Investigation into the Role of Tube Crimping in Medical Devices for Failed Epidural Analgesia

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Introduction

An epidural is an injection of medication into the back to induce a loss of sensation by blocking signals from nerves that transmit pain messages to the brain. Using a needle, a fine tube is inserted into the epidural space around the spinal cord and is connected to a catheter which anesthetic is administered through. Due to a number of possible reasons, some epidurals fail.
A theory for the failure is the crimping of the epidural tube within the catheters internal mechanisms creating different pressure levels when the medication is injected into the patient. The goal of this research is to determine if any or enough crimping occurs within an epidural catheter that would cause complications using various catheter types.

Methodology

Using cold mounting epoxy resin and catheter of choice pot the device with the following procedure.

1. Insert tubing into device and keep open. If device does not open, skip to step 3
2. Pour resin over the internal workings, making sure the inside is completely covered and close
3. Using a syringe, push resin through the tube until full
4. Place device in vertical position within the mounting cup, cover entirely in resin and hold until stable within the liquid
5. Once solid as seen in Figure A, remove sample from cup and cut to reveal a cross section of the device
6. Buff and polish the sample until it the tube's internal and external diameters are clearly visible
7. Examine under microscope and form conclusions

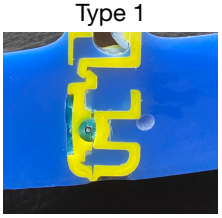

A

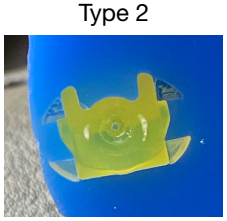
Results

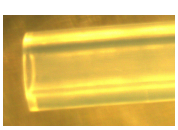

Type 1

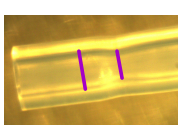

Type 2

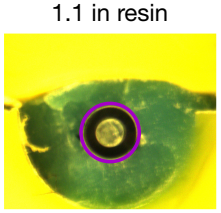

Type 3

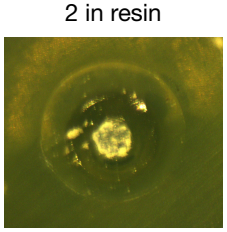

1.1 in resin

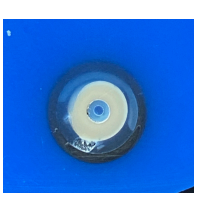

2 in resin

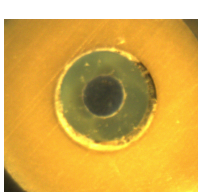

Tube before twist in device


Tube after twist in device


1.1 microscopic view


2 microscopic view


3 in resin


3 microscopic view

Conclusions

Although crimping may occur within the twisted catheter, not enough pressure change occurs to cause epidural failure as shown with the type 3 microscopic view. The tube is crimped within the device but resin is still able to fully pass through. The next step would be to test the syringe pressure when medication is injected.

Bibliography

Bullock, J. D., Warwar, R. E., & Green, W. R. (1998). Ocular explosion during cataract surgery: a clinical, histopathological, experimental, and biophysical study. Transactions of the American Ophthalmological Society, 96, 243–281.

NHS. (2020, March 11). Epidural Overview. NHS choices. Retrieved May 5, 2022, from https://www.nhs.uk/conditions/epidural/