

Clinical Significance of Stent Fractures

ENDOVASCULAR TODAY INTERVIEWS GARY M. ANSEL, MD

Dr. Ansel sat down with Endovascular Today to provide his take on stent fractures and their significance in clinical practice.

Endovascular Today: It seems that stent fractures were first observed in the SIROCCO trial. What were the outcomes of this trial, and why were fractures observed?

Dr. Ansel: The SIROCCO trial was the first time that nitinol stents were reviewed in a prospective fashion to see not only their restenosis rates, but actually prospectively look at their fracture rates. SIROCCO I and II really molded how we started to look at stenting of the superficial femoral artery (SFA), even though their purpose was to study the use of a restenosis-inhibiting drug. SIROCCO showed us that (1) we needed a lot more information about putting drugs on these stents (it is not a simple process), and (2) nitinol stenting itself had better clinical outcomes than expected, especially when compared to the self-expanding stainless steel stents. These better clinical outcomes took people aback because it was assumed that stenting did not work in the SFA. All of a sudden, we had outcomes with 24% duplex restenosis at 2 years (SIROCCO II); no one had predicted that. However, the negative aspect of SIROCCO was that it also showed that these devices can break. Even though the small numbers of the SIROCCO trial did not show a clinical relevancy, it was a wake up call that these devices need to be looked at more closely, certainly from a design standpoint, and to see what long-term outcomes would be.

Overall, SIROCCO showed us that nitinol stents, especially for medium-length lesions, seem to have very acceptable patency. SIROCCO I studied long disease (up to three stents), and the restenosis rates were in the 45% range at 2-year follow-up. When lesions that could be covered with two stents were studied in SIROCCO II, the restenosis rates decreased to 24%. Most stent fractures were observed in the population in which three or more stents were used. The use of three or more stents seemed to have a much higher correlation to stent fracture than did the use of one or two stents. However, no association between stent fracture and restenosis was found in SIROCCO.

Endovascular Today: What has been your experience with stent fractures?

Dr. Ansel: In thinking about this question, I asked myself 'Where was I, and how did I not get impressed by stent fractures early on?' We noted some rare stent fractures with the early stainless steel Wallstent (Boston Scientific Corporation, Natick, MA), but there was a significant occurrence of restenosis with this stent. In the first place, we did not know there was a correlation between fracture and restenosis because we saw restenosis with and without it, but we considered it to be a rare event. When we started using nitinol (early on, we used the Smart stent [Cordis Corporation, a Johnson & Johnson company, Miami, FL]), we were very pleased with the results, except for the expense. When the Memotherm stent (C.R. Bard, Inc., Murray Hill, NJ) became available, which was longer and less costly, we noticed within the first 6 months a few very complex fractures, to the point of total disarticulation of the stent. These fractures were noticed by the patients symptomatically with some complaints of pain or pressure. As a result, we stopped using that stent early on.

We retrospectively reviewed 5 years of SFA stenting (570 patients) at our institution. We offered screening with duplex on a regular basis. Utilizing this strategy, we had approximately 50 patients present back with restenosis. Of those 50 patients, we did see some stent fractures, but we did not note any of the really severe disarticulations noted by some investigators. We were as likely to see stent fracture as we were to see no stent fracture. Our gut feeling at that time was that we did not have a firm correlation between stent fracture and restenosis. We continued to follow these patients for an average of 3 years, and we were happy that we did not observe an increasing frequency of stent fractures or significant advancement in the fractures that were already present (SIROCCO showed us that the majority of fractures appear within the first year, with decreased incidence thereafter). Also, from a clinical perspective, the patients were still doing very well; 75% were still clinically improved. Repeat procedures in the restenosis cohort averaged less than two per patient. These data helped to drive our frequent clinical use of stents.

Endovascular Today: Can you summarize whether there is a clinical impact from stent fractures?

