intended. Patients in group A were operated on through a left anterior or left posterolateral thoracotomy through the 4th or 5th intercostal space without the use of cardiopulmonary bypass (CPB). Single lung ventilation facilitated access to the heart. Twenty three of the 27 patients in group B were operated on through a median sternotomy using CPB and antegrade delivered cold crystalloid cardioplegic solution; in these patients TMLR was performed in the reperfusion period subsequent to the CABG. The sites of revascularization were identified by intraoperative observation of the coronary anatomy. In the remaining patients of group B (n = 4) TMLR was performed without CPB.

Postoperative ECG was documented at 6, 12, 18, and 24 h postoperatively together with CK/CK-MB enzymes. A diagnosis of myocardial infarction was made when both of the following criteria were positive: (1) Development of a new abnormal Q-wave not present on the preoperative ECG; (2) Enzymatic changes defined as 10% or more of the ratio of peak CK-MB/peak total CK on three consecutive samples.

2.2. Follow-up

Follow-up examinations were done at 6, 12, 18, 24, and 36 months postoperatively and included a detailed medical history with an assessment of the functional status of the patient, relief of angina (expressed by the CCS classification) and quality of life (tested by the Seattle Angina Questionnaire), an exercise tolerance test, using a bicycle ergometer in which the initial workload of 50 W was increased by 25 W every 2 min. Reason for discontinuation was exhaustion, dyspnea, occurrence of angina or signs of ischemia in the ECG. By two-dimensional transthoracal echocardiography the ejection fraction was measured by the Simpson method. The examination was done by the same physician who was blinded to the method of operation.

At 12 months all surviving patients were subjected to coronary angiography.

A dipyridamole-thallium scan (using 90 Mbq of the isotope Tl 201-C14) under stress (induced by 0.54 mg/kg dipyridamole) and under resting conditions was performed at 6 and 12 months postoperatively: The myocardium of the left ventricle was divided into 14 separately analyzed segments: an anterior, a septal, an inferior and a lateral segment in each of the distal-, mid- and base views plus an anteroapical and inferoapical segment in the vertical long view. Perfusion signals of areas that had been treated by TMLR or CABG where compared by one investigator,

Table 1

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Group A (n = 14)</th>
<th>Group B (n = 27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td>Age (years)</td>
<td>64.5 ± 5</td>
<td>63.9 ± 8</td>
</tr>
<tr>
<td>Sex</td>
<td>11 male, 3 female</td>
<td>16 male, 13 female</td>
</tr>
<tr>
<td>Functional-class (CCS)</td>
<td>3.5 ± 0.5</td>
<td>3.5 ± 0.4</td>
</tr>
<tr>
<td>LVEF (%) (angiogram)</td>
<td>52.2 ± 10</td>
<td>51 ± 12</td>
</tr>
<tr>
<td>Previous MI</td>
<td>8 (57%)</td>
<td>21 (77%)</td>
</tr>
<tr>
<td>Previous PTCA</td>
<td>4 (23%)</td>
<td>6 (22%)</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>10 (71%)</td>
<td>11 (41%)</td>
</tr>
</tbody>
</table>

a) CABG, coronary artery bypass grafting; CCS, Canadian Cardiovascular Society Angina Scale; MI, myocardial infarction; PTCA, percutaneous transluminal coronary angioplasty.
who was blinded to the operative procedure, with the non-treated ventricular septum, that was set to the value of 100%.

The number of patients that were examined at 12 months was 11 patients in group A and 23 patients in group B respectively, at 24 months 9 patients of group A and 15 patients of group B were present for follow-up. Follow-up at three years was available of eight patients in group A and six patients in group B.

Short follow-up periods were due to death, voluntary exit from the study, and recent date of operation.

Data were analyzed by the paired and the unpaired Student t-test. A P-value less or equal than 0.05 was considered to be significant.

3. Results

In group A patients a mean of 23 ± 6 myocardial laser channels were created versus 16 ± 6 in the patients of group B. Averagely 2.3 ± 1 bypass-grafts were placed in group B patients. The duration of operation was 94 ± 27 min in group A and 167 ± 51 min in group B; for group B patients cardio-pulmonary bypass lasted 95 ± 45 min and myocardial ischemia was 40 ± 23 min. Injuries of the septum and the valves were excluded by transesophagial echocardiography performed after the TMLR. No patient required reoperation for bleeding.

3.1. Functional status

In group A patients the CCS functional class improved significantly up to 18 months postoperatively, but after 2 and 3 years recurrent angina with decrease of CCS-functional class in this group was observed to an extent that there was no improvement compared to preoperatively: 2.4 ± 1 after 2 years and 2.5 ± 1.2 after 3 years versus 3.5 ± 0.5 preoperatively (P > 0.05). In group B patients we documented a sustained improvement in functional CCS-class as compared to preoperatively (Table 2).

