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ORIGINAL RESEARCH

Transition to a novel advanced integrated vitrectomy platform: comparison of the surgical impact of moving from the Accurus vitrectomy platform to the Constellation Vision System for microincisional vitrectomy surgery

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Background: Microincisional vitrectomy surgery (MIVS) is the current standard surgical approach for pars plana vitrectomy. Historically, the most common surgical platform for vitrectomy surgery, since its introduction in 1997, has been the Accurus vitrectomy system. Recent introduction of the next generation of vitrectomy platforms has generated concerns associated with transitioning to new technology in the operating room environment. This study compared, in a matched fashion, surgical use of the Accurus vitrectomy system and the next generation Constellation Vision System to evaluate surgical efficiencies, complications, and user perceptions of this transition.

Methods: Electronic health records were abstracted as a hospital quality assurance activity and included all vitreoretinal surgical procedures at the Bascom Palmer Eye Institute, Anne Bates Leach Eye Hospital, during two discrete 12-month time periods. These two periods reflected dedicated usage of the Accurus (June 2008–May 2009) and Constellation Vision (July 2009–June 2010) systems. Data were limited to a single surgeon and evaluated for operating room (OR) total time usage/day, OR case time/case, and OR surgical time/case. Further analysis evaluated all patients undergoing combined MIVS and clear cornea phacoemulsification/intraocular lens (IOL) implantation during each individual time period to determine the impact of the instrumentation on these parameters. All records were evaluated for intraoperative complications.

Results: Five hundred and fourteen eligible patients underwent MIVS during the 2-year study windows, with 281 patients undergoing surgery with the Accurus system and 233 patients undergoing surgery with the Constellation system. Combined MIVS and phacoemulsification with IOL implantation was performed 141 times during this period with the Accurus and 158 times during the second study period with the Constellation. Total number of patients operated per day increased from 7.55 with Accurus to 8.53 with Constellation. Surgical room time decreased from 56 minutes with Accurus to 52 minutes with Constellation, and procedure time decreased from 35 minutes with Accurus to 31 minutes with Constellation ($P < 0.004$). Combined MIVS/phacoemulsification surgery saw similar declines in surgical room time and procedure time ($P < 0.001$). Subset analysis of procedures limited by case number per day (eg, four cases/day, five cases/day, six cases/day, and seven or more cases/day) showed similar outcomes with a decrease in surgical room time and procedure time. No increases in surgery-related complications were noted by quality assurance review during these time periods.

Discussion: Transitioning to advanced surgical technology is a complex issue for the surgeon, the hospital team, and the hospital administration. This study documents improvement in three

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significant measures of surgical efficiency: operative number of patients per day, operative room time, and surgical procedure time that reflect the positive impact of the novel, combined, integrated, posterior and anterior, ophthalmologic surgical platform of the Constellation Vision System. These data are imperative to evaluate the impact of transition from one surgical platform to another. During this transition, hospital quality assurance review and surgeon evaluation of operative complications showed no increased concerns for the shift from the Accurus to the Constellation Vision System surgical platform. Further, both operative staff and surgeons felt that the transition to the Constellation was not associated with increases in difficulty with setup, turnover, or use and that the Constellation decreased safety concerns for surgical usage. Ultimately, in this case, new technology benefited the surgeon, the patient, and the hospital.

Keywords: MIVS, vitrectomy, new technology

Rapid advances in surgical technology have occurred since the first automated vitrectomy was performed by Machemer in 1971.[1,2] From 1971 until 2012, instruments have moved from separate systems for vitrectomy cutting, illumination, air/fluid exchange, silicone oil injection, automated scissors/forceps, and operative laser photocoagulation toward integrated platforms that include multiple technologies.[3–5]

A major advance in technology occurred with the introduction of the Accurus-integrated platform in 1997 (Alcon Surgical, Fort Worth, TX, USA). This platform achieved enhanced vitrectomy cutter performance, improved surgical fluidics, automated silicone oil infusion, and incorporated a posterior segment fragmatome and an anterior segment phacoemulsification capability. The Accurus platform rapidly became the standard within the United States and internationally.

