ERUS2014 The EAU Robotic Urology Section

Learning Curve in robotic surgery Review of the literature

(RALP, RAPN and RARC)

G. De Naeyer, P. Schatteman, P. Carpentier, A. Mottrie

Department of Urology, OLV Clinic, Aalst, Belgium

ERUS2014 The EAU Robotic Urology Section

- Conflicts of interest
  - Robotic surgeon at OLV Aalst, Belgium
  - Proctor for Intuitive Surgical Sarl

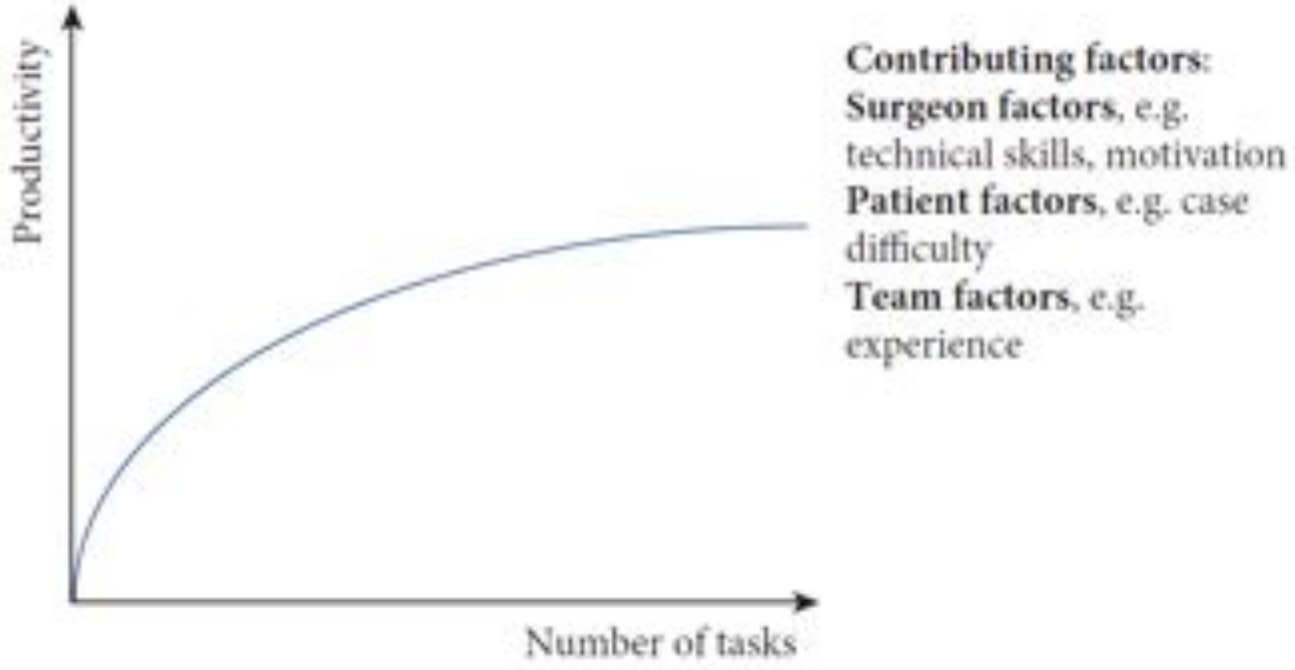
Hossein S. World J Urol (2013) 31:455–461

learning curve (LC) definition

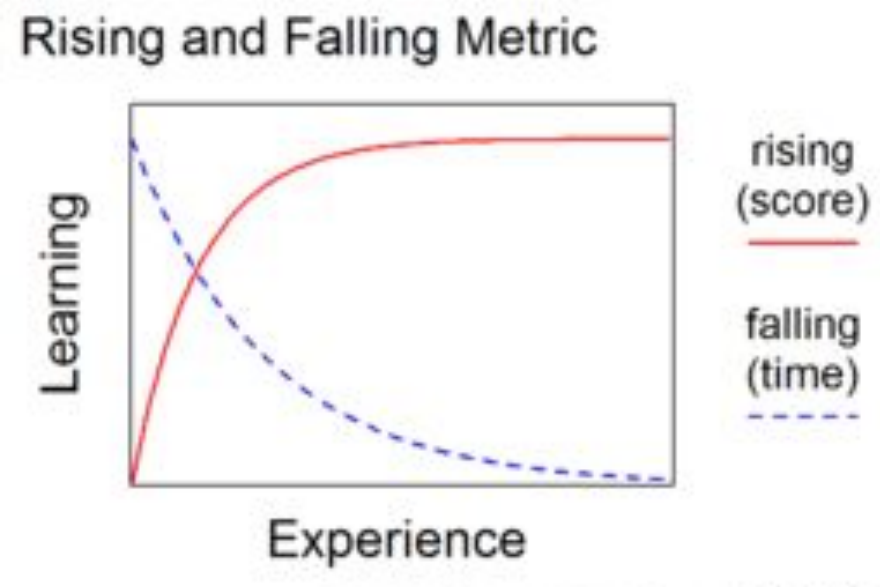
- the period during which a surgeon finds the procedure more difficult, takes longer, there is higher rate of complications and lower efficacy because of inexperience.

Hossein S. World J Urol (2013) 31:455–461

Fig. 1 Graphical illustration of a LC with reference to number of times a task is performed and productivity.



Khan N et al. BJU Int 2014; **113:** 504–508



Images from Wikipedia,blogspot

- no widely accepted standard way to define or measure this well recognized phenomenon of LC.
- definitions of LC have drawn exclusively on expert opinion (Level 4 evidence).
- 'procedure development learning curve' is the period in which, the inexperience of the surgeon with new technology makes the operation more difficult.