During follow-up the percentage of group A patients who reported to be free from angina and those who declared a benefit through the therapy as examined with the Seattle Angina Questionnaire increased until 18 months and fell after 24 and 36 months. However patients of group B revealed a rather constant improvement over 3 years in freedom from angina and in the subjective benefit assessment (Table 3).

3.2. Exercise capacity

The maximum workload achieved in the exercise tolerance test remained statistically unchanged in both groups (Table 4). However at 6 and 12 months the exercise capacity had improved in both groups, and also in the later follow-up only in group B, but this difference did not reach statistical significance.

3.3. Left ventricular function

The analysis of the ejection fraction as measured by trans-thoracal echocardiography demonstrated no significant differences over the entire follow-up period of 36 months.

A total of 29 patients underwent additional cardiac catheterisation at 12 months; the left ventricular ejection fraction, measured by left ventriculography, as compared to preoperatively, remained unchanged in both groups: 54.9 ± 17% and 55 ± 12%, respectively, in group A (P > 0.05) and 51.7 ± 19% and 53.9 ± 19%, respectively, in group B (P > 0.05).

Table 2
Development of the functional class (CCS)\(^a\)

<table>
<thead>
<tr>
<th>CCS-class</th>
<th>Group A (P value vs. Preop.)</th>
<th>Group B (P value vs. Preop.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>3.5 ± 0.5</td>
<td>3.5 ± 0.4</td>
</tr>
<tr>
<td>At 6 months</td>
<td>1.6 ± 0.7 (&lt;0.01)</td>
<td>1.6 ± 0.9 (&lt;0.01)</td>
</tr>
<tr>
<td>At 12 months</td>
<td>1.6 ± 0.7 (&lt;0.01)</td>
<td>1.5 ± 0.8 (&lt;0.01)</td>
</tr>
<tr>
<td>At 18 months</td>
<td>1.7 ± 0.5 (&lt;0.01)</td>
<td>1.4 ± 0.9 (&lt;0.01)</td>
</tr>
<tr>
<td>At 24 months</td>
<td>2.3 ± 0.9 (n.s.)</td>
<td>1.6 ± 0.8 (&lt;0.01)</td>
</tr>
<tr>
<td>At 36 months</td>
<td>2.4 ± 1.1 (n.s.)</td>
<td>1.7 ± 0.5 (&lt;0.01)</td>
</tr>
</tbody>
</table>

* CCS, Canadian Cardiovascular Society Angina Scale.

Table 3
Relief of angina and subjective benefit assessment\(^a\)

<table>
<thead>
<tr>
<th>Free from angina</th>
<th>Group A (n)</th>
<th>Group B (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 6 months</td>
<td>2/12 (17%)</td>
<td>14/25 (56%)</td>
</tr>
<tr>
<td>At 12 months</td>
<td>4/11 (36%)</td>
<td>14/23 (65%)</td>
</tr>
<tr>
<td>At 18 months</td>
<td>4/10 (40%)</td>
<td>10/16 (63%)</td>
</tr>
<tr>
<td>At 24 months</td>
<td>2/9 (22%)</td>
<td>8/15 (53%)</td>
</tr>
<tr>
<td>At 36 months</td>
<td>1/8 (13%)</td>
<td>3/6 (50%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subjective benefit (SAQ)</th>
<th>Group A (n)</th>
<th>Group B (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 6 months</td>
<td>7/12 (57%)</td>
<td>18/25 (72%)</td>
</tr>
<tr>
<td>At 12 months</td>
<td>9/11 (81%)</td>
<td>18/23 (78%)</td>
</tr>
<tr>
<td>At 18 months</td>
<td>7/10 (70%)</td>
<td>13/16 (81%)</td>
</tr>
<tr>
<td>At 24 months</td>
<td>5/9 (56%)</td>
<td>12/15 (80%)</td>
</tr>
<tr>
<td>At 36 months</td>
<td>4/8 (50%)</td>
<td>4/6 (67%)</td>
</tr>
</tbody>
</table>

* SAQ, Seattle Angina Questionnaire
3.4. Perfusion scans

In group A patients, myocardial perfusion under resting conditions of the laser treated myocardium as compared with the preoperative value of 89 ± 15% decreased significantly: 75 ± 17% at 6 months (P < 0.01) and 76 ± 16% at 12 months (P < 0.01). As compared to the preoperative value of 73 ± 17% the myocardial perfusion under stress conditions had diminished to 68 ± 15% at 6 months (P < 0.05) but had returned to the preoperative value after 1 year: 71 ± 17% (P > 0.05).

