

Initial experience of a novel ergonomic surgical chair for laparoscopic pelvic surgery

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ABSTRACT

Introduction: We present the initial experience of a novel surgical chair for laparoscopic pelvic surgery, the ETHOS™ (Bridge City Surgical, Portland, OR).

Materials and Methods: The ETHOS chair has an adjustable saddle height that ranges from 0.89 to 1.22 m high, an overall width of 0.89 m, and a depth of 0.97 m. The open straddle is 0.53 m and fits most OR tables. We performed 7 pelvic laparoscopy cases with the 1st generation ETHOS™ platform including 2 laparoscopic ureteral reimplantations, 5 laparoscopic pelvic lymphadenectomies for staging prostate cancer in which one case involved a laparoscopic radical retropubic prostatectomy, performed by 2 different surgeons.

Results: All 7 pelvic laparoscopic procedures were successful with the ETHOS™ chair. No conversion to open surgery was necessary. Survey done by surgeons after the procedures revealed minimal stress on back or upper extremities by the surgeons from these operations even when surgery was longer than 120 minutes. Conversely, the surgical assistants still had issues with their positions since they were on either sides of the patient stressing their positions during the procedure.

Conclusion: The ETHOS chair system allows the surgeon to operate seated in comfortable position with ergonomic chest, arms, and back supports. These supports minimize surgeon fatigue and discomfort during pelvic laparoscopic procedures even when these procedures are longer than 120 minutes without consequence to the patient safety or detrimental effects to the surgical team.

Key words: *perineum; equipment and supplies; laparoscopy; surgical instruments; pelvis*

Int Braz J Urol. 2011; 37: 455-460

INTRODUCTION

Present day surgeons are performing more minimally invasive procedures. The benefits of minimally invasive surgery (MIS) to patients include shortened hospital stay and recovery time as well as causing less scarring. Performing these procedures, however, often places physical demands on MIS surgeons that differ substantially from those of open surgery. These minimally in-

vasive procedures have altered the way surgeons interact with the surgical field. Long shaft instruments, access ports, and the endoscope image display systems can cause numerous challenges for the surgeon's ergonomics in the OR (1). Unfortunately, the modern operating room has been slow to evolve to the new constraints these surgeons endure. The posture of surgeons has changed from a freedom of movement of open surgery to a straight and static posture during laparoscopy. The chronic static positioning of surgeons has

been often related to discomfort. The upper extremities usually are in awkward and uncomfortable excursion for handling the long laparoscopic instruments, especially during pelvic procedures, where assistants and surgeons have to place themselves in a hip rotated position stressing the torso and the lower limbs. The upright posture during these procedures seems to be accompanied by the substantially less body movement and weight shifting than during open surgery (2). These observations suggest the advantage of supporting the surgeon's body during surgical procedures. The development of a novel surgical chair, the ETHOS (Bridge City Surgical, Portland, OR), was designed to improve the ergonomics of the laparoscopic pelvic procedures, effectively positioning the surgeon in the center of the patient's body.

MATERIALS AND METHODS

The ETHOS chair has an adjustable saddle height that ranges from 0.89 to 1.22 m high, an overall width of 0.89 m, and a depth of 0.97 m. The open straddle is 0.53 m and fits most OR tables. Two surgeons (FK and CT), and 2 surgical assistants performed 7 pelvic laparoscopic cases with the 1st generation ETHOSTM platform including 2 laparoscopic ureteral reimplantations, 5 laparoscopic pelvic lymphadenectomies for staging prostate cancer, and a laparoscopic radical retropubic prostatectomy. Future procedures will be performed in 2011 with the new design of the new generation of ETHOSTM chair.

RESULTS

All demographic, operative and peri-operative data, and laboratory / pathological data are shown in Tables 1,2 and 3, respectively.