Hossein S. World J Urol (2013) 31:455–461

Steep Trendelenburg + Modified Lithotomy position

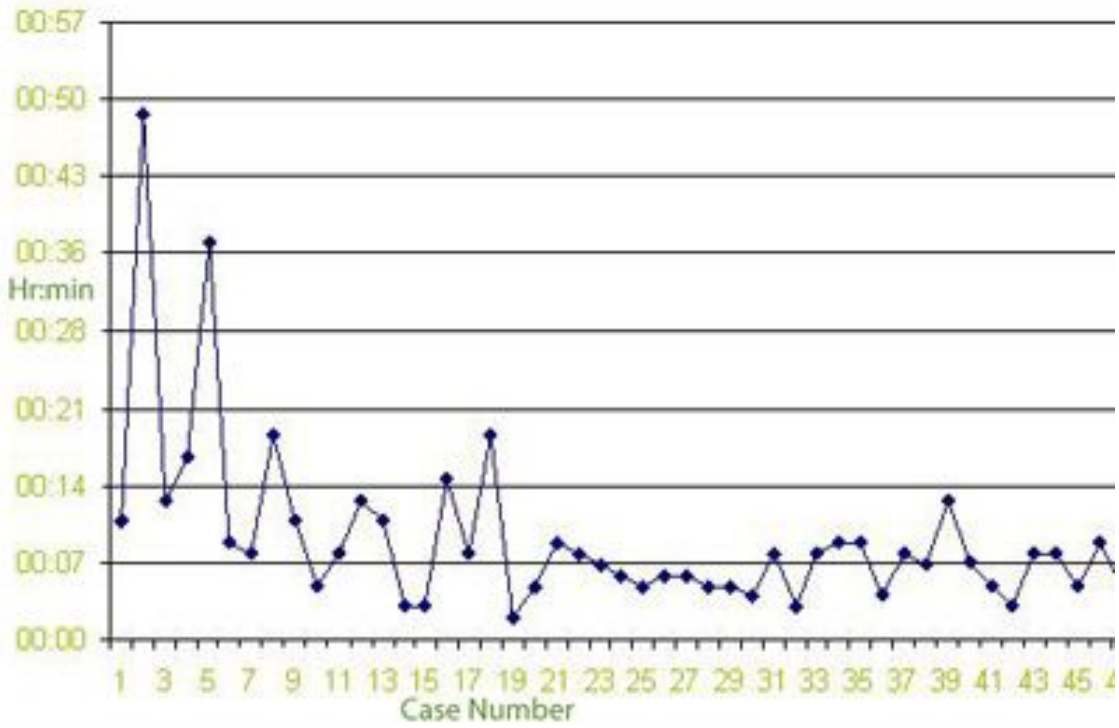
Table 1 Summary of definitions of competence

Author	Institution	Years	Definition of competence
Menon et al. [9]	Henry Ford, Detroit	2002	Operative time similar to laparoscopic cases
Ahlering et al. [38]	University of California (Irvine) medical center, Orange, CA	2003	Operative time <4 h
Herrell et al. [37]	Vanderbilt university medical center, Tennessee	2005	Similar outcomes compared with open RP and self-perception of a comparable degree of comfort with RALP
Ahlering et al. [39]	Tulane university, New Orleans, LA	2006	When considering various steps, from the initial task of gaining pneumoperitoneum, and adequate trocar placement to successfully completing the RARP to safe exit
Zorn et al. [40]	University of Chicago, Chicago, IL	2007	Operative time <4 h
Shah et al. [41]	Northwestern university, Chicago, IL	2008	Positive surgical margins
Jaffe et al.[42]	Paris, France	2009	Positive surgical margins
Freire et al. [43]	Brigham and women's hospital, Massachusetts	2010	Positive surgical margins
Sooriakumaran et al. [44]	Weill Cornell medical college, New York, NY	2011	Positive surgical margin rate <10 %

- Heterogenity of LC metrics
- different definitions of competence

Hossein S. World J Urol (2013) 31:455–461


SL | SANSONE · LAUBER
TRIAL LAWYERS
FREE CONSULTATIONS
314-863-0500
IF YOU DON'T GET PAID, WE DON'T GET PAID.
HOME
OUR PEOPLE
INJURY CASES
CRIMINAL LAW
BLOG
CLIENT REVIEWS
CONTACT US
Robotic Surgery: Beware Of The Learning Curve
Search...
Go
Home > Blog > Robotic Surgery: Beware Of The Learning Curve
Posted by Sansone / Lauber Trial Lawyers on October 9, 2013
+ SHARE IT
CATEGORIES
Bike Accidents



Docking times learning curve

available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Laparoscopy

Positive Surgical Margins in Robotic-Assisted Radical Prostatectomy: Impact of Learning Curve on Oncologic Outcomes

Fatih Atug[a,*], Erik P. Castle[a], Sudesh K. Srivastav[b], Scott V. Burgess[a], Raju Thomas[a], Rodney Davis[a]