There was no significant change in the resting perfusion of the myocardium that was treated with TMLR and CABG (group B patients). The perfusion remained at the preoperative level: 84 ± 14% at 6 months and 86 ± 18% at 12 months vs. 87 ± 19% preoperatively (P > 0.05). Under stress conditions the perfusion of the myocardial areas that were treated with TMLR remained unchanged at 6 and 12 months, whereas the perfusion improved in myocardial areas that were revascularized by CABG: 85 ± 17% at 6 months (P < 0.05) and 90 ± 13% at 12 months (P < 0.05) (versus 80 ± 21% before operation).

3.5. Morbidity and mortality

Low cardiac output after the operation necessitating high dosage of inotropic medication was documented in three patients of group B (11%), two of whom (7%) needed the insertion of an intraaortic balloon pump. Perioperative myocardial infarction was diagnosed in four patients of group B (15%) and in none of the patients of group A.

Late complications consisted of myocardial infarction in two patients of group B (7%), that in one patient was located in an area that had been treated with TMLR. One patient of group A developed myocardial failure secondary to ischemic cardiomyopathy at 2.5 years after TMLR and has been evaluated for heart transplantation. Of a total of 53 bypass grafts in these 29 patients analyzed by coronary angiogram after 12 months, five grafts (in five patients) were occluded, reflecting a patency-rate of 90.5%. Among the five patients with occluded grafts, three had a documented perioperative myocardial infarction; however four patients had little or no angina and were in CCS-class I or II.

Eight patients died, five in group A (mortality rate of 36%), and three in group B (mortality rate of 11%). The time of death was at 3, 5, 7, 9, 12, 18, 27, and 35 months. The cause of death was cardiac related in six patients: sudden cardiac death with unknown underlying mechanism (n = 3) or myocardial infarction and progresident cardiac failure (n = 3).

4. Discussion

TMLR is a safe procedure as complications that were specifically attributable to the TMLR technique were not observed. The perioperative complications and the post-operative events are comparable to other open heart operations.

If TMLR treatment of only the anterolateral myocardium is indicated, this area can be approached through a left anterior or posterolateral thoracotomy without the use of cardiopulmonary bypass. This technique reduces the risk of damaging patent coronary bypass grafts and the risk of sternal dehiscence or sternal infection.

To validate a possible clinical benefit an analysis of the Canadian Cardiovascular Society (CCS) functional class, freedom from angina and a subjective benefit (examined with the Seattle Angina Questionnaire) were performed. However these parameters may be biased by subjective influence, therefore three separate parameters for a better validation were studied.

Our results demonstrate three different clinical developments in patients that were subjected to TMLR alone (group A) or in combination with CABG (group B): (1) a lasting symptomatic improvement (as expressed by a reduction of angina and improved functional status), as present in 36% of the patients in group A and in 60% of the patients in group B; (2) no relevant improvement in symptoms (22% in group A and 12% in group B patients); (3) initial symptomatic improvement, followed by a worsening of the clinical status after a period of approximately 2 years (42% in group A and 28% in group B).

If the TMLR alone procedure is applied a lasting symptomatic improvement can only be predicted for a few patients.

Patients who were treated with a combined therapy a long term symptomatic betterment can be expected for at least 60%. It remains unknown to what degree this improvement can be contributed to the TMLR or the CAB-grafts. Further randomized studies are necessary.

Parallel to the subjective parameters of CCS, freedom from angina and SAQ more objective examinations as thallium perfusion scans, echocardiography, left heart catheterisation and ergometer stress testing were performed.

Exercise capacity did not change in either group. Consistent with the increase of angina in group A patients at 18 months the maximum workload decreased and at 3 years it had reached a lower value (although insignificant) than preoperatively. In group B patients the maximum exercise capacity was achieved at 12 months with a slight decrease at later follow-up, with values still above the preoperative level.

Left ventricular function analysis was done by transthoracal echocardiography and cardiac catheterization, the results showed a high degree of conformity. In both groups individual variances were seen, however the statistic value remained unchanged in each group. A correlation of clinical improvement or deterioration to individual changes of left ventricular function were not observed. A limitation is that no stress echocardiography or wall motion examinations were included in this study.

In group A patients the myocardial perfusion of TMLR treated areas, both under resting and stress conditions, was continuously below the preoperative level. The addition of a
bypass graft in group B patients appeared to compensate for the lack of improvement in myocardial perfusion as achieved by TMLR. This effect was also seen when the bypass graft was anastomosed to an area of the myocard that was not treated by TMLR; this phenomenon may have been caused by the presence of an extensive network of collateral coronary vessels, although the TMLR may cause an additional perfusion increase.

The 3 year mortality rate of 36% in group A patients reflects the clinical deterioration in this group, although we could not find a correlation between death and clinical status, as four of the six patients with cardiac related death were in CCS class I before they died. The substantially lower mortality rate of patients in group B (11%) was probably due to the coronary bypass grafts.