By 2008 the Accurus platform was present in over 90% of ophthalmologic operating rooms in the United States, including both hospital and ambulatory care surgical centers. The Accurus platform was characterized by an advanced cutter design, increased cutting rates to 2500 cuts per minute, gas-forced fluid infusion, dual halogen light sources, and software parameters that were established to maximize cutter efficiency at very high cut rates.

At the Bascom Palmer Eye Institute, Anne Bates Leach Eye Hospital (BPEI/ABLEH), the Accurus platform became the standard vitrectomy console from 1997 to 2008. The Vitreoretinal Surgical Service at the BPEI had extensive interest in improving surgical platforms and techniques for vitreoretinal surgery and actively pursued evaluation and acquisition of the next generation vitrectomy platform.

The Constellation Vision System (Alcon Surgical) was defined by a marked advance in cutter probe design specifically for micro-incisional vitrectomy surgery (MIVS), incorporating 23- and 25-gauge vitrectomy, markedly increased cutting rates to 5000 cuts per minute (enabled by elimination of spring technology to re-open the cutter after closure); integrated quadruple xenon light sources; had radiofrequency identification (RFID) recognition technology for identifying the cutter, light pipe, and endolaser probes; improved cassette design to eliminate loss of infusion fluidics; integrated a 532 nm solid state disc laser; and had torsional anterior segment phacoemulsification.

This next generation platform addressed many concerns for instrument limitation and fluidic compromise associated with very high cut rates, while incorporating features that had previously required independent stand-alone systems for use in complex vitrectomy surgery. Further, specific attention was given to the enhanced safety features and targeted platform improvements that were designed to increase operating room efficiency while improving patient safety; these were attractive to our hospital teams and hospital administration.

Prior to evaluation in this study, a transition period was established to educate our hospital teams, place the Constellation, establish a disposable supply support, and assist our vitreoretinal surgeons. This transition period utilized heavy educational support from the Alcon surgical support team and from in-house vitreoretinal surgeons aimed at supporting our hospital teams, with strong focus on our OR scrub teams and our OR circulating nursing teams.

This study was a follow-up to a pre-implementation review document that hypothesized reduction in OR turnover times that would enable increased surgical volume per vitreoretinal surgical room per day. In this study we compared two time periods: one in which the Accurus platform was utilized exclusively and one in which the Constellation platform was utilized exclusively. We evaluated a 12-month time period to better minimize potential case mix bias or transition bias and to capture a significant case volume for analysis. Use of the University of Miami electronic health record enabled broad data capture for evaluation of case volume per day, surgical room time per case, and surgical procedure time per case. Data sets were evaluated blinded to the platform utilized for both the Accurus and Constellation Vision System. These data provide a foundation for evaluating the selection of novel surgical systems for the ophthalmic hospital or ambulatory surgical center and delineate the impact of transition for critical technology required for vitrectomy surgery in the 21st century.

Methods

A data extract from the BPEI/ABLEH electronic health record system, satisfying internal review board requirements, was obtained for all surgeries performed by a single surgeon (TGM) during two time periods established through the hospital quality assurance program. The first time period, representing usage of the Accurus platform, was from June 2008 through May 2009. The second time period, representing usage of the Constellation platform, was from July 2009 through June 2010.

The patient's electronic health records were then matched to BPEI's billing system to extract the current procedural terminology (CPT) codes for each patient encounter. The two databases were then combined to form one de-identified analytic dataset. The dataset included the following variables: claim number, date of service, CPT codes, attending physician, operating room number, unique patient identifier, patient operating room in-time, surgery start time, surgery end time, patient operating room out-time.