- 100 consecutive RARP divided into 3 groups

F Atug Eur Urol. 2006 May;49(5):866-71

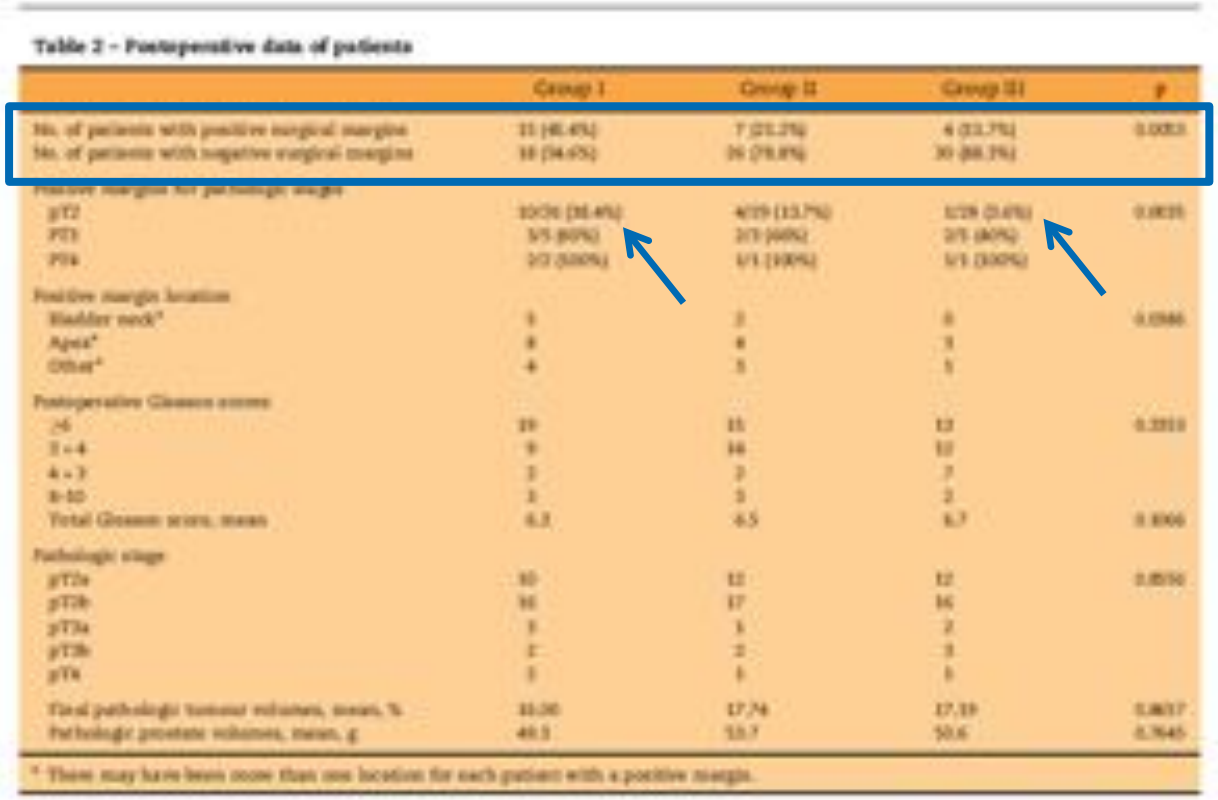


Table 2 – Postoperative data of patients

	Group I	Group II	Group III	p
No. of patients with positive surgical margins	11 (45.8%)	7 (21.2%)	4 (13.7%)	0.003
No. of patients with negative surgical margins	13 (54.2%)	26 (78.8%)	30 (86.3%)	
Positive margins for pathologic stage				
pT2	10/26 (38.4%)	4/33 (13.7%)	1/29 (3.4%)	0.035
pT3	5/5 (60%)	2/3 (66%)	2/5 (40%)	
pT4	1/2 (100%)	1/1 (100%)	1/1 (100%)	
Positive margin location				
Bladder neck*	1	2	0	0.066
Apex*	8	4	3	
Other*	4	3	3	
Postoperative Gleason score				
≤6	19	15	13	0.331
3 + 4	9	16	12	
4 + 3	2	2	7	
8-10	1	3	2	
Total Gleason score, mean	6.2	6.5	6.7	0.106
Pathologic stage				
pT2a	10	12	12	0.859
pT2b	16	17	16	
pT3a	1	1	2	
pT3b	2	2	3	
pT4	1	1	1	
Final pathologic tumour volume, mean, %	33.00	17.74	17.19	0.803
Pathologic prostate volume, mean, g	49.3	53.7	50.6	0.764

* There may have been more than one location for each patient with a positive margin.

"a learning curve, of approximately 30 patients, associated with RARP"

F Atug Eur Urol. 2006 May;49(5):866-71

JOURNAL OF ENDOUROLOGY
Volume 27, Number 1, January 2013
© Mary Ann Liebert, Inc.
Pp. 80–85
DOI: 10.1089/end.2012.0262

Evaluating the Learning Curve of Experienced Laparoscopic Surgeons in Robot-Assisted Radical Prostatectomy

Jens-Uwe Stolzenburg, MD, PhD,[1] Hasan A.R. Qazi, MD,[1] Sigrun Holze, PhD,[1] Meinhard Mende, PhD,[2] Martin Nicolaus,[1] Toni Franz,[1] Phuc Ho Thi,[1] Anja Dietel,[1] Evangelos Liatsikos, MD, PhD,[3] and Minh Do[1]

- 110 consecutive RARP with previous LRP experience

Stolzenburg JU et al. J Endourol. 2013 Jan;27(1):80-5.

TABLE 3. PATHOLOGIC DATA

	LRP (n=100)	RALP (n=100)	P value
Gleason grade (%)			
≤6	35	33	
7	48	52	
>7	17	15	
Pathologic stage (%)			
pT_{2a}	5	10	
pT_{2b}	2	2	
pT_{2c}	70	55	
$pT_{3\ (a,b)}$	20 (10,10)	33 (17,16)	
pT_4	3	0	
Positive surgical margins (%)			
Overall	14	19	0.343
pT_2	6.5% (5/77)	9.0% (6/67)	
pT_3	30% (6/20)	39.4% (13/33)	
pT_4	100% (3/3)		

LRP = laparoscopic radical prostatectomy; RALP = robot-assisted laparoscopic prostatectomy.

