S
tents are now used routinely for catheter-based coro-
nary revascularization procedures. Early clinical trials
of stents demonstrated reduced rates of angiographic
restenosis compared with balloon angioplasty alone.1–3 In a
registry analysis of 1403 patients, 64% of whom were treated
with stents, the need for repeat revascularization was 39% 
less than in a similar cohort having coronary intervention in
the prestent era. 4 In addition to enhancing the durability of
coronary angioplasty, stents appear to improve its safety. As
stent usage has increased further, the rates of abrupt artery
closure and complex dissection associated with catheter-
based interventions have declined progressively from 2% to
1% and from 11% to 5%, respectively. 5 Stents have also
expanded the pool of patients suitable for nonsurgical revas-
cularization. Lesions that are treated currently are longer and
are located in more tortuous and smaller arteries.

Although stents substantially reduce the relative risk for
lesion recurrence, the absolute chance of experiencing reste-
nosis is still significant. Furthermore, when restenosis occurs
within a stent, conventional treatments are of limited value, as
repeat in-stent restenosis is observed in 54% to 66% of
patients. 6–8 There have been many attempts to improve on
these results by placing a new stent within the original stent
and supplementing repeat balloon angioplasty with excimer
laser, high-speed rotational atherectomy and directional
atherectomy. None of these strategies, however, have proved
particularly successful.

Studies using intracoronary ultrasound have demonstrated
that in-stent restenosis is due to neointimal tissue proliferation.9
Considering that radiation has been effective in the treatment of
other hyperplastic disorders, both benign and malignant, inves-
tigators speculated that locally applied radiation might be useful
for the treatment of restenosis, especially in-stent restenosis.
Accordingly, intracoronary brachytherapy, using both β- and
γ-emitting sources, has been evaluated intensively. 6–8 ,10–12 Sev-
eral randomized clinical trials have focused on in-stent resteno-
sis. Data are available from 3 studies that used 192 Ir.6–8 The
results are remarkably consistent and demonstrate impressive
benefit, with treatment effects in the range of 50% to 60%.  
β-Sources have also been evaluated for in-stent restenosis, as
well as for de novo and restenotic lesions not previously
stenoted.10–12 Preliminary observational results are similarly
encouraging.

Although we have had considerable experience with intracor-
only brachytherapy in the short-term, our knowledge of late
patient outcome is limited. Natural questions relate to the
sustained effectiveness of intracoronary brachytherapy and its
safety. Does brachytherapy provide permanent protection
against restenosis, or is the process merely delayed? Is intracor-
onary brachytherapy harmful? Will it result in myocardial
damage and dysfunction with eventual heart failure? Will we see
pericardial disease? Does brachytherapy accelerate atheroscle-
rosis in neighboring coronary arteries? Do treated arteries
undergo degeneration or expansion or form aneurysms?13 In this
issue of Circulation, Teirstein and coauthors add important
information to help answer these questions. They report the
3-year clinical and coronary angiographic outcome of patients
enrolled in a trial that initially established the benefits of
intracoronary brachytherapy in treating restenosis.

Several aspects of the Teirstein report are worth noting. First,
the study was composed of patients with restenosis; some had
been treated previously with a stent. Thus, the results of the trial
apply to a mixed group of patients presenting with restenosis
rather than just to a specific subset. Some had in-stent restenosis,
and some did not.

For these patients, the cumulative 3-year rate of target-lesion
revascularization was substantially lower among those receiving
brachytherapy (15.4%) than among those treated by conven-
tional techniques (48.3%). The restenosis rate for radiated
patients having follow-up coronary angiography was 33.3%
compared with 63.6% for controls. This independent, parallel
assessment further validates treatment effectiveness. Also, when
target-lesion revascularization occurred in either group, it nearly
always occurred within the first 6 months. Thus, the effective-
ness of intracoronary brachytherapy was sustained over the
3-year period. There was no evidence of delayed restenosis in
treated patients. Importantly, the benefits of radiation remained
substantial even when restenosis at the edges of the original
lesions was classified as a treatment failure.

Second, adverse clinical events suggestive of serious myocar-
dial or arterial damage from radiation were not identified.
Review of hospitalizations for cardiac causes did not reveal the
development of excessive heart failure or pericarditis. Further-
more, follow-up coronary angiography did not detect any coro-
nary aneurysms or pseudoaneurysms among treated patients.

Third, there was considerable revascularization for lesions
other than the original restenotic lesions. It is not likely that

---

**Editors’ note:** The opinions expressed in this editorial are not necessarily those of the editors or of the American Heart Association.

From the Division of Cardiology, Department of Medicine, Rhode Island Hospital, Brown University, School of Medicine, Providence, RI.

Correspondence to David O. Williams, MD, Division of Cardiology, APC 814, Rhode Island Hospital, 593 Eddy St, Providence, RI 02903.

E-mail DWilliams@lifespan.org

(Circulation. 2000;101:350-351.)

© 2000 American Heart Association, Inc.

Circulation is available at http://www.circulationaha.org

---

**Intracoronary Radiation**

**It Keeps on Glowing**

David O. Williams, MD; Barry L. Sharaf, MD
radiation was responsible for these events, because the rates of nonindex lesion revascularization were similar in both the radiated and control groups. More likely is the explanation that coronary artery disease is a progressive illness, and measures to attenuate disease progression are required as adjuncts to revascularizations.\textsuperscript{15}

Fourth, a 0.37-mm decline in the mean value of minimal lumen diameter was observed in 17 irradiated patients but not in 10 control subjects. The significance of this observation is unclear. Both the magnitude of this change and the size of the group in which it was observed were small. Additional observations from larger patient cohorts will be needed for clarification.

Although this report helps to address several important questions about intracoronary brachytherapy, the small number of patients in the trial, the form of brachytherapy used, and the types of patients enrolled leave many additional, important questions unanswered. For example, we need to know more about each specific patient subgroup, including those who receive brachytherapy with or without a prior stent and with or without a new stent. Late stent thrombosis has been described recently. This condition, often presenting as unstable angina or nonindex lesion revascularization,\textsuperscript{15} we need to extend our observations after intracoronary brachytherapy beyond 3 years.

We appreciate the efforts of Teirstein and colleagues in the field of coronary brachytherapy for their initial and continued research. These efforts have clearly demonstrated that intracoronary brachytherapy can reduce the incidence of restenosis in both the short and long term and that it is of particular value to patients with in-stent restenosis for whom there is no effective catheter-based alternative. Although we are reassured by the safety data available through 3 years of follow-up, we encourage continued surveillance by early investigators to further augment our understanding of this very important and potent therapy.

Acknowledgment

The authors wish to thank Arlene S. Grant for assisting in the preparation of this manuscript.

References


Intracoronary Radiation: It Keeps on Glowing
David O. Williams and Barry L. Sharaf

Circulation. 2000;101:350-351
doi: 10.1161/01.CIR.101.4.350

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2000 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/101/4/350

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org//subscriptions/