The results of this study underscore the palliative character of TMLR therapy, because improvements in ergometric stress testing, left ventricular function and in the results of myocardial perfusion were not observed. Furthermore, TMLR was unable to protect from myocardial infarction or increase life expectancy.

A comparison of our results with other studies is difficult as only one other study, by Nägele and co-workers [11], with three year follow-up is available. The authors reported that the CCS-functional class was unchanged at 3 years after TMLR treatment following a tendency of clinical deterioration that started at 6 months postoperatively. Krabatsch and colleagues [12] noticed worse CCS-classifications at 12 and 18 months as compared to our results and Jones and associates [13] reported a functional class at 12 months that is comparable to our results.

The data regarding the maximum workload in the exercise tolerance test are conflicting. Schofield [14] reported an unchanged value in 77 patients at 1 year, whereas Krabatsch [12] documented a steady increase in the workload in 151 patients treated with TMLR at follow-up of up to 2 years.

Reports of improvement of left ventricular function after TMLR are absent in the literature: Nägele and co-workers [15] documented a significant reduction of left ventricular ejection fraction at 12 months as measured by angiography. Only Frazier and colleagues [16] using dobutamine stress echocardiography, described improvements of the wall motion score indices in the TMLR-treated myocardium. Similarly, reports regarding myocardial perfusion after TMLR are divergent in various studies. Our findings of a reduction in perfusion are confirmed by others [11,14]. In contrast, Krabatsch [12] reported absence of improvement in myocardial perfusion, whereas, Horvath and associates [17,18] and March [19] described a significant improvement of myocardial perfusion at 1 year. In addition, Frazier et al. [16] documented an improvement in the subendocardial myocardial perfusion at 3 and 6 months as measured by PET scintigraphy, whereas a transmural perfusion analysis remained unchanged. A limitation of our study is that thallium scintigraphy, as performed in our patient cohort, has a lower sensitivity to detect myocardial perfusion defects than PET scintigraphy and therefore may be less able to visualize minor or localized changes in perfusion.

Based on the results of this study that includes only a small number of patients we support the recommendations of Nägele [11] and Krabatsch [12] that the indication for TMLR should be limited only to highly symptomatic patients with end-stage coronary artery disease that are not amenable to PTCA or CABG.

References

[16] Frazier OH, Cooley DA, Kadipasaoglu KA, Pehlivanoglu S, Lindenmeir M, Barasch E, Conger JL, Wilansky S, Moore WH. Myocardial...


Appendix A. Conference discussion

**Dr G. Lutter** (Freiburg, Germany): I just wanted to ask you whether you classified your coronary vessels to do a comparison between these groups? I mean as long as you can do an approach for a CABG, you have a greater vessel diameter of 1 or even greater, 1.5 mm, to establish a CABG. In contrast, in the TMR group you can’t do so because there is no target for it. So why do you compare these groups? Furthermore, sole TMLR treatment was performed in only 14 patients. To correctly evaluate the TMLR method, you should only analyze sole TMLR-treated cases. Out of the small number of patients and the very small follow-up group, conclusions about TMLR cannot be drawn out of this study.

**Dr J. Schneider**: I don’t compare them. I just present the separate results of the two groups. It was not the aim of the study to compare the two groups. The anlyzation of the two groups was done independently. And we have seen a temporary effect in the first group. The second group benefited all over the period, and they had a reduction in angina. The first group, the TMR alone group, they did not.

**Dr S. Cicik** (Ankara, Turkey): I have two questions. First, this study is mainly done using the holmium:YAG laser. We know that there are differences with regard to channel, histological quality of the channels created by the holmium:YAG lasers and CO2 lasers. Do you have any postmortem studies on your patients that show the path of your channels?

And second, could you have any data comparing the CO2 and holmium:YAG lasers, or is this only a holmium:YAG laser study?

**Dr Schneider**: We only used the holmium:YAG laser, no other laser source.

**Dr Cicik**: Did you do any postmortem studies?

**Dr Schneider**: We tried to do autopsies, but we did not get permission in these seven patients.

**Dr F.W. Mohr** (Leipzig, Germany): I think this data clearly demonstrates that surgeons shouldn’t discuss laser anymore as a surgical procedure. And at least these data are very clear from our group. The cardiologists will open this discussion again, but I think we have a clear opinion about that.

**Dr E.V. Potapov** (Berlin, Germany): Did you compare CABG alone and CABG with TMLR in your institution?

**Dr Schneider**: No, we did not.

**Dr M. Turina** (Zurich, Switzerland): Are you still performing laser revascularization in Leipzig?

**Dr Schneider**: Not as a stand-alone procedure anymore since over a year, and a combined procedure only in very few cases.