TABLE 4. POSTOPERATIVE DATA AND OUTCOMES

	LRP	RALP	P value
Early complications (within 1 month)			
Anastomotic leakage			
Catheter >7 days	2%	7%	
Catheter >14 days	1%	4%	
Symptomatic lymphocele	3.5% (2/58)	2% (1/50)	
Bleeding/hematoma	0%	1%	
Oncologic and functional outcomes at 3 months			
PSA < 0.2 ng/mL	93.6%	91.4	0.346
Continence (number of pads/day)			
0–1	56	65	0.062
2	19	21	
>2	25	14	
Potency			
Able to achieve intercourse	8.8 %	13.6%	0.58

LRP = laparoscopic radical prostatectomy; RALP = robot-assisted laparoscopic prostatectomy; PSA = prostate-specific antigen.

lack of a steep learning curve for experienced laparoscopic surgeons in performing RALP.

The first 10 RALP cases were performed under the supervision of an experienced mentor and were excluded ! !

Stolzenburg JU et al. J Endourol. 2013 Jan;27(1):80-5.

Author	# cases	LC	Journal
Zorn K et al.	150	50 ?	J Endourol 2007
Artibani W et al.	41	short	Urol Int. 2008
Hashimoto T et al.	200	100	J Endourol 2013
Ou YC et al.	500	250	Asian J Androl 2014

available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Platinum Priority – Prostate Cancer

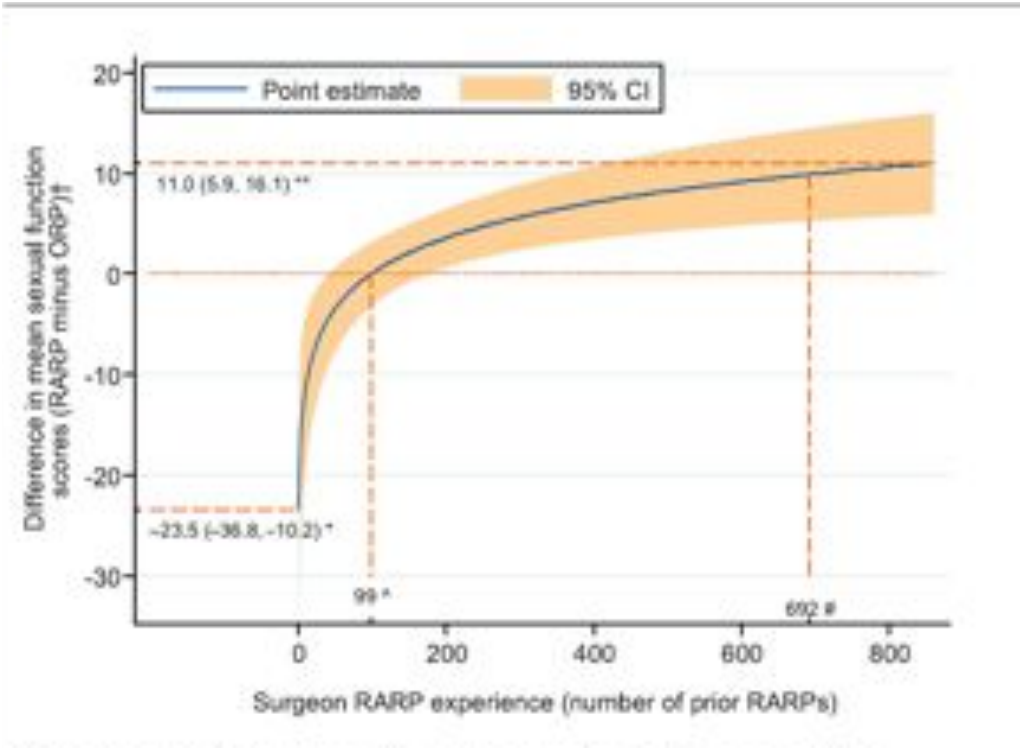
Editorial by Andrew J. Vickers on pp. 532–533 of this issue

Superior Quality of Life and Improved Surgical Margins Are Achievable with Robotic Radical Prostatectomy After a Long Learning Curve: A Prospective Single-surgeon Study of 1552 Consecutive Cases

