Short Report:
An Innovative Nerve Repair Simulation Model with a Technique to Assess Fasicular Coaptation.

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Citation

Submitted: Sep 5, 2019; Accepted: Oct 17, 2019; Published: Oct 30, 2019

Abstract: Traumatic nerve injuries and its repair are an integral part of hand surgery specialty. Along with suitable tension at the anastomotic site, another important factor that determines favourable outcome during repair is to obtain a proper coaptation of the nerve fascicles. Practice in microsurgical skill labs on simulation models helps residents and young surgeons to develop these key steps. An ideal simulation exercise should not only mimic the technical challenges involved in the procedure but should also allow the trainees to evaluate their own technique & methods. As there is lack of description of simulation exercises with provision for evaluation of extent of repair in the literature, we propose a simple model of nerve repair simulation emphasizing on evaluation of fasicular coaptation.

Key Words: Nerve repair simulation, Evaluation, Fasicular coaptation

Introduction:
Traumatic nerve injuries and its repair are an integral part of hand surgery specialty. Unpredictability and the critical time have been the hallmarks of results of nerve repair procedures. Clinical and Investigative modalities to confirm the success of nerve repair anastomosis takes time unlike in microvascular repair where the results can be immediately assessed. Appropriate tension at the anastomotic site and proper coaptation of nerve fascicles are the two critical steps in obtaining favourable outcome during nerve repair. It will be unethical for the budding surgeons to acquire this expertise directly on the patient in actual clinical scenarios. With the advent of new nerve transfer techniques, the art of peripheral micro neurosurgery and its training has acquired a new significance. An ideal simulation exercise should not only mimic the technical challenges involved in the procedure but should also allow the trainees to evaluate their own techniques & methods. There are some attempts to address this aspect of training in the literature.1,2 As there is further scope to improve it, we propose a simple method of nerve repair simulation emphasizing on evaluation of fasicular coaptation thus obtained following repair.

Material and Methods
This model involves preparing two conduits of desirable size using the sterile disposable hand towels available in operation theatres. The conduits are cut into a width of 1 inch to mimic the proximal and distal cut ends of nerve to be repaired. Different coloured hollow plastic tubes of suitable length are obtained by trimming the middle third of cotton ear buds to mimic the fascicles. Three or four such white and coloured tubes are inserted into the conduit representing proximal segment and distal segment respectively (Fig 1). The two segments are transfixed using a nerve approximator3 to suture both anterior and posterior wall keeping in mind the fascicular alignment (Fig 2).

After completion of the exercise, an android flexible HD Camera (diameter of 3.5 millimeters, with inbuilt 6 adjustable white LEDs and working length of 2 meters) is used to evaluate the degree of coaptation at the anastomotic site. The camera is connected to the laptop using an USB cable and the images are acquired with the help of inbuilt application. The distance of the camera from proximal segment is so adjusted...
that the images are properly seen (Fig 3). The camera is focused on each of the four fascicles separately and the resultant image is seen as overlap of white circles over coloured circles. The degree and the configuration of this overlap will give the evaluator an idea of level of coaptation. This is quantified as Grade 4 (100-75%), Grade 3 (75-50%), Grade 2 (50-25%), and Grade 1 (less than 25%) as depicted in Figure 4.

Figure 3: Evaluation of nerve repair using android camera : 3a: focusing the camera on the proximal end; 3b: image on the laptop monitor.

Figure 4: Grading of the nerve repair according to degree of fascicular coaptation.

As the trainees advance in their competencies, the exercise can be made more complex by reducing the size of the fascicles by using venflon catheter sheath/ infant feeding tube instead of plastic tubes. One can also opt for mismatched cut ends to simulate a nerve transfer exercise. All these variations can still be evaluated using the above described method.

**Results and Discussion**

As a pilot study, we in our department undertook an exercise involving 10 surgeons with varying degree of clinical experience (2 consultants, 3 associate professors, 5 residents). All the 10 participants were sensitised about the nerve repair simulatory exercise which comprised of epineurorraphy by putting five anterior and five posterior stitches using 8-0 nylon. The conduit involved only three cut fascicles to minimise the complexity of repair technique and evaluation. The emphasis was laid on introducing the first two key stitches taking care of adequate fascicular coaptation. At the end of the exercise, a questionnaire form was given to take feedback (Table 1). Evaluation of coaptation was assessed by a neutral observer using the grading system described earlier.

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<th>Questions</th>
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<td>1. Ease of construction and reusability of this model of nerve repair simulation. (easy/fair/difficult)</td>
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<td>2. Comfort level of using the nerve approximator(easy/fair/difficult)</td>
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<td>3. Intricacies and complexity involved in the nerve repair simulation. (easy/fair/difficult)</td>
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<td>4. Ease and feel during epineurorraphy (easy/fair/difficult)</td>
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<td>5. Ease of knot tying (easy/fair/difficult)</td>
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<td>6. Method of evaluation and quantification of fascicular coaptation. (easy/fair/difficult)</td>
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<td>7. Have you heard of any other nerve repair simulation exercise. (yes/no)</td>
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<td>8. Overall satisfaction (poor/moderate/good)</td>
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In the evaluation, out of 30 fascicular coaptation obtained after repair, we observed grade 4, 3, 2 in 1, 5, 11, 13 repairs respectively. It was observed that better repairs with good coaptation were linked to experience of the participants. Though small number of participants is the limitation of this study, we found this innovative method as encouraging and has got considerable potential to be included in the armamentarium of surgical simulation in the field of nerve repairs.

**Conclusion**

The above described method of nerve repair exercise is not only simple but also allows the evaluation of degree of coaptation of the fascicles.

**Conflict of Interest:** None

**Funding:** The authors hereby declare that no funding source has been involved in this study.

**References**