Dr. Ansel: I certainly feel there can be a clinical impact based upon the severity of fracture. In my opinion, based on our own population, our own data, and the data from the SIROCCO and FESTO trials, certain types of stent fractures are more prone to resulting in recurrent disease. The FESTO trial really highlighted this in that it looked at three different stents: Smart, Luminexx (C.R. Bard, Inc.), and SelfX (Abbott Vascular, Abbott Park, IL). The two stents that were associated with more complex fractures (ie, multiple tine fractures, disarticulations, blow outs) were the ones associated with restenosis, mostly with the Luminexx and the SelfX stents. The Smart stent, which tended to have more tine fractures only, did not appear (according to the investigators) to have a relationship to restenosis. If you create a stent that just has simple fractures, there does not appear to be a large impact on restenosis. However, if you have a stent that results in a lot of disarticulations and massive breaks, there is some type of design flaw that is associated with restenosis.

One of the other findings that we noticed when looking at the SIROCCO data was that many of the fractures were near the stent overlaps. One of the limitations of SIROCCO is that there was no access to a full array of stents from which to choose; only a few types of stents were available. The investigators were forced to frequently overlap stents for a significant length in the SIROCCO trial, which appears to increase the rigidity of this area, resulting in almost a fulcrum on each end. That fulcrum may be associated with stent fractures. The bottom line is that it is not a good thing for a stent to fracture and lose its integrity, and fracturing does appear to occur differently among the different stents.

Endovascular Today: What data currently exist regarding stent fractures?

Dr. Ansel: *Endovascular Today* had one of the first presentations in print on stent fractures. I have always said that my disgruntled nature about that article was because I really believe that particular data should have been presented in a peer-reviewed journal. It was, without a doubt, very important data. I am still troubled by the fact that the investigators collected so much detail on the stent fractures that they even proposed a grading scheme, but they could not identify the stents utilized.

The reality is that the FDA is going to require specific studies to examine stent fractures. The FDA has really hooked onto this issue; because one of their goals is pub-

lic safety. As soon as there was any potential for stent fractures and restenosis, the FDA became rightfully interested, which they should have. I suspect that all trials going forward are going to have to look at stent fractures on an ongoing basis, at least to midterm follow-up. RESILIENT will be the next trial to prospectively supply us with data about stent fractures. Our own VIBRANT trial, which is looking at nitinol stents versus PTFE-covered stents, will be evaluating stent fractures as well. I think we can expect to see a lot of data about stent fractures coming out in the next 2 to 3 years.

Endovascular Today: What was your experience with stent fractures in the BLASTER trial? Have you continued to see these patients, and have you seen stent fractures out to a longer time frame?

Dr. Ansel: BLASTER was a multicenter, prospective trial meant to study abciximab with SFA nitinol stenting. It has been completed, and the early results have been published. We did not look at stent fractures in a prospective fashion, although fractures did affect the trial because we had started before SIROCCO data were first released. We were about halfway through our enrollment when the SIROCCO data came out. Because SIROCCO did show fractures and we did not know the clinical significance, we had to re-evaluate continued enrollment. At that time, we could either choose between changing the enrollment criteria from long lesions (>7 cm), which we did not want to do, or we could unblind the trial and evaluate whether we could prove the hypothesis by continuing.

We had some patients who came back with restenosis at 9 months (24%) and, of the patients who had been retreated, none experienced a stent fracture at that interval. These results led us to wonder why we were experiencing a significantly different result than the SIROCCO I data during the same time frame. When I looked back at some of the angiograms from both the SIROCCO trial and the BLASTER trial, what I noticed was that we had different overlap because we had designed short stent overlap (≤ 5 mm) in BLASTER by using long stents (the most common stent was 120 mm). We really minimally overlapped the stents, but we did not do it to decrease fractures—we did not know about fractures yet—we did it just because it seemed like the right thing to do (ie, not have so much metal on the luminal surface). In retrospect, that lack of overlap length may have affected our fracture rate.

