USABILITY ANALYSIS OF THE ARTHROFREE WIRELESS SURGICAL CAMERA IN GENERAL LAPAROSCOPY

Francisco Quinteros, MD, FACS, FASCRS[1], Rami Lutfi MD, FACS, FASMBS, ABOM[1]
[1]Chicago Institute for Advanced Surgery

BACKGROUND

A new wireless surgical visualization technology – ArthroFree® - offers the promise of improved ergonomics, ease of use, safety, and efficiency in laparoscopy. An iterative product development process established the usability of ArthroFree, a wireless surgical camera system for arthroscopy (shown in Figure 1). Conventional arthroscopes require two cables, one providing power and the other fiber-optic light. These cables are often burdensome, routed on or around the patient, and can pose significant fire and burn risks. Designed to eliminate these burdens, ArthroFree features wireless communication and battery power. The system can be used with existing laparoscopes (compatible with both 5 and 10 mm), monitors, and insufflation systems. Control of the angle of the camera is similar to conventional laparoscopy.



Figure 1. ArthroFree Wireless Surgical Camera

METHODS

ArthroFree®, a wireless surgical camera coupled with image enhancement, was used here for two types of laparoscopic cases – a small bowel resection (a first-use surgery) and an inguinal hernia repair. Eight surgeons performed surgery using ArthroFree and then completed a ranked survey assessing ergonomics, ease of use, image quality, patient experience, and surgeon/staff experience with ArthroFree. The survey asked each participant to review 19 positive statements about ArthroFree and respond on a scale ranking the statements from "Strongly Agree," to "Strongly Disagree." The users' opinions on each statement were gauged using a 5-point Likert scale (1 = strongly disagree and 5 = strongly agree). The average score for each statement was calculated. Statements were grouped into categories based on how they related to ergonomics, image quality, ease of use, and patient experience. A score of 3 in any category was interpreted as a neutral response. An increase from 3 indicated a proportional increase in agreement with a statement of approval and considered a good (4) or excellent (5) response. Conversely, a decrease from 3 indicates a proportional decrease in agreement with a statement.

RESULTS

The mean score for all survey statements was 4.08 with an overall average of 76.32% of responses in agreement with the positive statements, rating the experience with ArthroFree as good or excellent. The highest score for agreement with a single statement was 100.00% for the statements "I could easily determine the battery level," "It is important to have the fewest items possible in the sterile field," and "I felt supported during the evaluation with proper training." Survey results are represented in **Table 1** below.

SURVEY STATEMENT	MEAN	AGREEMENT
The camera head felt well balanced.	3.88	75.00%
The camera head was comfortable to hold.	4.25	75.00%
The weight of the camera head felt good to me.	3.75	75.00%
ArthroFree increased my physical comfort without sacrificing my productivity.	3.88	62.50%
The navigation buttons were easy to access.	4.38	87.50%
I was able to manipulate the camera functions easily.	4.13	75.00%
I could easily determine the current battery level.	4.50	100.00%
The light engine was comfortable to touch temperature-wise.	4.13	75.00%
The light engine produced a level of brightness appropriate for the procedure(s).	4.00	87.50%
The quality of the visual display was appropriate for the procedure.	3.75	62.50%
ArthroFree's elimination of power and light cables will have a positive impact on patient safety.	3.88	62.50%
ArthroFree's elimination of power and light cables will have a positive impact on my efficiency.	4.25	87.50%
It is important to have the fewest items possible on the sterile field.	4.63	100.00%
ArthroFree's elimination of power and light cables will reduce my level of stress in the operating room.	3.88	75.00%
ArthroFree's elimination of power and light cables will reduce staff stress level in the operating room.	4.00	75.00%
ArthroFree is clinically equivalent to what I currently use.	3.13	50.00%
I would recommend the ArthroFree system to a colleague.	3.63	62.50%
I felt supported during the evaluation with proper training.	4.75	100.00%
I would support adding ArthroFree to our facility.	3.75	62.50%
Average	**4.08**	**76.32%**

Table 1. Positive Responses by Survey Statement

Statements were grouped into categories (**Table 2**) based on their impact on ergonomics, ease of use, image quality, patient experience, and surgeon/staff experience. The percent agreement by category ranged from 65.63 – 83.33%. Statements related to ergonomics (weight, balance, comfort) scored a mean of 3.94 with 71.88% in agreement with the statements. Statements related to ease of use (navigation buttons, camera function, battery indicator, heat) scored a mean of 4.28 with 65.63% agreement. Statements related to image quality (light/brightness, latency) scored a mean of 3.88 with 75.00% in agreement. Statements related to patient experience (safety, efficiency, sterile field) scored a mean of 4.25 with 83.33% in agreement. Lastly, statements related to surgeon/staff experience (stress, equivalency, support) scored a mean of 3.85 with 70.83% in agreement with the statements.

	SURVEY STATEMENT	MEAN	AGREEMENT
Ergonomics	The camera head felt well balanced.	3.94	71.88%
	The camera head was comfortable to hold.		
	The weight of the camera head felt good to me.		
	ArthroFree increased my physical comfort without sacrificing my productivity.		
Ease of Use	The navigation buttons were easy to access.	4.28	65.63%
	I was able to manipulate the camera functions easily.		
	I could easily determine the current battery level.		
	The light engine was comfortable to touch temperature-wise.		
Image Quality	The light engine produced a level of brightness appropriate for the procedure(s).	3.88	75.00%
	The quality of the visual display was appropriate for the procedure.		
Patient Experience	ArthroFree's elimination of power and light cables will have a positive impact on patient safety.	4.25	83.33%
	ArthroFree's elimination of power and light cables will have a positive impact on my efficiency.		
	It is important to have the fewest items possible on the sterile field.		
Surgeon/Staff Experience	ArthroFree's elimination of power and light cables will reduce my level of stress in the operating room.	3.85	70.83%
	ArthroFree's elimination of power and light cables will reduce staff stress level in the operating room.		
	ArthroFree is clinically equivalent to what I currently use.		
	I would recommend the ArthroFree system to a colleague.		
	I felt supported during the evaluation with proper training.		
	I would support adding ArthroFree to our facility.		

Table 2. Positive Survey Statement Responses by Category

CONCLUSIONS

The mean score for all survey statements was 4.08 with an overall average of 76.32% of responses in agreement with the positive statements, rating the experience with ArthroFree as good or excellent. The highest score for agreement with a single statement was 100.00% for the statements "I could easily determine the battery level," "It is important to have the fewest items possible in the sterile field," and "I felt supported during the evaluation with proper training." As this first-generation camera receives further development, we anticipate quality approaching current generation systems