

# Evaluation of Efficacy of Four Laparoscopic Needle Drivers

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## ABSTRACT

**Introduction:** To evaluate the impact of needle driver design on laparoscopic suturing skills by experts and novices.

**Methods:** Three experienced laparoscopic surgeons and 3 novice junior residents were asked to perform a fixed set of suturing tasks in a laparoscopic pelvic-trainer. The laparoscopic needle drivers compared were (1) the Ethicon driver (E 705R), (2) Karl Storz (KS) pistol grip (26173 KC), (3) KS finger grip (26167 SK), and (4) KS palm grip (26173 ML). Times were recorded for each operator to grasp and position a needle for suturing in a particular angle, as well as to throw a horizontal and a vertical stitch and tie a single square knot using 2–0 Vicryl suture with a taper CT-1 needle. Subsequently, participants were asked to complete a subjective questionnaire rating the drivers.

**Results:** The average suturing time provided the most discriminatory power in comparing the needle drivers. For experienced operators, the KS pistol grip allowed faster suturing times than did the KS finger grip and the KS palm grip but not the Ethicon driver. For novice users, the Ethicon driver allowed faster suturing times than did the KS finger grip but not the KS pistol grip or the KS palm grip. In the subjective questionnaire, the KS pistol grip received the highest scores, and the KS finger grip received the lowest scores.

**Conclusion:** Novice laparoscopists performed best with the KS pistol grip as well as the Ethicon laparoscopic needle drivers while experienced laparoscopists performed best with the pistol grip KS needle driver.

**Key Words:** Laparoscopy, Needle driver, Education.

## INTRODUCTION

As surgeons have gained experience and skill, laparoscopic urology has evolved from extirpative procedures to complex reconstructive procedures. A variety of techniques have been described to train residents in the basic principles of laparoscopy.<sup>1,2</sup> These basics develop hand-eye coordination, instrument manipulation in 2 dimensions, and dissection techniques. Laparoscopic free-hand suturing, once considered an advanced technique, is today an essential part of every laparoscopic urologist's armamentarium. Again, a variety of training modules and simulators are available to train residents in free-hand laparoscopic suturing.<sup>3,4</sup>

In this study, we evaluated the impact of laparoscopic needle driver design on performance metrics of expert and novice laparoscopic surgeon. We evaluated 4 common commercially available laparoscopic needle drivers to decide which one was most suited to train residents in laparoscopic suturing.

## METHODS

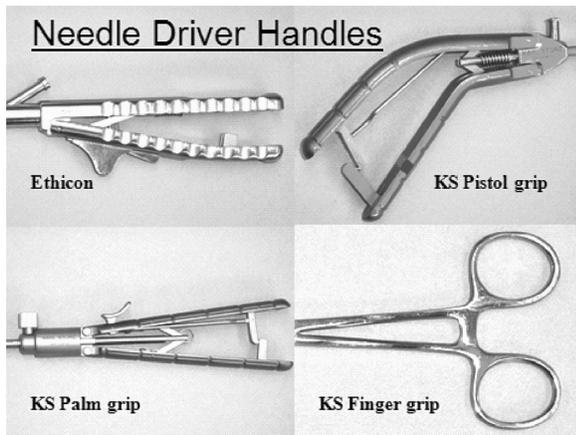
Three experienced laparoscopic surgeons and 3 junior residents (PGY2) with no prior laparoscopic suturing experience were selected for this study. The 4 needle drivers studied were the Ethicon (E705R), Karl Storz pistol grip (26173 KC), Karl Storz finger grip (26167 SK), and Karl Storz palm grip (26173 ML) (**Figure 1**). Each participant was allotted a fixed set of suturing tasks to be performed laparoscopically with each of the needle drivers. The suturing was performed in a laparoscopic pelvic-trainer model (Ethicon Endosurgery, Cincinnati, OH) guided by a 30-degree lens (Karl Storz). The expert laparoscopic surgeons were utilizing the Ethicon needle driver in their surgical practices at the time of the study. To maintain uniformity, the suturing was performed on premarked ink spots on a foam block fixed within the pelvic-trainer.

Tasks included<sup>1</sup> positioning the needle in the needle driver in the correct angle to take a suture bite, after the needle was dropped into the pelvic-trainer within a set area<sup>2</sup>; a horizontal stitch between 2 spots marked horizontally from each other at a distance of 2cm followed by a square knot with a 2–0 Vicryl on a CT-1 taper needle<sup>3</sup>; a

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**Figure 1.** Handle configurations for needle drivers studied (KS=Karl Storz).

vertical stitch between 2 spots marked vertically from each other at a distance of 2cm followed by a square knot. Each of these tasks was timed by a neutral observer. For the horizontal and the vertical stitches, the timer was started after the needle was positioned within the driver.