All 7 pelvic laparoscopic procedures were successful with the ETHOSTM chair. No conversion to open surgery was necessary. Survey done by surgeons after the procedures revealed minimal stress on back or upper extremities by the surgeons from these operations even when surgery was longer than 120 minutes. The surgeon dictated an effortless customization of the forearm, chest, and lower back supports which lead to nominal strain on his shoulders, back, and legs after each surgery. Table-4. Conversely, the surgical assistants still had issues with their positions since they were on either sides of the patient causing physical stress during the procedure. Discomfort was prominent during procedures that lasted more than 27 minutes. The areas affected were back, lower and upper limbs. Table-5. Integration of a Vicky robotic camera driver (Endocontrol, Grenoble, France) was also used during the procedures. Specific measurements of the ETHOSTM chair are depicted in Figure-1. The Anesthesiologists survey with a short questionnaire on access to patient also reported no issues with the chair in terms of patient's safety at the end of each the procedure. Confidence was indicated by the surgeons that the surgical chair could easily be disengaged from the operating position if emergent access was required during the entirety of all procedures. The Anesthesiologists in these cases reported minimal interference from the chair's positioning. Easy access to the patient by the anesthesiologist achieved optimally deliver care. Table-6. Finally, the

Table 1 - Patient Demographic data.

Patient	Age(yr)	Sex	Height (cm)	Weight (kg)	BMI (kg/m ²)
1	56	Male	185	71.1	21.26
2	60	Male	152	63.0	19.92
3	57	Male	182	83.3	24.89
4	61	Male	170	75.6	26.1
5	69	Male	175	87.3	28.42
6	46	Female	155	67.0	27.93
7	54	Female	160	69.3	27.3

Table 2 - Peri-Operative Data.

Patient	Procedure	ASA	ORT (min)	EBL (mL)	Complications
1	Lap. Lymphadenectomy and Lap. Prostatectomy	2	160	450	None
2	Lap. Lymphadenectomy	3	61	Minimal	None
3	Lap. Lymphadenectomy	2	47	Minimal	None
4	Lap. Lymphadenectomy	3	29	Minimal	None
5	Lap. Lymphadenectomy	2	45	75	None
6	Ureteral Reimplantation	3	77	Minimal	None

Table 3 - Pathology Results in Patients that underwent Laparoscopic Pelvic/Obturator Lymphadenectomy.

Patient	PSA (ng/dL)	Gleason	Pathology	# Lymphnodes
1	5.2	3+3	No cancer	7
2	5.4	3+4	No cancer	5
3	29.4	3+4	No cancer	14
4	7.2	3+4	No cancer	7
5	6.3	3+3	No cancer	7

nurses and OR staff were surveyed to express their concerns and satisfaction rates for space constraints, safety, appearance and mobility. Table-7.

DISCUSSION

Although while standing the human body appears static, continuous active control to maintain proper balance is always required. The body has been characterized as an unstable balance system, has two-thirds of its mass located at two-thirds of its height above the ground (3). Posture during standing thus forms an inverted pendulum, appearing to be static but actually under dynamic control (4). Neck and shoulder pain have been exhibited by laparoscopic surgeons' and their posture (5,6). In an assessment of fatigue of laparoscopic surgeons, the static contraction of the upper trapezius, middle trapezius, lower erector spinae, and hamstrings exceeded maximal voluntary isometric contraction threshold limits for a fatigue response. The median MVS fatigue threshold was also exceeded in the middle trapezius and the lower erector spinae (7). Correct posture is very important not only with minimizing physical discomfort but also with improving task performance (8).

In addition to poor posture, the surgeons also deal with problems related to non-optimal working

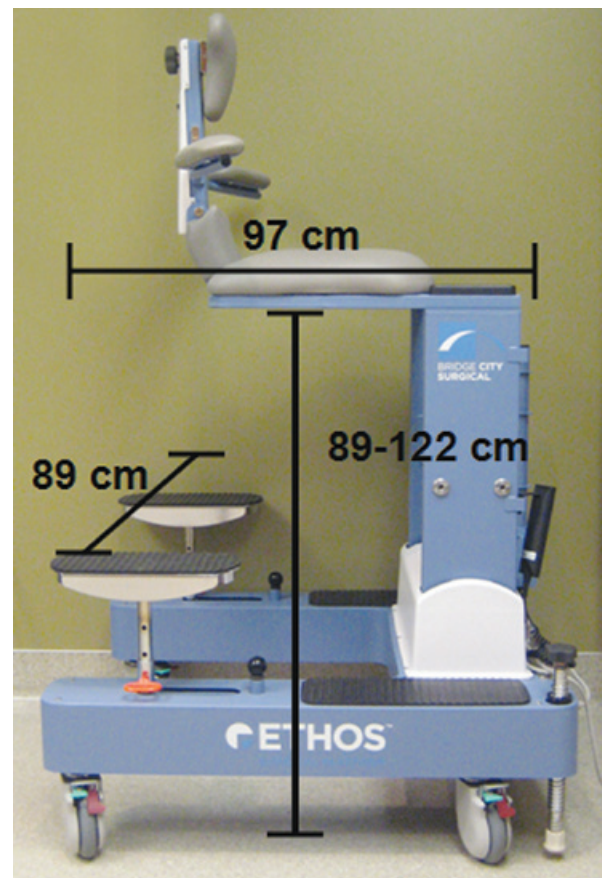
**Figure 1 - Dimensions of the ETHOS Surgical Platform.**