We are bringing the BLASTER patients back; the time frame is 3 to 6 years. Our site is done, and I can tell you that we have not seen stent explosions and the patients

have done very well clinically, but these data are still being processed.

Irrespective to BLASTER, over the years, the area in which we have seen the biggest problem with complex stent fractures has been in bypass grafts. That may be why the article that was published in *Endovascular Today* showed so many complex SFA stent fractures. One of the lead authors is a vascular surgeon and possibly sees many more bypass grafts that need treatment than the majority of us. That is where we have seen stents not do well at all regarding stent fractures. In fact, it changed our practice pattern. We will only very rarely place nitinol stents in bypass grafts because of this finding. When we have reviewed our patient population for fractures, the complex fractures that we have seen were usually in bypass grafts.

Endovascular Today: What, if anything, should manufacturers be doing to address the issue of stent fractures, and are they doing it?

Dr. Ansel: We must be sure that we do not throw the baby out with the bath water because there is this hysteria about stent fractures. By looking for stents that do not fracture, we may forget the basis by which stents decrease restenosis. I think we all have to remember that the basic way stents work is by increasing maximum luminal diameter upfront so that any tissue ingrowth has less of an effect on the luminal diameter. The stents that do this currently are often a little more rigid (potentially). We do not want to use a stent with low radial force or poor tissue coverage just because it does not fracture. In my opinion, the Intracoil (now the Vascucoil, ev3, Plymouth, MN) stent had these characteristics and did not provide adequate increase in the maximum luminal diameter. As manufacturers develop future stents, they need to take into account stent fractures but also ensure that the resulting stents provide significant gains in maximum luminal diameter. They need to make sure that stents are manufactured well and that they are polished well. The aSpire stent (Vascular Architects, Inc., San Jose, CA) and the Luminexx stent really taught us a lesson—it appears that polishing is very important. The aSpire was a covered wire stent studied in the REAL SFA trial. Results have been presented, and there was a significant number of fractures, which took everyone by surprise—a wire stent should not fracture. However, it turns out that because it was a covered stent, it was not well-polished because it was not thought to be necessary. This taught us that we really do need to have a very good level of electropolishing for stents, that stent designs do need to focus on com-

plex stent fractures, and that stents do need to be able to achieve sufficient luminal gain.

I think we understand the forces that act upon the SFA—it is not so much the bending forces in the SFA as it is the compression and elongation that may lead to fractures. As engineers focus on stent designs that allow the stent to absorb these types of punishment, we will begin to see better stents.

I believe the manufacturers are really stepping up to the plate with regard to stent fractures and the need to design/re-design stents. I have been in many different company labs, and the engineers are really clued into this—it is a hot topic to them. They are trying to mimic what happens in the body and to create the fractureless stent. Industry knows that this is going to be important to the FDA, and they know that it is going to be important to our patient population. These companies really do have efficacious safe treatment as their bottom line because, not only is it the right thing to do, it is the only way they are going to survive in the marketplace.

Looking beyond 5 years, I think that nitinol will continue to be the metal of choice, but I think we will soon be looking for and finding new metals that will give us better and stronger characteristics. In the shorter term, we have an approved PTFE-covered stent, and the only fractures reported to date have been in popliteal aneurysms. The usefulness of the application of antirestenosis medications and their effect on potential fractures is currently being evaluated by Cook Incorporated (Bloomington, IN).

The dark horse that may go beyond current expectations in the near future is the PTFE-covered stent. I was really taken aback by the surgical graft data for heparin bonding. Early data appear to show that it is now possible to take PTFE-heparin-bonded surgical bypass grafts and make them act like a vein bypass below the knee. If this technology can be adapted and applied to endovascular stent grafts, everyone is going to have to watch out because I do not think the FDA is going to have a problem with heparin. The heparin will also be bonded, not eluted, which means this could be a very quick and efficacious product. ■

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