We randomized the order of tasks, order of needle drivers, and order of participants as determined by a name draw to avoid acclimatization to the task. It was important to randomize these aspects of the procedure to prevent the impact of a “learning curve” confounding the outcome variables. Participants were not allowed to practice the tasks prior to evaluation. No participant performed more than 2 tasks at one sitting. All the participants were blinded to the other participants’ performance. Average glove size was 7.5 (range, 7.0 to 8.0).

Once participants had completed their set of tasks, they were asked to complete a written questionnaire. The questionnaire had 5 categories to evaluate each needle driver, including<sup>1</sup>: instrument weight and hand fatigue,<sup>2</sup> ease of handling the driver,<sup>3</sup> ease of gripping the needle,<sup>4</sup> ease of unlocking the driver,<sup>5</sup> ease of suturing. Each category was assigned a subjective score of 1 (poor), 2 (fair), 3 (good), 4 (excellent), or 5 (outstanding).

The Student *t* test was used to compare outcomes between the needle drivers. Comparison data were limited to the needle drivers, and no comparison was made between the 2 groups.

**RESULTS**

Overall, the Ethicon and the Karl Storz pistol grip needle drivers outperformed the other 2 drivers in all categories, subjective and objective.

In the first task of picking the needle from the model floor and positioning it in the correct position in the driver, the novice group took an average of 11.2 seconds (Ethicon), 15.8 (KS pistol grip), 16.5 (KS finger grip), and 13.4 (KS palm grip). The experienced group took 4.9, 4.7, 6.4, and 7.6 seconds respectively for the 4 needle drivers.

Due to our small sample size, the times for each individual skills task did not reveal a significant difference between needle drivers. The average suturing time provided the most discriminatory power in comparing the needle drivers.

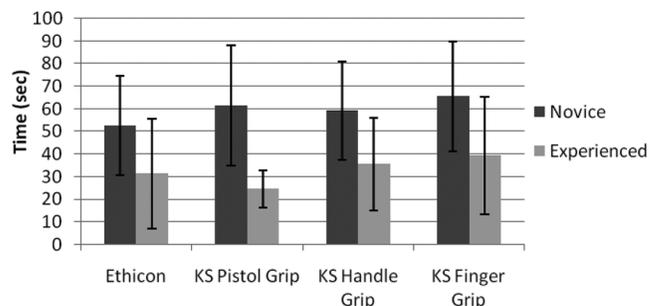
The results of the combined vertical and horizontal suturing times are presented in **Figure 2** (Novice and Experts). In the novices, the Ethicon needle driver performed better than did the KS finger grip (P=0.05), but it had equal scores to the KS palm grip (P=0.29) and the KS pistol grip (P=0.19). In the experienced group, the KS pistol grip performed better than did the KS finger grip (P=0.01) and the KS palm grip (P=0.02) but had equal scores as those for the Ethicon needle driver (P=0.2).

The results of the subjective scores awarded to each of the needle drivers by all the participants are presented in **Figure 3**. The KS pistol grip received the highest ratings from both the novices and experts.

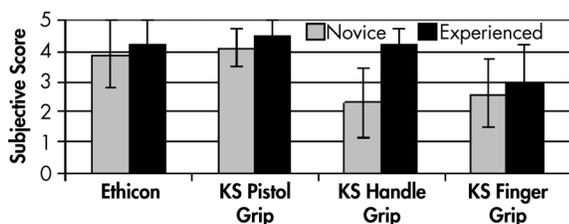
**DISCUSSION**

Laparoscopic reconstructive procedures, such as laparoscopic partial nephrectomy, laparoscopic pyeloplasty, and laparoscopic radical nephrectomy, rely on mastering the challenge of intracorporeal free-hand suturing. This skill is also essential to deal with complications, such as a small bowel tear or a minor vascular injury, where laparoscopic suturing skills may prevent an open conversion.

