Intraoperative Neuromonitoring in Rectal Surgery

The potential benefit of ensuring patient safety has led to the widespread application of intraoperative neuromonitoring in various surgical disciplines.

Surgical interventions in the small pelvis expose the autonomous nerve structures – particularly the **inferior hypogastric plexus**, including the **neurovascular bundle**, which is close to the rectum, and the **splanchnic nerves** – to the risk of damage. This includes complete severing of nerves and indirect destruction of nerve fibers through traction, bruising or heat. Intraoperative nerve damage has been identified as one of the main reasons for postoperative dysfunctions of **total mesorectal excision** (TME), such as anorectal incontinence, voiding dysfunction and sexual dysfunction (Abdelli et al., 2017; Lent and Junginger, 2011). These problems and solution approaches have been described in a growing number of publications and have been examined in clinical studies for more than 30 years. Although the reported damage rates vary considerably, they still seem to present a common problem. Until now, scientists have been unable to prove any significant improvement by conducting studies on the introduction and implementation of surgery which is gentle on the nerves and based on the visual depiction of nerves as well as studies on robot-assisted surgery (Celantano et al. 2017).

Pelvic intraoperative neuromonitoring (pIOM®) has the potential to decisively support the surgeon in preserving deep nerve structures during surgical procedures in the small pelvis.

Clinical studies have shown that by combining electromyography (EMG) of the smooth muscles of the internal anal sphincter (IAS) with intravesical pressure measurement, surgeons can examine a sufficiently large area of the neural structures of the inferior hypogastric plexus in order to assess the postoperative outcome also with regard to sexual functions (Kauff et al., 2013). By using pIOM®, the surgeon can thus selectively stimulate the nerves in order to identify and protect relevant fibers as well as to check and document their integrity. The impact of this measurement on the postoperative outcome of TME patients has been examined in two prospective studies:

- **Preserving anorectal function** (Kauff et al., 2020)

  The comparison of 23 patients who have been treated without and 29 patients who have been treated with neuromonitoring has shown **significantly reduced rates of incontinence** for the group treated with neuromonitoring at all 4 measuring points and up to 24 months after surgery.

- **Preserving urogenital function** (Kauff et al., 2017)

  The comparison of 42 patients who have been treated without and 43 patients who have been treated with neuromonitoring has shown **significantly reduced rates of voiding dysfunction** and **significantly reduced rates of sexual dysfunction** for the group treated with neuromonitoring at all 4 measuring points and up to 24 months after surgery.

Other publications have also shown the feasibility and benefits of pelvic neuromonitoring for rectal resection (Fang et al. 2015; Wałęga et al., 2017; Zhou et al. 2018).

Apart from rectal resection, pIOM® can be used during all procedures in the deep pelvic nerve structures, for example for treating deep infiltrating endometriosis or for other gynecological procedures such as radical hysterectomy.

The implementation of pIOM® is described for both the ISIS IOM system and the C2 NerveMonitor (Kauff et al., 2013, 2016, Kneist et al., 2013a, 2013b) and does not have any impact on the surgery. The surgeon only uses the stimulation probe at critical points to examine the nerves, a technique which can be compared to intermittent, localizing neuromonitoring of the thyroid (Kneist et al., 2015).

As surgeons measure the reaction of the smooth muscles in order to control the autonomous nerves, a complete relaxation of the skeletal muscles improves the signal quality of the measurement. The best results can be achieved during intravenous anesthesia with propofol (Heid et al., 2015).

Due to the continuous further development of the technology, pIOM® can be used for all surgical procedures. The long stimulation probe can be used during open and laparoscopic surgery and can also be inserted through the anus. A specially adapted probe facilitates the application during robot-assisted surgery (Schiemer et al., 2018a; Schiemer et al., 2018b).

More safety and a better quality of life for patients

In 2019, the developers of the pIOM® technology received the German **Award for Patient Safety in Medical Technology**. On behalf of the German Society for Biomedical Engineering in the VDE (DGBMT) and the German Coalition for Patient Safety (APS), an independent body of clinicians, medical technicians and health economists evaluated the value of the technology for enhancing patient safety.