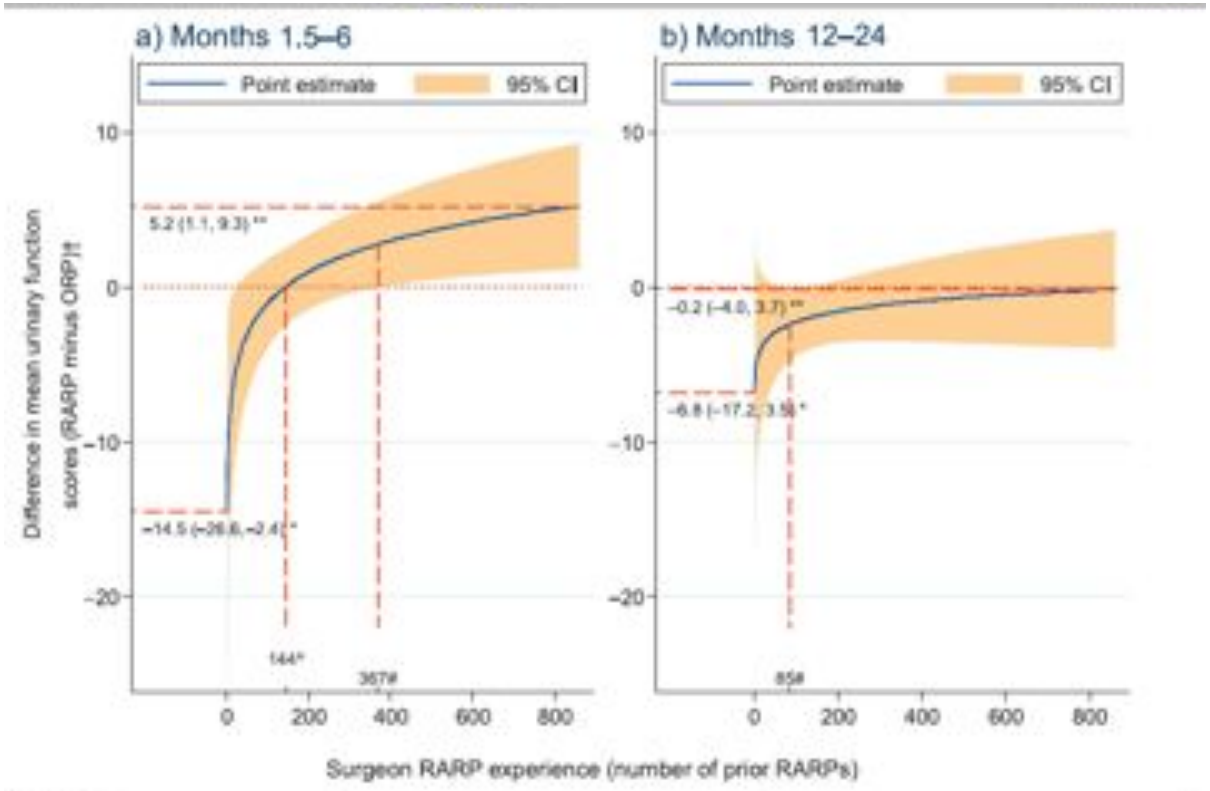
James E. Thompson[a,b,c,*], Sam Egger[d], Maret Böhm[b], Anne-Maree Haynes[b], Jayne Matthews[a], Krishan Rasiah[a], Phillip D. Stricker[a,b,c]

- RARP (866) or ORP (686) by one surgeon with 3000 prior ORPs

Thompson J. Eur Urol 65 (2014) 521–531



RARP sexual function scores surpassed ORP scores after 99 RARPs and increased to a mean difference at 861st case of 11.0 points plateauing around 600–700 RARPs



RARP had a long learning curve with inferior outcomes initially, and then showed progressively superior sexual, early urinary, and pT2 PSM outcomes and similar pT3 PSM and late urinary outcomes.

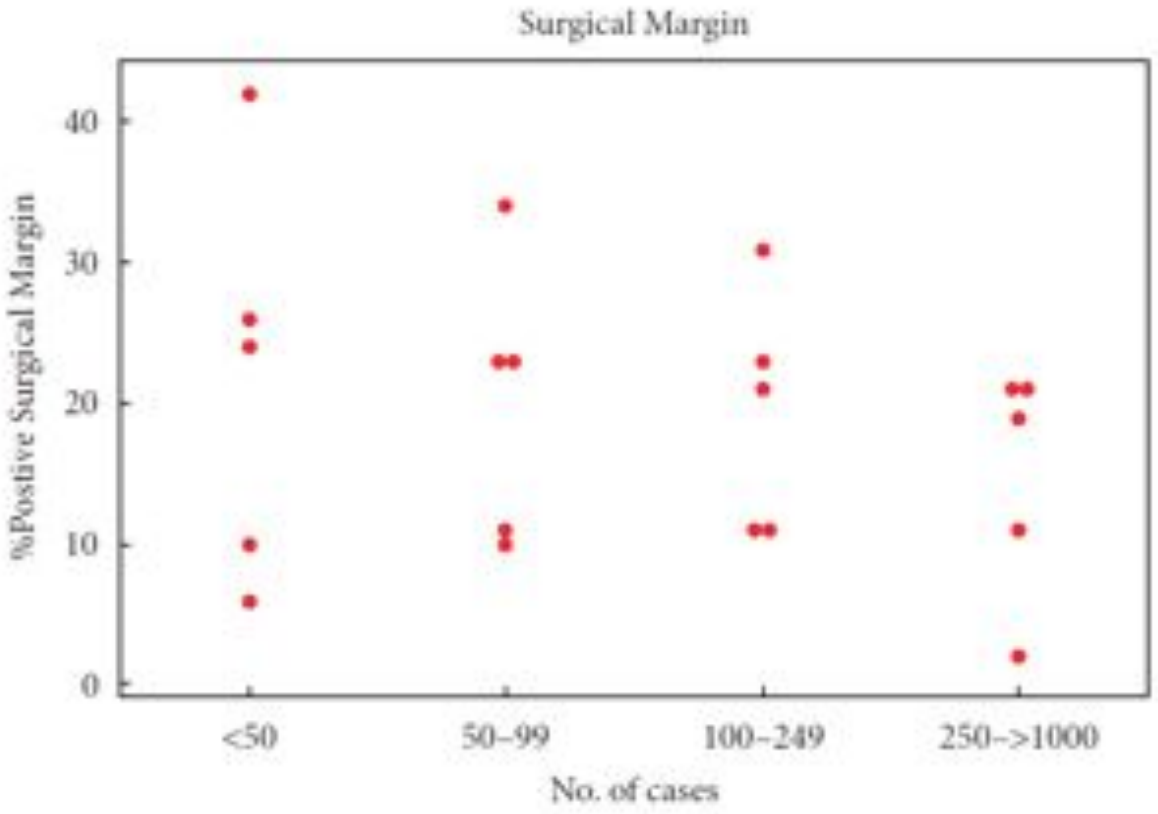
- A multi-institutional (3) review of 3794 RALP patients evaluating OT and PSM
  - Mean OT plateaued after 750 cases
  - The learning curve for PSM rates for all patients demonstrated improvements continued with increasing surgeon experience, with over 1600 cases required to get a PSM rate <10%.
  - When pT3 patients were evaluated, the learning curve started to plateau after 1000-1500 cases.
- RARP for high-risk disease should be avoided early in the learning curve but appears equivalent in experienced robotic surgeons…

Sooriakumaran P. Minerva Urol Nefrol. 2011 Sep;63(3):191-8.