The operative time data was manually entered into the patient electronic health record by the nursing staff on the service date as part of their standard operating procedures. Total room time was calculated by subtracting the in-room time from the out-room time. Total surgery time was calculated by subtracting the surgery start time from the surgery end time. Total surgical day time was calculated from the first time in the OR to the last time in the OR for the entire surgical day.

We eliminated procedures that could not be performed on the two platforms, such as primary scleral buckle, enucleation, or examination under anesthesia. To enhance the evaluation, we evaluated all surgical dates and then surgical dates with four, five, six, or greater then/equal to seven cases per day. Finally, we eliminated cases that did not include MIVS surgery on the surgical day evaluated, such as primary scleral buckle, enucleation, or examination under anesthesia.

To evaluate the changes in efficiency between the two platforms, we analyzed three metrics: case volume by analyzing patient volume per day, patient throughput by analyzing the operating room time, and intra-operative time by analyzing procedure time.

A subset analysis was performed on combination MIVS and phacoemulsification surgeries. Combination surgeries were defined as surgeries with both an anterior segment and a posterior segment procedure coded on the same claim.

We evaluated risk management reporting to detect any increase in operative complications, instrument concerns, or reported surgical delays. We did not measure the profitability or profit margin between the two time periods. Based on the staffing model at BPEI, it was determined that staffing levels and staff hours remained consistent between the two time periods and did not affect any change in throughput efficiency.

Statistical analysis utilized a paired *t*-test (Student's paired *t*-test, SAS v9.3; SAS, Cary, NC, USA). Statistical significance was established as a *P*-value less than 0.05 for the comparative analysis.

Results

A total of 514 eligible patients identified by evaluation of the surgical electronic health records were included in this analysis. In the first 12-month study period (Accurus surgical system), 281 patients underwent vitrectomy surgery with 141 patients undergoing combined pars plana vitrectomy and phacoemulsification/IOL implantation. In the second 12-month study period (Constellation Vision System), 233 patients underwent vitrectomy surgery with 158 patients undergoing combined pars plana vitrectomy and torsional phacoemulsification/IOL implantation (Table 1).

Evaluation of surgical efficiencies documented an increase from an average of 7.5 cases per day during the Accurus time period to 8.5 cases per day during the Constellation Vision System time period. During these study windows, overall surgical time per day decreased during the Constellation Vision System time period (Table 1).

Operating room case times averaged 58 minutes during the Accurus time period and decreased to 52 minutes during the Constellation Vision System time period. Operating room

Table 1 Overall efficiency review comparing the Accurus to the Constellation surgical platform

	Accurus platform	Constellation platform	*P*-value
MIVS cases	281	233	n/a
MIVS/phaco	141	158	n/a
Surgical patients (per day)	7.55	8.53	$P < 0.04$
MIVS surgical room time (per case, minutes)	56	52	$P < 0.01$
MIVS surgical case time (per case, minutes)	35	31	$P < 0.004$
MIVS/phaco surgical case time (per case, minutes)	43	37	$P < 0.001$

Notes: Statistically significant increase in number of cases per day (surgical patients), decrease in surgical room time, and decrease in surgical procedure time (surgical case time). Combined MIVS and phacoemulsification with IOL implantation showed greatest improvement in time reduction for Constellation compared with Accurus across the entire 2-year cohorts. Note sample size of 514 MIVS cases and 299 combined MIVS/phacoemulsification cases accrued over two 1-year windows.
Abbreviations: MIVS, microincisional vitrectomy surgery; IOL, intraocular lens; Phaco, phacoemulsification.

surgical times averaged 36 minutes during the Accurus time period and decreased to 31 minutes during the Constellation Vision System time period ($P < 0.004$) (Tables 1–5).

Finally, operating room surgical times for combined pars plana vitrectomy and phacoemulsification with IOL implantation averaged 43 minutes during the Accurus time period and decreased to 37 minutes during the Constellation Vision System time period ($P < 0.001$) (Tables 1, 6–9).

