Commentary: The Quest for the Ideal Patch

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Patches are often needed for vessel enlargement or replacement, valve reconstruction, or septal defect closure. Ideally, the patch material should have the capacity to function like normal tissue and have characteristics that match or compliment those of the tissue it is intended to replace without eliciting rejection, fibrosis, or calcification.

Unfortunately, there is no such material. Several attempts by both medical and industry researchers have come up with satisfactory, albeit, not ideal patches that offer a temporary solution, but suboptimal long-term outcome. They are made of nonviable tissue that does not have the anatomical configuration or structure necessary for normal function. Their tissue characteristics change drastically once in use due to the significant inflammatory process they induce. These shortcomings are most apparent when these patches are used for valve reconstruction.

In their quest to define some of the characteristics of the available patch material, Hofferberth et al[1] tried to analyze one important aspect of valve tissue substitutes, mainly the effect of different fixation techniques on compliance/deformation of several currently used patch materials when exposed to "normal work" hemodynamics. This work is an important preliminary study. It attempts at providing the surgeon with additional guidelines that take into consideration the deformation factor and provide an estimate of the optimal dimensions of the patch when used for valve reconstruction. The sample used is small, and the selection criteria are not well defined or controlled. Several additional data points are needed to make the study clinically more relevant. The "normal work" the authors refer to is defined in static terms, but in reality, it is a dynamic parameter that varies considerably with changes in hemodynamics. The experimental range they used in their work does not necessarily cover the normal range of "normal work." Also, the study does not address the progressive changes in stiffness/compliance of the patch once it is exposed to the body metabolic and immune responses. Aggressive fixation of these patches could minimize deformation but would result in accelerated calcification and distortion of the patch and impairs modeling the patch to the appropriate functional shape. These adverse responses highlight the need for long-term longitudinal deformation data.

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Central Message

Several studies have attempted at studying the biological and physical properties of available patches. None of these studies however has helped in defining the biophysical properties of the ideal patch. Further bioengineering research may come out with the solution.

Finally, the experimental model involves testing the patch in a biaxial fashion. However, these patches do not assume a straight/linear configuration when used for vessel or valve reconstruction. It would have been more informative to evaluate these materials using a configuration that is similar to normal valve cusps, and in an environment similar to that of normal circulation.

The quest of the ideal patch lies in developing a biodegradable scaffold that assumes the configuration of a normal valve or vessel and is populated with stem cells. Until that is realized, this and other similar studies provide the ground work toward the ultimate goal.

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