Table 1 Learning curve studies on RALP

Study*	No. of participating surgeons	Previous experience	Outcome measures	Statistical analysis	Learning curve No. of cases; outcome measure
Herrell and Smith 2005 [1]	1	>2500 RRPs	OT, EBL, LOS, TR, continence, potency, PSM		250
Ficarra et al. 2011 [8]	1	Laparoscopically naive	OT, EBL, LOS, PSM, EC, potency		80–120
O'Malley et al. 2006 [9]	2	Laparoscopically naive	OT, VUAT, PSM		40–OT, 10–VUAT, 200–PSM
Lowrance et al. 2010 (A) [10]			OT, EBL, TR, PSM, CR, C		50–OT, 150–PSM
Ivanovskaya P et al. 2011 (A) [11]	1		OT, PSM rate		750–OT, 1600–PSM
Dasgupta et al. 2010 [12]	1		OT, PSM, C, EC	One-sample t-test, nonparametric regression, chi-squared with Yates correction, anova	110 –OT; 140 – PSM (pT2)/176–PSM (pT2); 200; EC
Tabatabaei et al. 2011 (A) [13]	1		OT, PSM, C		100–PSM; >200–OT
Kim et al. 2010 (A) [14]			OT, LOS, EBL, pad-free continence rate, potency		>200; LOC/OT/EBL/PSM; pad-free continence rate; >200; potency
Lowrance et al. 2010 (A) [15]			OT, EBL, PSM, LOS, early postoperative complications		50–PSM (pT2)
Lowrance et al. 2011 (A) [16]	13		PSM	Logistic regression and weighted means	50; PSM
Sanchez-Salas et al. 2011 (A) [17]	1	>500 LRPs	PSM		100–PSM (pT2)
Berg et al. 2010 (A) [18]	8	Laparoscopic surgeons	PSM		200
Chang et al. 2011 (A) [19]	8	Four robotic surgeons, four laparoscopic surgeons	PSM	Chi-squared test, multivariate analysis	Individual laparoscopic surgeons + robotic surgeons at 40 cases; laparoscopic surgeons group + robotic surgeons after 100 cases
Yun-Chuan Chu et al. 2011 [20]	1		OT, console time, EBL, TR, PSM, node positive rate, C	Mann–Whitney U test, Fisher's exact test, Yates correction	150
Sharma et al. 2011 [21]	2	Extensive open and laparoscopic experience	OT, EBL, PSM, C, potency	Multivariable logistic regression, multivariable linear regression, chi-squared test	>100
Gilbert C et al. 2010 (A) [22]			OT, TR, CR, CBT, PSM, EC, potency		200
Lim et al. 2010 (A) [23]	1		OT, EBL, LOS, TR, PSM, CR		>20

Abboudi et al. BJU Int 2013;



With increasing level of experience, the PSM rate decreases.

Abboudi et al. BJU Int 2013;

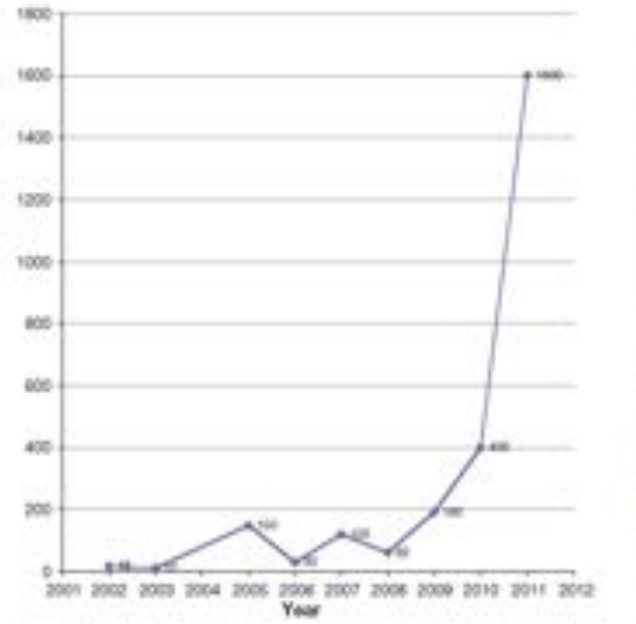


Fig. 2 Published number of cases recommended to achieve competency for robotic-assisted radical prostatectomy, 2002 to 2011. References citing minimum number of cases per year [8, 35, 36, 37, 38, 39, 40, 41, 42]

How Many Surgeries Makes a Surgeon an Expert?

Hossein S. World J Urol (2013) 31:455–461

- Fellowship training likely shortens the learning curve
  - Safety and peri-operative outcomes during learning curve of robot-assisted laparoscopic prostatectomy: a multi-institutional study of fellowship-trained robotic surgeons versus experienced open radical prostatectomy surgeons incorporating robot-assisted laparoscopic prostatectomy.

    Leroy T et al. J Endourol 2010 Oct;24(10):1665-9..

- Surgeons with open and laparoscopic experience have a learning curve of 250 and 100–300 cases, respectively.
  - The learning curve of laparoscopic versus robotic trained surgeons during implementation of a robotic prostatectomy program.