Ongoing surgical documentation of intra-operative and postoperative complications noted stable complication profiles as previously reported.

To determine the potential impact of case volume on efficiency evaluation, we correlated all cases and then independently evaluated datasets with cutoffs of at least four, five, six, or greater than/equal to seven cases per day. This analysis showed no statistically significant increased efficiency but clearly suggested a trend to increased efficiency with increasing case volume. Clear positive impacts were seen for each case volume noting a benefit even for surgical volumes as low as four cases per day (unreported analysis of a second data set documented improved efficiencies with case volumes averaging approximately two cases per day) (Tables 2–5).

Statistical analysis noted statistically significant improvements in efficiencies for operative time with both decreased procedure and room time associated with transition to the Constellation Vision System ($P < 0.0004$). Additionally, for combined MIVS pars plana vitrectomy and torsional phacoemulsification/IOL implantation, a marked decrease in both procedure and room time were documented ($P < 0.0001$) (Tables 6–9).

Discussion

Vitreoretinal surgical advances have been rapid since the first automated vitrectomy surgical units were developed four decades ago.[6–12] During this period, marked improvements in instrument design contributed to significant increases in patient safety and improved surgical outcomes. Initially, Machemer and others focused on multifunction single-port instrumentation, but instrument design continuously evolved toward smaller instrument sizes and integrated multiport pars plana vitrectomy surgery.[1,13–15]

Further modifications, from Machemer's initial vitrectomy system[1] continued to decrease instrument size, ultimately achieving a standard instrument approach with 20-gauge instruments placed through the sclera in a three-port pars plana vitrectomy approach whereby one port was utilized for infusion, one port for illumination, and one port

Table 2 Comparison of Accurus and Constellation surgical platforms by procedure time and room time (in minutes) for all cases performed with at least seven cases per day

Surgical volume: seven or more patients per day
OR 5 and 6, at least seven patients/day, ±2 standard deviation from mean room and procedure time
Minimum 15 minute procedure time

Equipment	OR num	N claims	N patients	N days	Claims per day	Patients per day	Calc room time (H:MM)				Calc procedure time (H:MM)			
							Min	Median	Max	Mean	Min	Median	Max	Mean
Accurus	5	123	110	29	4.24	3.79	0:27	0:56	1:37	0:57	0:15	0:36	1:18	0:36
	6	126	120	29	4.34	4.14	0:30	0:56	1:40	0:58	0:15	0:31	1:14	0:36
	All	249	219	29	8.59	7.55	0:27	0:56	1:40	0:58	0:15	0:35	1:18	0:36
Constellation	5	87	84	19	4.58	4.42	0:28	0:48	1:17	0:51	0:15	0:30	0:57	0:31
	6	86	85	19	4.53	4.47	0:31	0:53	1:31	0:54	0:15	0:33	1:03	0:34
	All	173	162	19	9.11	8.53	0:28	0:52	1:31	0:52	0:15	0:31	1:03	0:32

Notes: Data presented include number of patients, patients per day, room time, and procedure time. Times are reported as minimum, median, maximum, and mean time for operating rooms 5 and 6 and as combined (all). The comparison by case number per day was to evaluate the impact of high surgical numbers per day on overall efficiency in the operating room.
Abbreviation: OR, operating room.

Table 3 Comparison of Accurus and Constellation surgical platforms by procedure time and room time (in minutes) for all cases performed regardless of number of cases per day

Surgical volume: all days
OR 5 and 6, all days, ±2 standard deviations from mean room and procedure time
Minimum 15 minute procedure time

