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ABSTRACT

Background and Purpose: Laparoscopic hand-assist devices have facilitated the broad application and acceptance of laparoscopy in urology and other surgical fields. This study evaluated forearm compression by these devices.

Materials and Methods: Five commercially available hand-assist devices were tested (Gelport, Intromit, PneumoSleeve, Handport, LapDisc). In three surgeons using a porcine model, compressive forces were measured along the paths of the median and ulnar nerves at the point of maximum proximal forearm circumference using FlexiForce A101 sensors. Glove size for all three surgeons was 7 1/2; however, the maximum forearm circumference ranged from 26 to 33 cm. The hand-assist devices were placed in pigs after skin and fascial incision (9 cm), and the insufflation pressure was set at 18 mm Hg. Surgeons subjectively rated the ease of device insertion and hand insertion, degree of forearm compression, and the development of paresthesias.

Results: The LapDisc was rated superior with regard to insertion. The Gelport was rated superior for hand insertion and removal; however, moderate to severe forearm compression and paresthesias were reported. The maximum forearm compression forces were highest with the LapDisc (97 mm Hg) and the Gelport (78 mm Hg) and lowest with the Handport (33 mm Hg).

Conclusion: The choice of hand-assist device is dependent on its ease of use, efficacy at maintaining insufflation, and effect on the surgeon’s performance and fatigue. The impact of forearm compression should be considered in the selection of the hand-assist device and in the development of new devices.

INTRODUCTION

LAPAROSCOPIC HAND-ASSIST DEVICES have facilitated the broad application and acceptance of laparoscopy in urology and other surgical fields. We have noticed the presence of forearm compression while utilizing hand-assist devices. This study systematically evaluated forearm compression by these devices.

MATERIALS AND METHODS

Five commercially available hand-assist devices were tested: Gelport (Applied Medical), Intromit (Applied Medical), PneumoSleeve (Dexterity), Handport (Smith-Nephews), and LapDisc (Ethicon). The devices were placed in six female pigs (60 kg) after skin and fascial incision (9 cm), and the insufflation pressure was set at 18 mm Hg with the animals under general anesthesia without muscle relaxation. All five devices were tested in each animal, and the order of device insertion was randomized for each animal. A larger fascial incision (9 cm) than recommended by the device manufacturers was utilized to minimize the impact of fascial constriction on forearm pressures. Glove size for all three participating surgeons was 7 1/2 to eliminate one source of variability, although the maximum forearm circumference ranged from 26 to 33 cm. Surgeons placed their forearms into the hand-assist device until the point of maximum forearm circumference was within the ring of the device. The tightness of the devices was then adjusted if needed (LapDisc by twisting, Handport by insufflation) until just enough pressure was exerted to maintain the pneumoperitoneum without leakage of gas.

Compressive forces were measured continuously for 3 minutes along the paths of the median and ulnar nerves at the point of maximum proximal forearm circumference (Fig. 1) using FlexiForce A101 sensors (Tekscan, South Boston, MA). The
sensors have two pressure transducers in parallel, allowing positioning of one of the two sensors at the point of maximum forearm circumference. The maximal compressive force detected was recorded. Surgeons subjectively rated the ease of device insertion and hand insertion, the degree of forearm compression, and the development of paresthesias (tingling, numbness, and/or pain).

RESULTS

No consistent differences in objective or subjective compression were identified according to the surgeon’s forearm circumference. The maximum forearm compression forces (Fig. 2) were highest with the LapDisc (97 mm Hg) and Gelport (78 mm Hg) and lowest with the Handport (33 mm Hg). Subjective ease of device insertion was superior for the LapDisc, while ease of hand insertion and removal was superior for the Gelport (Fig. 3). Compression and paresthesias were worse with the Gelport device (Fig. 4).

DISCUSSION

This study evaluated the amount of forearm compression exerted by hand-assist laparoscopic devices. The potential implications of forearm compression include surgeon fatigue and temporary or permanent neurologic or vascular deficits.

Measurements were obtained with the forearm extended into the device to the point of maximum forearm circumference to approximate the worst-case scenario during a clinical application. One would anticipate that the operative time in such a position would represent the minority of a laparoscopic procedure; for example, during dissection between the kidney and the spleen or liver during a laparoscopic radical nephrectomy. Three-minute readings were selected to minimize changes in forearm compression caused by swelling of the forearm from prolonged use that could increase pressures or relaxation of the abdominal fascia that could decrease pressures. To limit potentially confounding variables, we studied only surgeons with a glove size of 7 1/2 and utilized a 9-cm fascial incision in all experiments. Future studies may evaluate the impact of varying these parameters on forearm pressures.
Most studies have evaluated the impact of compression on the anterior compartment of the leg and the carpal tunnel of the wrist. These studies have demonstrated that the threshold for sensory loss is a function of both intramuscular pressure and duration of compression. Following relatively short (1–3 hours) periods of compression of the anterior compartment of the leg, sensory loss occurs at 30 to 40 mm Hg below diastolic pressure or about 40 to 50 mm Hg of absolute muscle pressure. After only 45 minutes of compression, sensation is completely lost at 10 to 25 mm Hg below diastolic pressure or 55 to 70 mm Hg of absolute muscle pressure. The pressures measured with the Gelport and LapDisc devices would correlate with the latter observations.

It is interesting that the subjective compression by the Gelport was highest, although objective measurements of compression were highest with the LapDisc. This difference may relate to the thickness of the device; with the thicker Gelport, the pressure would be distributed over a larger portion of the forearm, leading to a more pronounced feeling of compression.

In a recent survey of 18 leading urologic laparoscopists, 28% and 17% reported frequent neck and shoulder pain, respectively. However, hand or wrist pain was reported by 67% of the respondents. The study did not compare the prevalence of wrist and hand pain in surgeons performing hand-assist procedures with those performing conventional laparoscopy.

**CONCLUSION**

The choice of hand-assist device is dependent on its ease of use, efficacy at maintaining insufflation, and effect on the surgeon’s performance and fatigue. The impact of forearm compression should be considered in the selection of the hand-assist device. We can hope pressure on industry to develop improved devices will take the pressure off surgeons.

**REFERENCES**


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