Brief Communication

A Mannequin Based Training System for Practicing Sub-Tenon's block

Jaichandran V V[1], Nimal J. Kumar[2], Boby George[2], Mohanasankar Sivaprakasam[2]

[1]Department of Anaesthesiology, Sankara Nethralaya, Chennai,
[2]Department of Electrical Engineering, IITM, Chennai.

Background and Aims

Sub-tenon ophthalmic block (STB) is gaining popularity in ophthalmic anesthesia as it is safer than needle (peribulbar) blocks. But, still complications such as orbital and retrobulbar haemorrhage,[1,2] recti muscle paresis and trauma,[3] globe perforation,[4] central spread of local anaesthetic solution[5] and orbital cellulitis[6] have been reported.

An animal model (goat's eye) for learning and practicing STB has been described by Vohra.[7] The animal eye model appears to be useful, more realistic (the size and shape being like the human eye), effective, reproducible, and inexpensive. However, the animal eye cannot be a true substitute for human anatomical equivalent, and there are other limitations including religious constraints. STB is challenging to simulate on a skull or plastic mould because the procedure requires a delicate dissection of the conjunctiva and Tenon's capsule. Anatomical training simulators for STB are virtually non-existent, and STB is often performed on actual patients. Training on actual patients may be dangerous and can lead to undesirable consequences. STB requires thorough anatomical knowledge and prior practice for safe and precise administration of local anaesthetic solution under the Tenon's capsule. With this background, we developed a prototype silicone membrane-based simulator, first of its type, for practicing STB.

Methods

An integrated, conductive silicone-based eye model sensor was developed (Figure 1). The simulator replicates the anatomy of the globe, the tenon membrane and the conjunctiva. The globe was moulded using platinum cure silicone rubber. The globe was ellipsoid and measured 26.5 and 24 mm in the major and minor axes, respectively. To make the globe conductive, chopped carbon fibres(CCF) were added (Figure 2).

Address for correspondence:
Dr Jaichandran V V
Deputy Director,
Department of Anaesthesiology,
Sankara Nethralaya,
No. 41(Old No. 18), College Road,
Chennai 600006, Tamil Nadu, India
Email: drvvj@snmail.org

Article History
Received: 29th April 2023
Revision: 7th May 2023
Accepted: 13th June 2023
Published: 30th June 2023

How to cite this article: Jaichandran V V. A mannequin based training system for practicing subtenon's block. Indian J Ophthal Anaesth 2023;3(2):27-3

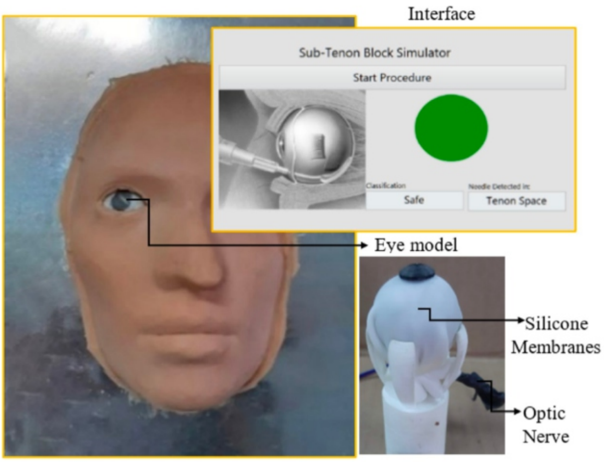

Figure1: Sub-tenon block simulator with interface

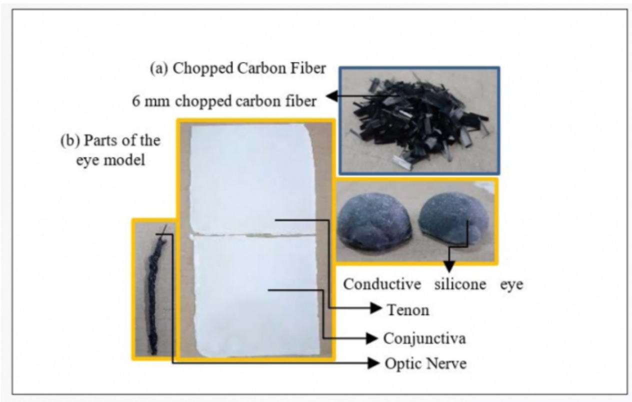

Figure2: Platinum cure Silicone based Tenon, Conjunctiva, globe and optic nerve prepared