Equipment	OR Num	N claims	N patients	N days	Claims per day	Patients per day	Calc room time (H:MM)				Calc procedure time (H:MM)			
							Min	Median	Max	Mean	Min	Median	Max	Mean
Accurus	5	162	145	47	3.45	3.09	0:27	0:54	1:49	0:57	0:15	0:35	1:21	0:36
	6	163	154	47	3.47	3.28	0:30	0:58	1:47	0:59	0:15	0:35	1:19	0:37
	All	325	281	49	6.63	5.73	0:27	0:57	1:49	0:58	0:15	0:35	1:21	0:37
Constellation	5	130	121	39	3.33	3.10	0:28	0:52	1:27	0:52	0:15	0:31	1:12	0:33
	6	129	127	38	3.39	3.34	0:31	0:53	1:37	0:54	0:15	0:31	1:12	0:33
	All	259	233	39	6.64	5.97	0:28	0:53	1:37	0:53	0:15	0:31	1:12	0:33

Notes: Data presented include number of patients, patients per day, room time, and procedure time. Times are reported as minimum, median, maximum, and mean time for operating rooms 5 and 6 and as combined (all). The comparison by all case number per day was to evaluate the overall impact on efficiency in the operating room.
Abbreviation: OR, operating room.

Table 4 Comparison of Accurus and Constellation surgical platforms by procedure time and room time (in minutes) for all cases performed with at least four cases per day

Surgical volume: at least 4 patients per day
OR room 5 and 6, at least 4 patients/day, ±2 std dev from mean room and procedure time
Minimum 15 minute procedure time

Equipment	OR room num	N claims	N patients	N days	Claims per day	Patients per day	Calc room time (H:MM)				Calc procedure time (H:MM)			
							Min	Median	Max	Mean	Min	Median	Max	Mean
Accurus	5	155	139	43	3.60	3.23	0:27	0:54	1:37	0:57	0:15	0:35	1:18	0:36
	6	157	149	42	3.74	3.55	0:30	0:58	1:40	0:59	0:15	0:35	1:14	0:36
	All	312	270	43	7.26	6.28	0:27	0:56	1:40	0:58	0:15	0:35	1:18	0:36
Constellation	5	133	123	36	3.69	3.42	0:28	0:53	1:56	0:55	0:15	0:31	1:26	0:35
	6	128	126	36	3.56	3.50	0:31	0:54	1:49	0:56	0:15	0:33	1:28	0:35
	All	261	236	36	7.25	6.56	0:28	0:53	1:56	0:55	0:15	0:32	1:28	0:35

Notes: Data presented include number of patients, patients per day, room time, and procedure time. Times are reported as minimum, median, maximum, and mean time for operating rooms 5 and 6 and as combined (all). The comparison by case number per day was to evaluate the impact of lower surgical numbers per day on overall efficiency in the operating room.
Abbreviation: OR, operating room.

Table 5 Comparison of Accurus and Constellation surgical platforms by procedure time and room time (in minutes) for all cases

Accurus versus Constellation Vision System: room time and procedure time (minutes) *t*-**test procedure**											
Variable	**Equipment**	**N**	**Lower CL mean**	**Mean**	**Upper CL mean**	**Lower CL Std dev**	**Std dev**	**Upper CL Std dev**	**Std err**	**Min**	**Max**
Statistics											
Procedure time minutes	Accurus	249	34.148	35.916	37.683	13.019	14.163	15.53	0.8976	15	78
Procedure time minutes	Constellation	173	30.727	32.422	34.117	10.216	11.294	12.628	0.8586	15	63
Procedure time minutes	Diff (1–2)		0.952	3.4937	6.0354	12.238	13.064	14.012	1.2931		
Room time minutes	Accurus	249	55.664	57.783	59.902	15.604	16.975	18.613	1.0758	27	100
Room time minutes	Constellation	173	50.371	52.341	54.311	11.873	13.126	14.676	0.9979	28	91
Room time minutes	Diff (1–2)		2.4237	5.4421	8.4605	14.533	15.515	16.64	1.5356		
Variable	**Method**	**Variances**	**DF**	***t*-value**	**Pr > |t|**						
***t*-tests**											
Procedure time minutes	Pooled	Equal	420	2.70	0.0072						
Procedure time minutes	Satterthwaite	Unequal	412	2.81	0.0051						
Room time minutes	Pooled	Equal	420	3.54	0.0004						
Room time minutes	Satterthwaite	Unequal	415	3.71	0.0002						
Variable	**Method**	**Num DF**	**Den DF**	**F value**	**Pr > F**						
Equality of variances											
Procedure time minutes	Folded F	248	172	1.57	0.0016						
Room time minutes	Folded F	248	172	1.67	0.0003						