A variety of adjuncts are available to train residents to suture laparoscopically. Some of these include, the pelvic-



**Figure 2.** Combined suturing time (horizontal + vertical) for experts and novices.



**Figure 3.** Comparison of cumulative subjective scores on post study questionnaire (score 0–5, highest score=5).

trainer (Ethicon-Endosurgery) and simulation software (Simulab Corporation, Washington). The specific challenge in free-hand intracorporeal suturing lies in the ability to grab a free needle with the needle driver, position it within the driver, execute a precise suture bite, and tie a square knot under 2-dimensional vision. Many instruments that will minimize the learning curve have been described in the literature to assist free-hand suturing.<sup>3,4</sup> These include the Endo Stitch (United States Surgical Corp, Norwalk, CT), the Suture Assistant (Ethicon Endosurgery, Cincinnati, OH), and the da Vinci Robotic system. However, we believe that facility with free-hand suturing is necessary and can reduce dependence on these aids.

Prior studies have documented that for the novice laparoscopic surgeon, needle grasping and positioning it within the driver is the most difficult and time consuming laparoscopic task.<sup>5</sup> In our study of the 4 needle drivers for the task of positioning the needle in the needle driver, the novice group performed the best with the Ethicon needle driver. The Ethicon driver is a sturdy instrument with a ribbed grip and a conveniently located needle release button on the grip. The ergonomic shape of the needle driver grip makes for a sturdy, comfortable grasp and easy manipulation of the free needle compared with the other drivers. The experienced group found that the Ethicon and Karl Storz (KS) pistol grip performed better than the other 2 drivers performed. The KS pistol grip driver, as the name suggests, has a convenient nonribbed pistol grip. This also makes for a comfortable grip with a more neutral angulation of the wrist that facilitates rotation of the wrist during suturing. The needle release mechanism in this driver though off center and not as easy to reach as the Ethicon driver requires minimal pressure to release the needle and thus is also user-friendly. The KS palm grip driver performed poorly in the task of positioning the needle in our study in both groups. In this driver, both the locking and unlocking mechanisms are built into the grip of the driver with alternate pressure on the grip locking and unlocking the instrument. This leads to reasonable difficulty in unlocking the instrument to release the nee-

dle. The KS finger grip driver also performed poorly in both groups. This driver's design is based on its open counterpart. However, due to the length of the laparoscopic driver, it is fairly difficult to unlock the ratchet between the fingers, adding to time and effort.

Previous studies have demonstrated the utility of inanimate and animal models in developing suturing skills, and indeed our study relies on the use of such models to help discriminate between needle drivers. Mori et al<sup>6</sup> showed that knot tying abilities improve with hands-on training. Recently, simulator training has also been shown to be as effective as the animal model.<sup>7</sup> However, no literature reports indicate which type of needle driver design best suits the needs of the laparoscopic surgeon in training. Emam et al<sup>8</sup> have shown that there is no difference in motion analysis of the joints of the hand while performing horizontal or vertical suturing. In our study, we evaluated a combined time to execute a horizontal and a vertical stitch followed by a square knot with all 4 needle drivers. In the novice group, The Ethicon needle driver, the Karl Storz pistol and palm grip performed equally well and better than the finger grip. The experienced group found that the Karl Storz pistol grip and the Ethicon needle driver performed equally well and better than the finger grip and the palm grip drivers. Ethicon needle drivers are self-righting, and this may be why they worked better in the novice group.

The subjective questionnaire completed by the participants suggested that the primary difficulties with the KS finger grip driver and the KS palm grip driver were the complicated unlocking mechanism that increased the effort and time to release the needle. This translates into objective increases in suturing times. The Ethicon and the KS pistol grip driver with their inherently easy unlocking mechanism were preferred by both groups for suturing tasks and ability to manipulate the needle between the drivers in the 2 hands. In contrast, the Ethicon driver received a high score in all categories except its weight and hand fatigue where the KS pistol grip was superior.

Since the study, all residents in our center now train with the Ethicon needle driver. The same driver is also preferred in the operating rooms thus making for an easy transition from the laboratory to the operating room for the residents. With increased experience, they are offered the alternative of the KS pistol grip in both the operating room and simulation-training center.

## CONCLUSION

Laparoscopic suturing is technically challenging but is an essential part of resident training. An ideal needle driver is essential to the performance of precise free-hand laparoscopic suturing. An ideal needle driver is one that is light, has an easy unlocking mechanism, a good grip, and handles the needle well. Probably the most pivotal factor deciding a needle driver's effectiveness is its unlocking mechanism. In our study, the Ethicon needle driver and the KS pistol grip emerged as the best drivers to train resident surgeons and have replaced all other needle drivers in the training facility.

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