The two membranes, Tenon's capsule and conjunctiva, were also cast using compound silicone rubber (Smooth-on Ecoflex). The rubber layers for the Tenon's capsule were 1.5 mm in thickness. The dimensions of the globe and thickness of the layers realistically simulated the eye of an average healthy human. The simulated optic nerve was a cylinder measuring approximately 1.8 mm in diameter. This was prepared using a standard wire gauge wire, which was coated with silicone to provide a realistic optic nerve appearance and feel (Figure 2).

The four pieces, once fabricated, are assembled to form the sub-tenon eye model. The optic nerve is inserted into the eyeball posteriorly and insulated from the eyeball. The tenon layer is wrapped around the eyeball and held using a cable tie. Finally, the conjunctiva is wrapped around the eyeball and tied posteriorly. The eye setup is held in the simulator using a 3D printed holder that resembles the ocular muscle anatomy. The eye model attaches to conductive protrusions with mating sockets in the holder (Figure 3).

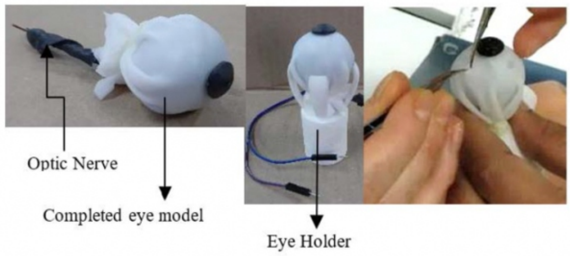

Figure3: The assembled eye model and the eye holder

A method of cannula insertion position (entry quadrant) sensing was developed using a small permanent magnet attached to the bottom of the barrel of the syringe such that the magnet is approximately 30 mm from the point of insertion once the cannula is fully inserted. The curvature and stiffness of the cannula allows only one possible orientation of entry and prevent rolling and bending of the stem of the cannula within the eye. Hence, the quadrant of the insertion is determined simply by sensing the position of the magnet once the cannula is fully inserted. The construction of the cannula and anatomical space restriction within the eye ensure that the quadrant of insertion cannot change once the cannula enters the eye.

Sensing whether the cannula is in the sub tenon space and whether the cannula has touched the optic nerve is achieved through the capacitive touch sensing method.7 The interface is displayed on a personal computer as colour indications. A red indication is presented for a cannula insertion in the wrong plane (sub-conjunctival plane) and a green indication is presented if the cannula is inserted in the right plane. (Figure 1).

The body of the cannula touches or comes in proximity with the conductive eyeball if inserted in the correct plane (sub-tenon space), namely, in between the eyeball and the tenon. If the cannula is inserted in between the tenon and conjunctiva, the cannula is not in contact with the eyeball. The touch/proximity sensing must be accomplished without connecting a wire to the syringe. The eye model and the optic nerve are already fabricated to be conductive. To ascertain the touch of the cannula on the eyeball (or optic nerve), the syringe itself is made conductive (to reduce the capacitance offered by the syringe to zero) by inserting copper strips, one inside the syringe and in contact with another copper strip pasted outside. The outer metal strip is in contact with the hand of the trainee, (Figure 4). The modifications do not hinder the sub-tenon block process in any way.However, the syringe is blocked so that no liquid enters the sensory setup.With the syringe modified to be conductive, then there is sufficient capacitive coupling between the user's body and the conductive eyeball that enables sensing of whether the cannula had touched the eyeball. Also, with a conductive syringe, the cannula-optic nerve touch can also be sensed.