    Chang A et al. J Endourol 2011; 25: A108–9

- Surgeons without lap or open experience require 40 cases to reach similar OTs and 200 cases to reach acceptable PSM rates.
  - The learning curve of robot-assisted radical prostatectomy.

    Gumus E, et al. J Endourol 2011; 25: 1633–7

RARC

- Learning curve metrics correlating with oncologic efficacy
  - lymph node (LN) yield
  - surgical soft tissue margins

- Several of the RARC series noted that the LN yield increased with progression of the learning curve.
  - *Is patient outcome compromised during the initial experience with robot-assisted radical cystectomy? Results of 164 consecutive cases.*

    Hayn MH et al. BJU Int. 2011 Sep;108(6):882-7.

- One series found that LN yield is surgeon-dependent (1st quintile LN yield equal to the 5th quintile for surgeon with robotic experience)
  - *Evaluating the learning curve for robot-assisted laparoscopic radical cystectomy.*

    Pruthi et al. J Endourol 2008;22:2469–2474

SCIENTIFIC PAPER JSLS

The Learning Curve for Robot-Assisted Radical Cystectomy

Khurshid A. Guru, Adam E. Perlmutter, Zubair M. Butt, Pamela Piacente, Gregory E. Wilding, Wei Tan, Hyung L Kim, James L. Mohler

Table 2.
Results by Cohort

	Cohort 1	Cohort 2	Cohort 3	Cohort 4
Total OR Time (Min)	375	321	321	352
Time for Cystectomy (Min)	187	176	165	165
Time for PLND (Min)	44	45	71	77
Estimated Blood Loss (cc)	536	591	573	695
Lymph Node Yield (Nodes)	14	21	26	25
Positive Surgical Margins	4	1	2	0
Length of Stay (Days)	9	10	11	11
Complications	9	10	10	9

Guru KA et al. JSLS (2009)13:509–514

available at www.sciencedirect.com
journal homepage: www.europeanurology.com

Platinum Priority – Bladder Cancer

Editorial by Eric E. Snader and Laurence Collette on pp. 203–204 of this issue

The Learning Curve of Robot-Assisted Radical Cystectomy: Results from the International Robotic Cystectomy Consortium

Matthew N. Hayn [a], Abid Hussain [a], Ahmed M. Mansour [a], Paul E. Andrews [b], Paul Carpentier [b], Erik Castle [b], Prokar Dasgupta [d], Peter Rimington [d], Raju Thomas [e], Shamim Khan [f], Adam Kibel [g], Myung Kim [h], Muruganan Manoharan [i], Mani Menon [j], Alex Mottrie [k], David Ornstein [l], James Peabody [d], Raj Pruthi [f], Joan Palou Redorta [k], Lee Richstone [l], Francis Schanne [m], Hans Stricker [g], Peter Wilkand [n], Ramesh Chandrasekhar [o], Greg E. Wilding [o], Khurshid A. Guru [a,*]

Attempt to determine learning curve by predetermined cutoff points for various operative and pathologic parameters

Hayn M et al. Eur Urol 58 (2010) 197–202

Table 3 – Clinical and pathologic features stratified by cumulative surgeon volume

Variable*	Surgeon RARC volume (cases)			p value
	<30	30–50	>50	
Overall OP time, min	454 (106)	392 (128)	339 (107)	<0.0001
EBL, ml	477 (476)	283 (193)	451 (419)	<0.0001
LNY, No.	13 (9)	18 (10)	20 (9)	<0.0001
LOS, d	11 (9)	11 (8)	11 (8)	0.4880
Positive margins, No. (%)	12 (9)	10 (7)	12 (6)	0.6054
Intraoperative transfusion, No. (%)	21 (19)	27 (21)	26 (13)	0.1013
Pathologic stage higher than T2, No. (%)	57 (40)	50 (34)	67 (33)	0.2923

SD = standard deviation; OP = operative; EBL = estimated blood loss; LNY = lymph node yield; LOS = length of stay.
* Continuous variables are specified as mean (standard deviation); categorical variables are specified as frequency (percentage).

" by the 30th case, the individual surgeon had reached an acceptable level of proficiency "

Hayn M et al. Eur Urol 58(2010): 197–202

RAPN

Table 4 Learning curve studies for upper urinary tract procedures.

Author	Procedure*	No of participants	Previous experience	Outcome measures	Statistical analysis	Learning curve No. of cases: outcome measure
Lavery et al. 2011 [37]	RALPN	1	>100 RALPs and 15 robot-assisted pyeloplasty's	OT, WIT	Chi-squared and Student's t-test	5 to convert from laparoscopic to robotic approach
Piovesano et al. 2011 [38]	RALPN	1	Robot-naïve	OT, WIT, EBL	t-test, chi-squared test, anova	25 to convert from laparoscopic to robotic approach
Finnegan et al. 2010 (A) [39]	RALPN	1		OT, WIT, LOS, C, EBL		Significant difference in WIT, LOS and C in 1st 75 vs last 75 cases
Jacobsohn et al. 2011 (A) [40]	RALPN	1		WIT		>72, no plateau
Talenfeld et al. 2011 (A) [41]	RALPN	1	Extensive previous robotic surgery experience	OT, WIT, EBL		32
Oh et al. 2011 (A) [42]	RALPN	1		OT, WIT, LOS, C	Linear regression analysis, multivariate analysis	20: WIT and C, 50: OT

Abboudi et al. BJU Int 2013;

SCIENTIFIC PAPER JSLS

Transition From Laparoscopic to Robotic Partial Nephrectomy: the Learning Curve for an Experienced Laparoscopic Surgeon

Hugh J. Lavery, MD, Alexander C. Small, David B. Samadi, MD, Michael A. Palese, MD

LC was defined as number of cases required to perform RPN with equal or shorter average OT and WIT than the average of the last 18 LPN.