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Bibliography

Abdelli, A., Tillou, X., Alves, A., and Menahem, B. (2017) Genito-urinary sequelae after carcinological rectal resection: What to tell patients in 2017. J. Visc. Surg. *154*, 93–104

Celentano, V., Cohen, R., Warusavitarne, J., Faiz, O., Chand, M. (2017) Sexual dysfunction following rectal cancer surgery. *Int J Colorectal Dis* 32, 1523–1530 doi:10.1007/s00384-017-2826-4

Fang, J.-F., Wie B., Zheng, Z.-H., Chen, T.-F., Huang, Y., Huang, J.-L., Lei, P.-R., and Wei, H.-B. (2015) Effect of intraoperative autonomic nerve stimulation on pelvic nerve preservation during radical laparoscopic proctectomy. Colorectal Disease 17(12) O268-O276. doi:10.1111/codi.13115

Heid, F., Kauff, D.W., Lang, H., and Kneist, W. (2015) Impact of inhalation vs. intravenous anaesthesia on autonomic nerves and internal anal sphincter tone. Acta Anaesthesiol. Scand. *59*, 1119–25

Kauff, D.W., Koch, K.P., Somerlik, K.H., Hoffmann, K.P., Lang, H., and Kneist, W. (2013) Evaluation of two-dimensional intraoperative neuromonitoring for predicting urinary and anorectal function after rectal cancer surgery. Int. J. Colorectal Dis. *28*, 659–64

Kauff, D.W., Kronfeld, K., Gorbulev, S., Wachtlin, D., Lang, H., and Kneist, W. (2016) Continuous intra-operative monitoring of pelvic autonomic nerves during TME to prevent urogenital and anorectal dysfunction in rectal cancer patients (NEUROS): a randomized controlled trial. BMC Cancer *16*

Kauff, D.W., Lang, H., and Kneist, W. (2017) Risk Factor Analysis for Newly Developed Urogenital Dysfunction after Total Mesorectal Excision and Impact of Pelvic Intraoperative Neuromonitoring? a Prospective 2-Year Follow-Up Study. J. Gastrointest. Surg. *21*, 1038–47

Kauff, D.W., Roth, Y.D.S., Bettzieche, R.S., and Kneist, W. (2020) Fecal incontinence after total mesorectal excision for rectal cancer—impact of potential risk factors and pelvic intraoperative neuromonitoring. World Journal of Surgical Oncology (2020) 18:12 doi:10.1186/s12957-020-1782-6

Kneist, W., Kauff, D.W., Rubenwolf, P., Thomas, C., Hampel, C., and Lang, H. (2013a) Intraoperative Monitoring of Bladder and Internal Anal Sphincter Innervation: A Predictor of Erectile Function following Low Anterior Rectal Resection for Rectal Cancer? Results of a Prospective Clinical Study. Dig. Surg. *30*, 459–65

Kneist, W., Kauff, D.W., Juhre, V., Hoffmann, K.P., and Lang, H. (2013b) Is intraoperative neuro-monitoring associated with better functional outcome in patients undergoing open TME? EJSO *39*, 994–9

Kneist, W., Rink, A.D., Kauff, D.W., Konerding, M.A., and Lang, H. (2015) Topography of the extrinsic internal anal sphincter nerve supply during laparoscopic-assisted TAMIS TME: five key zones of risk from the surgeons' view. Int. J. Colorectal Dis. *30*, 71–8

Lent, V., and Junginger, T. (2011) Nervenstörungen der Harnblasen- und Sexualfunktionen nach Rektumresektionen und -exstirpationen. CHAZ *12*, 257–61

Schiemer, J.F., Zimniak, L., Hadzijusufovic, E., Lang, H., and Kneist, W. (2018a) Novel multi-image view for neuromapping meets the needs of the robotic surgeon. Tech. Coloproctology.

Schiemer, J.F., Zimniak, L., Grimminger, P., Lang, H., and Kneist, W. (2018b) Robot-guided neuromapping during nerve-sparing taTME for low rectal cancer. Int. J. Colorectal Dis.

Wałęga, P., Romaniszyn, M., Wałęga, M., Świrta, S., and Nowak, W. (2017) Intraoperative neuro-monitoring of hypogastric plexus branches during surgery for rectal cancer - preliminary report. Pol. Przegl. Chir. 69–72

Zhou, M.W., Huang, X.Y., Chen, Z.Y., Li, Z.Y., Zhou, Y.M., Yang, Y., Wang, Z.H., Xiang, J.B., Gu, X.D. (2018) Intraoperative monitoring of pelvic autonomic nerves during laparoscopic low anterior resection of rectal cancer. Cancer Management and Research 2019:11, 411-17