Notes: Statistical evaluation using Student's *t*-test with evaluation of equality of variance. Note Constellation procedure and room times both show a statistically significant reduction with an average reduction of approximately 5 minutes ($P < 0.007$ and $P < 0.0004$) per procedure and per case.

Abbreviations: CL, confidence level; std dev, standard deviation; std err, standard error; Pr, probability.

Table 6 Comparison of Accurus and Constellation surgical platforms for combined microincisional vitrectomy surgery with phacoemulsification and IOL implantation for all cases performed with at least seven cases per day

Murray combined surgery: subset of at least 7 patients per day
Murray combined surgery summary
Anterior: 66820–66986 Posterior: 67015–67113, not 67028 and 67107
OR room 5 and 6, at least 7 patients/day, ±2 std dev from mean room and procedure time
Minimum 15 minute procedure time

Equipment	OR room num	N claims	N patients	N days	Claims per day	Patients per day	Calc room time (H:MM)				Calc procedure time (H:MM)			
							Min	Median	Max	Mean	Min	Median	Max	Mean
Accurus	5	60	59	29	2.07	2.03	0:47	1:06	1:32	1:06	0:24	0:42	1:01	0:43
	6	52	51	28	1.86	1.82	0:37	1:09	1:40	1:09	0:26	0:43	1:14	0:44
	All	112	108	29	3.86	3.72	0:37	1:07	1:40	1:07	0:24	0:43	1:14	0:43
Constellation	5	57	56	18	3.17	3.11	0:36	0:56	1:17	0:56	0:23	0:35	0:57	0:36
	6	62	62	19	3.26	3.26	0:37	0:56	1:31	0:58	0:20	0:38	1:00	0:37
	All	119	114	19	6.26	6.00	0:36	0:56	1:31	0:57	0:20	0:35	1:00	0:37

Notes: Data presented include number of patients, patients per day, room time, and procedure time. Times are reported as minimum, median, maximum, and mean time for operating rooms 5 and 6 and as combined (all). The comparison by case number per day was to evaluate the impact of higher surgical numbers per day on overall efficiency in the operating room.
Abbreviations: OR, Operating room; IOL, intraocular lens.

Table 7 Comparison of Accurus and Constellation surgical platforms for combined microincisional vitrectomy surgery with phacoemulsification and IOL implantation for all cases performed

Combined surgery summary: all days
OR room 5 and 6, all patients/day, ±2 std dev from mean room and procedure time
Minimum 15 minute procedure time

Equipment	OR room num	N claims	N patients	N days	Claims per day	Patients per day	Calc room time (H:MM)				Calc procedure time (H:MM)			
							Min	Median	Max	Mean	Min	Median	Max	Mean
Accurus	5	74	73	40	1.85	1.83	0:46	1:06	1:49	1:06	0:24	0:42	1:15	0:43
	6	71	70	40	1.78	1.75	0:37	1:09	1:40	1:09	0:26	0:45	1:14	0:45
	All	145	141	44	3.30	3.20	0:37	1:07	1:49	1:07	0:24	0:44	1:15	0:44
Constellation	5	80	78	34	2.35	2.29	0:36	0:58	1:23	0:58	0:20	0:35	1:02	0:37
	6	86	86	34	2.53	2.53	0:37	0:56	1:32	0:58	0:20	0:36	1:00	0:37
	All	166	158	37	4.49	4.27	0:36	0:57	1:32	0:58	0:20	0:35	1:02	0:37

Notes: Data presented include number of patients, patients per day, room time, and procedure time. Times are reported as minimum, median, maximum, and mean time for operating rooms 5 and 6 and as combined (all). The comparison by all cases per day was to eliminate selection bias on evaluation of operating room efficiency.
Abbreviations: OR, Operating room; IOL, intraocular lens.

