Use of a Small Intestine Submucosa Extracellular Matrix Patch in Repeated Carotid Endarterectomy
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Various patches have been described in the literature for patients undergoing carotid endarterectomy. In the present report, the authors present the case of a 71-year-old woman who had bilateral carotid endarterectomies 17 years earlier and greater than 80% restenosis of the right internal carotid artery. The patient underwent a repeated right carotid endarterectomy using a small intestine submucosa extracellular matrix patch for closure of the arteriotomy. Given the unique biologic properties of the small intestine submucosa patch and the technical advantages associated with its use for patch angioplasty, further studies to define its efficacy are warranted. J Am Osteopath Assoc. 2014;114(9):732-734 doi:10.7556/jaoa.2014.143

Report of Case
A 71-year-old woman presented to the clinic for biannual carotid duplex ultrasonography. Her medical history included cerebrovascular disease, congestive heart failure, chronic obstructive pulmonary disease, hypertension, and skin infections resulting from methicillin-resistant Staphylococcus aureus (MRSA). Her surgical history included bilateral CEA performed 17 years before presentation and repeated endarterectomy of the left carotid artery performed 2 years before presentation. The results of ultrasonography revealed greater than 80% stenosis of the right internal carotid artery. The results of neurologic examination indicated that she was asymptomatic.

The patient was scheduled for elective repeated endarterectomy of the right carotid artery performed with intraoperative electroencephalographic monitoring. Dissection and exposure were carried out in a standard fashion and revealed a synthetic patch from her previous CEA and a heavily calcified vessel. An arteriotomy was performed and the endarterectomy completed without the need for a shunt. A patch angioplasty was performed using an ECM carotid patch (CorMatrix) with a 6-0 polypropylene suture. No hemostatic agents or drains were used, and the operation was a technical success. The patient was discharged from the hospital on postoperative day 1. Serial duplex ultrasonography images obtained thereafter revealed a widely patent internal carotid artery.

Discussion
With patch closure being the standard of care for patients with CEA, consideration must be given to the type of patch that will be used. Although the preference of the surgeon has an obvious role in this decision, other properties should also be considered to ensure adequate long-term results. The biologic properties of ECM and its potential inherent mechanical and biologic advantages over other types of patches should be understood.

Small intestine submucosa (SIS) has been the most extensively studied ECM patch material. The composi-
tion of SIS includes approximately 90% collagen (primarily type I collagen). In addition, SIS ECM also contains glycosaminoglycans, including heparin and heparin sulfate, as well as fibronectin and laminin, which are sources of growth factors. The CorMatrix ECM used in our patient is an example of an acellular porcine SIS non-cross-linked ECM material.

Physiologic remodeling is associated with different types of carotid patches. When a synthetic patch material is inserted, an inflammatory cascade is initiated that leads to the release of proinflammatory cytokines, ultimately resulting in inflammation and fibrosis. The end result of these processes is evident in any repeated surgical procedure, as seen with our patient. In contrast, when ECM patch materials are inserted, the process of macrophage infiltration initiates an anti-inflammatory cascade characterized by secretion of regenerative factors that promote cell proliferation and angiogenesis and enhance the rate of endothelialization, yielding a more physiologic-based remodeling process.

As a possible complication of CEA, infection is associated with potentially fatal sequelae that have an estimated incidence of less than 1%. However, infection is of particular concern in patients who have a history of MRSA infection and in those undergoing any operation that requires placement of a synthetic implant. Although several mechanisms of infection have been proposed, adherence of bacteria to the surface of synthetic materials is believed to play a role. Such bacterial adherence is the initiating event and is followed by bacterial colonization and formation of a biofilm that is able to resist both host defenses and penetration of antibiotics. Gram-positive bacteria, which are most commonly implicated as the cause of local infections, are also known to produce an extracellular mucin that further promotes the adherence of bacteria to biomaterials. To our knowledge, autogenous vein patches or bovine pericardial patches have been the primary options for use in patch angioplasty in patients with infection or a high risk of infection. However, the biologic properties of the ECM patch make the use of this material a valid alternative.

As seen in our patient’s surgical history, restenosis is a major challenge when considering the long-term outcome of CEA. Several studies assessing restenosis in patients who have undergone peripheral bypasses have demonstrated that mechanical factors, including material mismatch and compliance mismatch, are associated with decreased short- and long-term patencies. Moreover, the lack of a confluent endothelium associated with synthetic materials is also involved in thrombus formation, embolism, and occlusion. Comparison of various bypass materials has demonstrated that the physical properties of SIS more closely resemble those of the native arteries than vein or synthetic grafts, thereby minimizing these discrepancies. Although no similar studies to our knowledge have compared the mechanical properties of carotid patch materials, a more thorough understanding may help predict long-term rates of restenosis and yield insight into the mechanical factors associated with adverse neurologic events after CEA.

Technical considerations must also be taken into account when choosing a patch material. In our experience, the handling properties of the ECM patch were similar to those of the autogenous vein patch. The hemostatic properties of the ECM patch are another of its desirable qualities. No hemostatic agents have been required by any of our patients who have undergone CEAs using the ECM patch. The potential cost savings resulting from not using such agents may offset the difference in price between the ECM patch (which is more expensive) and other available patches.

**Conclusion**

The ideal carotid patch material has yet to be identified. Perioperative complications, ease of handling, economic factors, and long-term outcomes must all be taken into account when assessing such materials. We believe that an ECM patch may offer an attractive alternative to tra-
ditional patches given its biocompatibility, resistance to infection, hemostatic properties, and ease of handling. In our patient with a history of MRSA infection who underwent repeated CEA, the ECM patch offered a good technical outcome. Long-term studies are warranted to determine the efficacy of an ECM patch compared with other available options.

References