



Impact of Artificial Neural Network in Predicting Safe Time for Temporary Artery Occlusion in Aneurysm Surgery: Results of a Pilot Study

Saeed Ansari MD; Shahab Kamali-Ardakani; Seyed Mohammad Ghodsi; shima shahjouei MD-MPH; Morteza Zanganeh Soroosh; Mohammad Babakmehr; Navid Redjal MD; Vishnumurthy Shushrutha Hedna; Spiros L. Blackburn MD

[Institution]



Introduction

The purpose of this study is to construct a software using Artificial Neural Network (ANN) to predict the safe time period of Temporary Artery Occlusion (TAO) during intracranial aneurysm surgery.

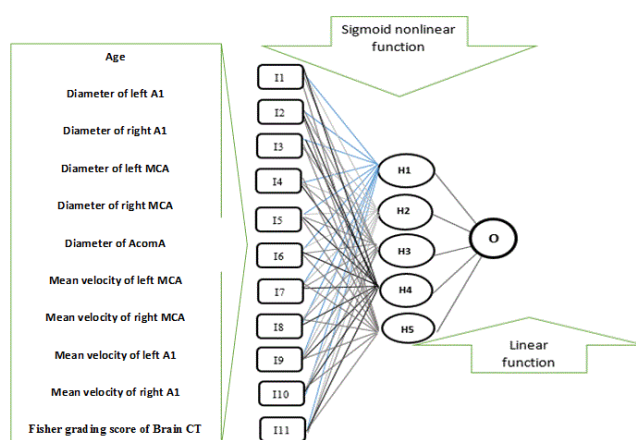
Methods

Using a retrospective database of 105 patients with ACommA or MCA aneurysms, an ANN model was developed. The model was constructed in three layers: input, hidden and output layers. A total of 11 inputs - age, diameter of left and right A1, diameter of left and right MCA, diameter of AcomA, mean velocity of left and right MCA, mean velocity of left and right A1 and Fisher grading score of brain CT scan were considered. There are five neurons in the hidden layer with a nonlinear assumption. The only output neuron represented the safe time period of TAO as assessed by the development of stroke in the distribution distal to TAO. The models learned the algorithm by the 11 inputs of the study cases, then underwent prospective "training" and "testing" through 20 cases.

Results

In the retrospective analysis of 105 patients, 32 (30.4%) were male and 73 (69.6%) were female (age range 30-72 years) with 80 (76.1%) aneurysms located in MCA and 25 (23.9%) in AcomA. Temporary clipping time varied from 120s-950s. Among 20 patients in prospective dataset analysis, 9 (45%) were male and 11 (55%) were female (age range 30-76 years). Fourteen (70%) had MCA and 6 (30%) had AcomA aneurysms with temporary clipping time ranging from 75s-930s. Safe time for TAO was higher in AcomA aneurysm surgery rather than MCA aneurysm surgery. Characteristic validity of the model assessed 87% in the prospective test cases with 13% a relative risk.

Architecture of the Artificial Neural Network



The input layer include 11 neurons (I1-I11). The hidden layer include 5 neurons (H1-H5) and the output layer consist of one neuron (O). The function applied on the hidden layer is sigmoid function while function over the output layer is linear function. The lines represent the weights of the connections. I: Input unit; H: Hidden unit; O: Output unit.

Output values

Site of obstruction	Safe time interval (s)	
	Min	Max
Overall	90	960
Right MCA	240	960
Left MCA	90	950
AcomA	120	932

The safe time interval for each aneurysm and overall result are demonstrated. MCA: middle cerebral artery; AcomA: anterior communicating arteries.

Ranked output of sensitivity analysis

Rank	Input value	Sensitivity (%)
1	Mean velocity of left MCA	56/32±4/32
2	Mean velocity of left ACA	48/78±5/92
3	Fisher scoring grade of Brain CT Scan	42/56±3/60
4	Mean velocity of right ACA	35/42±6/42
5	Diameter of right MCA	23/45±2/15
6	Diameter of AcomA	20/35±5/37
7	Diameter of left MCA	15/48±5/37
8	Diameter of left A1	56/32±4/32
8	Age	56/32±4/32
8	Mean velocity of right MCA	56/32±4/32

These result show which of the input variables has the greatest effect on the output value.

Learning Objectives

By the conclusion of this session, participants should be able to describe the importance and accuracy of artificial neural network (ANN) in predicting a safe time period for temporary artery occlusion in aneurysm surgery.

Conclusions

The concept of ANN modeling for TAO is introduced for a neurosurgical audience. Authors suggest that the validity (87%) of this ANN model should be tested in a larger patient population. However, the bias in this model leave enough degree of freedom to produce acceptable generalization.

References

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