Table 8 Comparison of Accurus and Constellation surgical platforms for combined microincisional vitrectomy surgery with phacoemulsification and IOL implantation for all cases performed with at least four cases per day

Combined surgery summary: at least 4 patients per day **OR room 5 and 6, at least 4 patients/day, ±2 std dev from mean room and procedure time** **Minimum 15 minute procedure time**												
Equipment	**OR room num**	**N claims**	**N patients**	**N days**	**Claims per day**	**Patients per day**	**Calc room time (H:MM)**				**Calc procedure time (H:MM)**		
							Min	**Median**	**Max**	**Mean**	**Min**	**Median**	**Max**	**Mean**
Accurus	5	71	70	38	1.87	1.84	0:46	1:06	1:32	1:05	0:24	0:42	1:01	0:43
	6	69	68	38	1.82	1.79	0:37	1:09	1:40	1:08	0:26	0:45	1:14	0:45
	All	140	136	41	3.41	3.32	0:37	1:07	1:40	1:07	0:24	0:44	1:14	0:44
Constellation	5	80	78	34	2.35	2.29	0:36	0:58	1:56	0:58	0:20	0:35	1:19	0:37
	6	86	86	34	2.53	2.53	0:37	0:56	1:45	0:59	0:20	0:36	1:00	0:37
	All	166	157	36	4.61	4.36	0:36	0:57	1:56	0:58	0:20	0:35	1:19	0:37

Notes: Data presented include number of patients, patients per day, room time, and procedure time. Times are reported as minimum, median, maximum, and mean time for operating rooms 5 and 6 and as combined (all). The comparison by case number per day was to evaluate the impact of lower surgical numbers per day on overall efficiency in the operating room.
Abbreviations: OR, Operating room; IOL, intraocular lens.

for the cutter/forceps/scissors. Seeking smaller wounds, more rapid wound healing, and elimination of transscleral repetitive instrument passage led to smaller gauge instruments that incorporated transconjunctival/transscleral trocars focused on 23-gauge and 25-gauge surgical instruments.[16–20] This MIVS approach has rapidly become the current standard with a transition from 20-gauge sutured sclerotomies to 23-gauge and 25-gauge trocared instrument approaches not requiring suture closure. Currently, 27-gauge (and smaller) instruments are available and in design.

A major impetus for the development of a novel, advanced, integrated platform design has been the surgical requirements of increased cutting rates, improved intraocular fluidics, enhanced lighting, and deliverable endolaser. This shift to small gauge surgery, along with the interest in an integrated platform, necessitated the design and development of a novel next-generation surgical platform. This ideal platform would incorporate very high speed cutting, stable real-time evaluation of intraocular fluidics, markedly improved illumination sources, capacity for delivery of high centistoke liquids, microvolume deliveries, and integrated laser technology.[21–37] These characteristics define the minimal surgical requirements for an integrated platform designed for the 21st century.

Additionally, this study took place during the transition from 20-gauge pars plana vitrectomy to 23/25-gauge MIVS. This surgical platform transition recognized the initial concerns for increased risk of endophthalmitis, choroidal detachment, iatrogenic retinal tear and/or detachment, or postoperative hypotony associated with microincisional vitrectomy.[38–42] Focused investigation and training on wound construction and surgical technique were instrumental in the use of transconjunctival, trocared, nonsutured pars plana vitrectomy in the surgical care of our patients. Fortunately, these concerns have been alleviated by clinical reviews that have not noted increased complication profiles with microincisional vitrectomy.[43]

