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Monitoring Epidural Needle and Catheter Placement through Optical Fiber Sensor Technology

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Abstract

Abstract

We have recently proposed an optical guidance system, which combines the principle of operation of the LOR technique with the advantages offered by the optical fiber sensor technology [1-3]. Our system is based on a customized optical fiber sensor called fiber Bragg grating (FBG) which has been widely used in medical applications. In our specific application, the FBG detects in real time the consistency of the tissues encountered by the needle during penetration by means of strain measurements. Specifically, FBG is integrated inside a conventional epidural catheter (EC) which, on its turn, is inserted inside the epidural needle. Through in vivo tests, we demonstrate how the new device, being based on the optically sensitized catheter, is able to assist clinicians not only in the correct positioning of the needle, but also of the EC inside the ES. This may seem a trivial aspect, but it is definitely not. In fact, during the advancement, the catheter might deviate from its straight course and bend in such a way that the injected drug is not beneficial. This side-effect, known as catheter "kinking" or "coiling", is very common in the clinical practice, and it represents the major cause of failed epidural, with more than the 40% of the cases [4]. We demonstrate that, if the EC bends during its advancement through the ES, so does the embedded optical fiber sensor, thus involving an intensity drop of the FBG back-reflected signal. Overall, the proposed device has the potentiality to assist the clinicians during the entire epidural procedure, from the needle positioning to the catheter insertion monitoring inside the ES.

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Abstract
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References

1. B. Carotenuto, A. Micco, A. Ricciardi, E. Amorizzo, M. Mercieri, A. Cutolo, and A. Cusano, “Optical Guidance Systems for Epidural Space Identification,” IEEE J. Sel. Top. Quantum Electron. 2017;23(2):1–9

2. Carotenuto, B.; Ricciardi, A.; Micco, A.; Amorizzo, E.; Mercieri, M.; Cutolo, A.; Cusano, A. Optical Fiber Technology enables Smart Needles for Epidurals: an in-vivo swine study. Biomed. Opt. Express 2019;10(3):1351-1364

3. Carotenuto, B.; Ricciardi, A.; Micco, A.; Amorizzo, E.; Mercieri, M.; Cutolo, A.; Cusano, A. Smart Optical Catheters for Epidurals. Sensors. 2018;18:2101

4. Hermanides, J.; Hollmann, M. W.; Stevens, M. F.; Lirk, P. Failed epidural: causes and management. Br. J. Anaesthesia. 2012;109:144-154