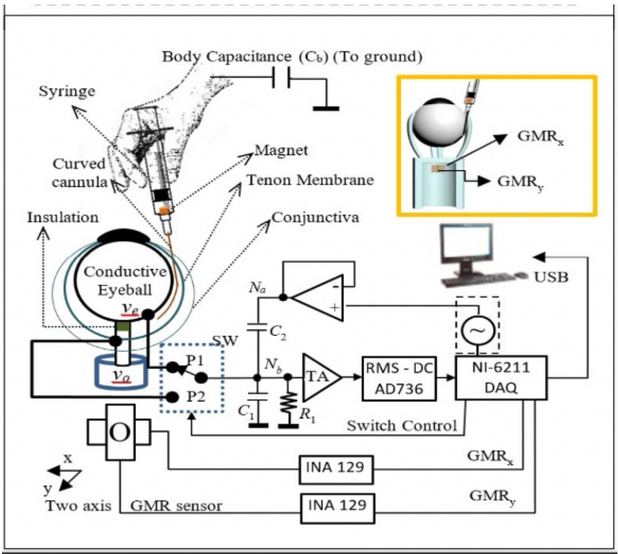

Figure4: Detection of plane of entry using Capacitive touch sensing method

The developed system was validated in a pilot clinical study for naturality and usage in a clinical setting with 37 ophthalmic anaesthetists.8 The system recorded 98.3% accuracy assessing the performed procedure during the clinical study, and the participants rated the naturality of the system with a score of 8.0 ± 0.63 (on a scale of 10) ($p < 0.01$).2 Eighty nine percent of the total participants and experienced sub tenon block instructors who previously used provisional animal eye-based models for training preferred the training system for its usage of anatomically accurate models and effective warning systems that evaluate the performed procedure.8

Future scope

We are planning to integrate and simulate major vessels inside the orbit like ophthalmic

We are trying to simulate abnormal globe:orbit conditions so that trainees can learn performing eye blocks in these challenging cases.

Conclusion

This type of training system can be utilized as a teaching module as well as a practicing tool to perform STB. This in turn can enable them to administer safe regional anaesthesia in their patients.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Rahman I, Ataullah S. Retrobulbar hemorrhage after sub-Tenon's anesthesia. J Cataract Refract Surg 2004;30:2636–7.
2. Olitsky SE, Juneja RG. Orbital hemorrhage after the administration of sub-Tenon's infusion anesthesia. Ophthalmic Surg Lasers 1997;28: 145–6.
3. Pierer A, Schwalb E. Superior oblique muscle paresis after sub-Tenon's anesthesia for cataract surgery. J Cataract Refract Surg 1999;25: 144–5.
4. Frieman BJ, Friedberg MA. Globe perforation associated with subtenon's anesthesia. Am J Ophthalmol 2001;131:520–1.
5. Ruschen H, Bremner FD, Carr C. Complications after sub-Tenon's eye block. Anesth Analg 2003;96:273–7.
6. Kumar CM, Dodds C, Dowd TC, Boyce R. Orbital cellulitis following peribulbar and sub- Tenon's block. Eye 2004;18:418–20.
7. Vohra SB. Equatorial sub-Tenon blocks: animal model training. Trends Anaesth Crit Care. 2015;5:141–5.
8. Kumar NJ, George B, Sivaprakasam M, Jaichandran VV. A Mannequin-Based Training System With Integrated Sensors for Ophthalmic Sub-Tenon Anesthesia. IEEE Sensors Journal 2021;21(3):3839-48.
9. Jagadeesh Kumar N, Venkatakrishnan JV, Kumar CM, George B, Sivaprakasam M. Comparative study of silicone membrane simulator and animal eye models for sub-Tenon's block. J Clin Monit Comput. 2021 Dec;35(6):1519-24.