



Methylene blue fluorescence: a new way to protect the ureters?

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Iatrogenic ureteral injury during colorectal surgery is a rare complication, with described rates between 0.15% and 1.9% (1,2). It is however associated with considerable mortality, morbidity and medico-legal issues. Strategies to prevent such injury are diverse but none succeeded to significantly reduce its frequency (3). Identifying ureter in surrounding tissue may be difficult, especially in conditions such as obesity, adhesions, inflammatory status or anatomic variations. Ureter stenting is routinely used in such situation, but has never proved to be efficient and is associated with its own morbidity and increased operative time. Recent development of fluorescence based augmented reality techniques to improve visualization of important structures may provide an elegant answer to this problematic. As such, ureter fluorescence after methylene blue (MB) intravenous injection has been described as feasible in few clinical studies, although results are still heterogeneous (4,5).

In this open label prospective study, Barnes *et al.* investigated performances of a new dedicated device (PINPOINT Deep Red, NOVADAQ, USA) to identify ureters during colorectal procedures after MB injection. Forty-two patients undergoing colorectal surgery received intravenous MB injection at doses between 0.25 and 1 mg/kg, 10 to 15 minutes before approaching estimated ureter region during dissection. Ureter was then searched both under standard white light and fluorescent light. Two patients were excluded from analysis. In total, 69 ureters were searched in 40 patients. Sixty-four were visible under fluorescent light, the 5 remaining being neither found under white light. Fourteen ureters (20%) could only be identified in fluorescent mode. Subjective assessment considered MB fluorescence useful in 13 cases, showing ureter at an

unexpected place in 10 cases, and substantially modifying operative strategy in 2 cases. Optimal dose of MB was estimated at 0.75 mg/kg, and peak of ureter identification probability was obtained at 58 min after injection. No adverse event occurred.

Since it was first described in human by Verbeek *et al.* (6), MB fluorescence has been investigated in few studies (4,5). Main limitation of this technology to date was low intensity of fluorescent emission by this fluorophore. Thus, new devices improving stimulation intensity and detectors sensitivity were needed. Excellent results from Barnes *et al.* show that such technology is now available. Noticeably, 20% of ureters identified under fluorescence could not be seen under white light, and in 10 cases ureter was not found where it was expected to. Even though these ureters would not necessarily have been damaged, fluorescence did undoubtedly help at least to reduce operative time and surgeon's stress. It is important as well to have a precise idea of the concentration needed to have a proper signal according to an optimal dose. Thus, allowing to standardize a technique for the future studies.

Subjective appreciation is a very important parameter when it comes to augmented reality techniques. However, a proper quantification is not yet available and will need to be addressed in future studies.

Events such as iatrogenic ureter injuries or anastomotic leak have become, hopefully, so rare that statistically improving them tends to be difficult. Alternatively, parameters such as attitude change, operative time and surgeon's general appreciation could be good indicators of usefulness (7). The present study can thus, in our opinion, be considered as proof of concept of this technology as well as a proof of safety.

Overall, this study adds some more evidence that future improvements in minimally invasive surgery will benefit greatly from fluorescence based augmented reality technologies.

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