Letter to the Editor

How should the tortuosity index and curvature ratio be used correctly in the ductal stenting procedure?

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Mini *et al.* published an article that named “Use of the ductal curvature index to assess the risk of ductal stenting in patients with duct-dependent pulmonary circulation” (1). Patent ductus arteriosus stenting is used as an alternative to surgical shunt procedures in newborns with pulmonary atresia. Ductus arteriosus in pulmonary atresia with some congenital heart defects such as pulmonary atresia and ventricular septal defect/tetralogy of Fallot, pulmonary atresia and transposition of great arteries/congenital corrected transposition of the great arteries, and pulmonary atresia and single ventricle/isomerism are very bizarre. This kind of patent ductus arteriosus has increased tortuosity and curvature (1,2). Tortuous vessels have various phenotypes such as curving, angulation, looping and increased coils formation (3). Increased tortuosity makes very difficult of stenting the patent ductus. To determine the difficulty level of ductus stenting, some concepts like such as tortuosity index, curvature index have been transferred to pediatric interventional cardiology from adult cardiology. However, there is a confusion about the use of tortuosity index and curvature index at the article.

In the retrospective analysis, the authors calculated the ductal curvature index to contribute to risk stratification of ductal stenting procedures. And they found that the ductal curvature index ≥0.45 was showing a high-risk group, in which procedures is associated with some complications or risk of early surgery (1). But unfortunately, they used tortuosity index formula instead of curvature calculation.

The actual curvature rate formula is derived by dividing the length of the outer curvature of the vessel by the centrally measured length of the vessel (4,5). Curvature is defined as inverse radius and is measured any single point along the path. And tortuosity should depend on the severity of curvature. Several types of methods are used to evaluate the tortuosity index. Simply, tortuosity is classified as type I if the vessel is relatively straight, as type II if it has one turn, and as type III if it has multiple turns (3). This evaluation is a basic or quantitative assessment of the tortuosity index. In most publications, the tortuosity is classified in this way, making type III the most challenging group. Moreover, the tortuosity index could be measured qualitative way using its formula. This is what the authors have tried to say in the article, but it given wrongly expressed as the curvature index formula. The formula must be as follows: tortuosity index = (L1 – L2)/L1. By definition, L1 should be the entire length of the ductus to be measured, namely, the actual length, while L2 should be the direct distance from the aortic origin of the ductus to the pulmonary end (6-11). How to take the measurements is shown in *Figure 1*. I would like to emphasize again that this is the tortuosity index formula, not the curvature index. The formula was adopted from a previously study by Quershi *et al.* in the text (2). But unfortunately, Qureshi *et al.* used the formula incorrectly, and more the formula was given the

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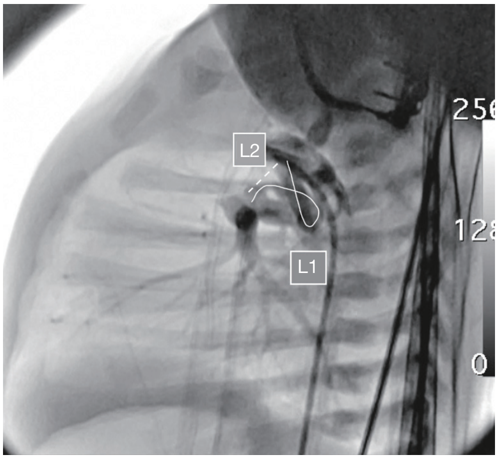

Figure 1 Vertical tortuous ductus arteriosus and tortuosity index measurements are seen in the lateral angiographic view of the tetralogy of Fallot with pulmonary atresia in a cyanotic newborn baby. Length 1 (L1) indicates the actual length of the curved ductus. Length 2 (L2) is the shortest distance between the ductus arteriosus ampulla and the pulmonary entry point.

study totally deficient (2).

As a result, what the authors have compared in the table and in the text is the simplified tortuosity index (classified as I, II, III) and the numeric tortuosity index, wrongly called the curvature index. The curvature ratio has not been measured at all. The curvature index term in the entire text should be interpreted by replacing it with the concept of tortuosity index, so as not to misguide the reader.

Conclusions

Tortuosity index and curvature ratio measurement in ductus arteriosus stenting in cyanotic newborns are useful tools in determining difficulty. However, not uncommonly errors are made in formulas related with them. The minireview is written clarify this issue with giving the highlighted the correct formula.

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Footnote

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Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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