In this study, we evaluated the "real world" surgical performance of the platform that has been the "gold standard" in vitreoretinal surgical systems, the Accurus platform, and contrasted that performance with the next generation vitreoretinal platform, the Constellation Vision System.[44–48] This comparison utilized standard metrics incorporated within the BPEI/ABLEH surgical electronic medical record to determine case volume per room per day, operating room time per case, and surgical time per case along with total operating time per room per day. These metrics allow a standardized comparison of technologies but require evaluation after a transition window when each technology has achieved a steady implementation

Table 9 Comparison of Accurus and Constellation surgical platforms by procedure time and room time (in minutes) for combined microincisional vitrectomy and phacoemulsification with IOL implantation

Accurus versus Constellation Vision System
Combined MIVS and phacoemulsification
Procedure time and room time (minutes)
***t*-test procedure**

Variable	Equipment	N	Lower CL Mean	Mean	Upper CL Mean	Lower CL std dev	Std dev	Upper CL std dev	Std err	Min	Max
Statistics											
Procedure time minutes	Accurus	112	41.471	43.339	45.208	8.8203	9.978	11.488	0.9428	24	74
Procedure time minutes	Constellation	119	35.041	36.773	38.505	8.4632	9.5407	10.935	0.8746	20	60
Procedure time minutes	Diff (1–2)		4.0357	6.5662	9.0967	8.9376	9.7551	10.738	1.2843		
Room time minutes	Accurus	112	64.746	67.205	69.665	11.611	13.135	15.123	1.2411	37	100
Room time minutes	Constellation	119	55.09	57.126	59.162	9.9497	11.216	12.855	1.0282	36	91
Room time minutes	Diff (1–2)		6.9187	10.079	13.24	11.163	12.184	13.412	1.604		
Variable	**Method**	**Variances**	**DF**	***t*-value**	**Pr > |t|**						
***t*-test**											
Procedure time minutes	Pooled	Equal	229	5.11	<0.0001						
Procedure time minutes	Satterthwaite	Unequal	226	5.11	<0.0001						
Room time minutes	Pooled	Equal	229	6.28	<0.0001						
Room time minutes	Satterthwaite	Unequal	219	6.25	<0.0001						
Variable	**Method**	**Num DF**	**Den DF**	**F-value**	**Pr > F**						
Equality of variances											
Procedure time minutes	Folded F	111	118	1.09	0.6310						
Room time minutes	Folded F	111	118	1.37	0.0917						

Notes: Statistical evaluation using Student's *t*-test with evaluation of equality of variance. Note Constellation procedure and room times both show a statistically significant reduction with an average reduction of approximately 7 minutes ($P < 0.0001$) and 10 minutes ($P < 0.0001$) per procedure and per case.
Abbreviations: IOL, intraocular lens; MIVS, microincisional vitrectomy surgery; CL, confidence level; std dev, standard deviation; std err, standard error.

state of usage. Further, evaluation of a large time frame coupled with high surgical numbers, as in this study, eliminates many potential biases to evaluation of the utility of new technology, such as the Constellation Vision System.

This study documents the increased efficiency of the Constellation platform relative to the prior standard Accurus system. The Constellation achieved increased patient surgical cases per day by decreasing both operative case time and room time. This increase is related to an integrated design that facilitates case turnover, vitrectomy instrument and cassette setup (and particularly combined vitrectomy/phacoemulsification instrument setup), and enhancements with integrated instrument recognition technology, prepopulated user settings, surgeon-controlled endolaser parameters, and rapid priming associated with improved fluidics. These platform design changes clearly target improvements for the surgeon, the OR team, and the patient.

Ultimately, the decision to transition from existing technology to new technology should focus first on enhanced patient care, including patient safety, improved anatomic outcomes, improved visual outcomes, and translation to a better quality of life.

Disclosure

The authors report no relevant financial conflicts of interest in this work. Dr Murray consults for Thrombogenics and Alcon.

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