Table 4 - Surgeon Post-Operative Muscular Discomfort Questionnaire.

	Never	Sometimes	All the Time
Abdominal	2	0	0
Back	2	0	0
Upper Limbs	2	0	0
Lower Limbs	2	0	0

Table 5 - Surgical Assistant on Post-Operative Muscular Discomfort Questionnaire.

	Never	Sometimes	All the Time
Abdominal	4	0	0
Back	0	0	4
Upper Limbs	0	0	4
Lower Limbs	0	0	4

Discomfort was prominent during procedures that lasted more than 27 minutes.

height. Unfavorable table height can increase the upper extremity effort and has potential for musculoskeletal injury. Operative tables were originally designed for open surgery and thus not optimal for MIS. Operating tables may not be capable of translating to the proper height at or 5-10 cm below the elbow of the surgeon (9,10). In the study by Engsborg it was also shown that the anterior deltoid exceeds the static, median, and peak limits of maximal voluntary isometric contraction thresholds (7). Physical constraints on the shoulders and arms also contribute to the surgeon's fatigue.

The crowding in the operating room and the positioning of the surgical team around the operating table also contributes to poor ergonomics. Laparoscopic procedures have shown to significantly increase crowding in the room (11). The percentage of operating space occupied by equipment and personnel increased from 36% for open surgery to 41% for laparoscopy. The total count of equipment present in the operating room increased from 6 for open procedures to 13 for laparoscopic (11). The freedom of the positioning the surgical team and equipment around the operating table is limited because the operating table is fixated to the floor.

Table 6 - Anesthesiologist Access to Patient Questionnaire.

	easy	Difficult	impossible
Access to Face	7		
Access to Tubes	7		
Access to Wire	5	2*	
Safe device to place above patient	7		

**due to surgical drapes covering the face.*

Table 7 - Anesthesiologist Access to Patient Questionnaire.

	No	Yes	Do not know
Space constraints	5	0	0
Safe	5	0	0
Pleasing appearance	2	3	0
Easy mobility	2	3	0

The ETHOS™ positions the surgeon in a chair above the patient with minimal interference to the surgical team. Crowding is therefore minimized by moving the surgeon from tableside to above the patient. Forearms, chest, and lower back support with adjustable locking mechanisms are customizable to the surgeon's size and preferred positioning. Manipulation of laparoscopic instruments can occur without stressing the surgeon's back, upper, or lower limbs. Moreover, the disengagement mechanism of the chair from the operative position would allow emergent access if needed maintaining patient safety.

CONCLUSIONS

The ETHOS™ system enables the surgeon to operate seated in comfortable position with ergonomic chest, arms, and back support effectively reducing muscle activity and discomfort which portends to improve surgeon satisfaction. Although many Urologists have adapted use of the da Vinci robotic surgical system to overcome the aforementioned ergonomic challenges; the cost of the robotic system, steep learning curve, and remote surgeon location are substantial issues that must be considered. The ETHOSTM system avoids these issues. Cost is below these robotic systems, surgeons use laparoscopic tools they have familiarity with, and the ETHOS places the surgeon in the orthotopic position above the patient. Although further clinical validation is needed; the ergonomics of the ETHOS chair for minimally invasive procedures will improve conditions for laparoscopic surgeons by overcoming the constraints of robotic and conventional bedside surgery.

CONFLICT OF INTEREST

None declared.

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Submitted for publication:
June 16, 2010

Accepted after revision:
May 05, 2011