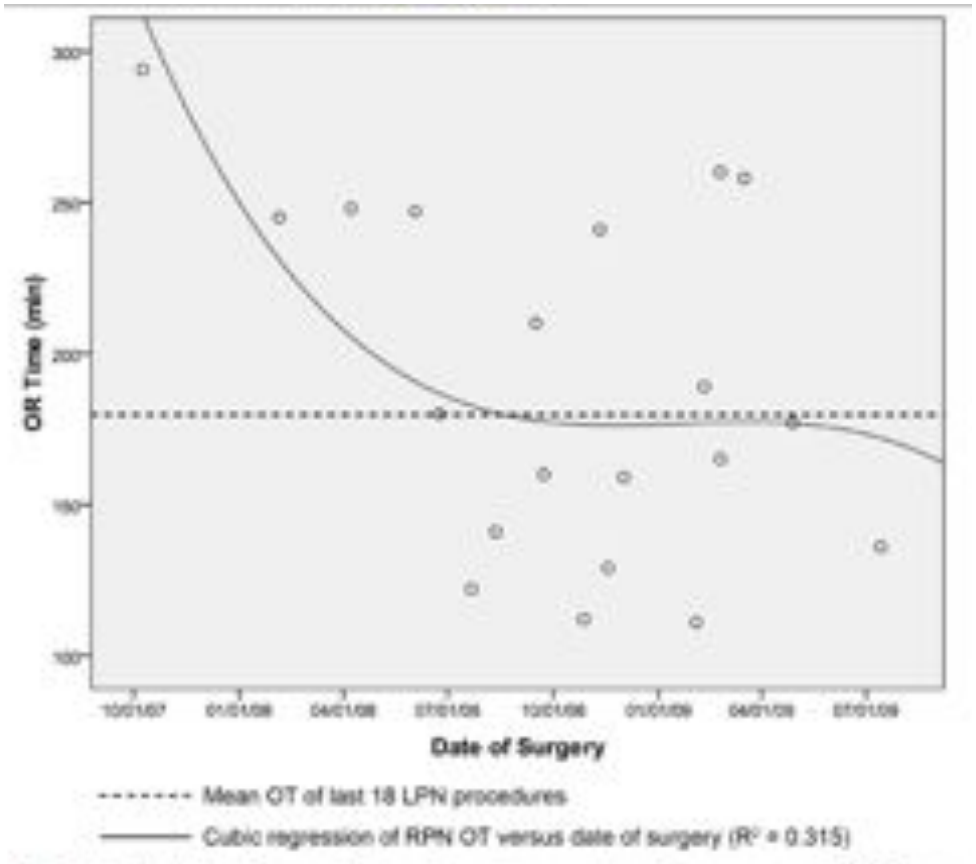
Lavery H et al. JSLS (2011)15:291–297

Table 2.
Operative and Postoperative Data

	LPN	RPN	P
N	16	20	
Operative Time (minutes) (range)	179.7 (132–225)	160.2 (111–294)	.54
Warm Ischemia Time (minutes) (range)	24.7 (18–34)	22.7 (12–40)	.52
Estimated Blood Loss (mL) (range)	139.7 (25–500)	95.5 (20–350)	.07
Hospital Stay (days) (range)	2.9 (1–5)	2.6 (1–5)	.25
Postoperative Creatinine (mg/dL) (range)	1.2 (0.8–1.8)	1.0 (0.1–1.4)	.06
Postoperative Hemoglobin (g/dL) (range)	13.2 (10.5–15.5)	12.5 (9.5–14.7)	.45
Postoperative GFR (mL/min/1.75 m^2) (range)	72.3 (33.6–108.5)	68.5 (5.3–106.7)	.60
Intraoperative Complications	0	0	
Postoperative Complications	2 (13%)	5 (25%)	1.00
Respiratory	1	1	
Vascular	1	2	
Transfusions	1	0	.47

[a]LPN = laparoscopic partial nephrectomy; RPN = robotic partial nephrectomy.
[b]GFR (glomerular filtration rate) calculated using the Modification of Diet in Renal Disease (MDRD) formula.

Lavery H et al. JSLS (2011)15:291–297



for experienced laparoscopic surgeon short (5 cases) !

Lavery H et al. JSLS (2011)15:291–297

- **Robot-assisted partial nephrectomy: evaluation of learning curve for an experienced renal surgeon.**

  Haseebuddin M et al. J Endourol 2010 Jan;24(1):57-61.

  - 38 consecutive patients undergoing RAPN by a single surgeon
  - WIT and overall operative times were recorded as indices of learning progression.
  - Defined by the overall operative time, the LC for RAPN was 16 cases, and by ischemic time, the LC was 26 cases.
  - Tumor size did not have an effect on the learning curve.

- **Learning Curves for Robotic-Assisted and Laparoscopic Partial Nephrectomy.**

  Hanzly M et al. J Endourol. 2014 Aug 11.

  - 116 LPN versus 116 RAPN
  - Similar intra-operative and post-operative complications
  - Shorter OR time and WIT in RAPN group
  - LC for warm ischemia time is shorter for RAPN.

EUROPEAN UROLOGY 58 (2010) 127–133

available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Kidney Cancer

Impact of the Learning Curve on Perioperative Outcomes in Patients Who Underwent Robotic Partial Nephrectomy for Parenchymal Renal Tumours

Alexandre Mottrie[a,b,*], *Geert De Naeyer*[a], *Peter Schatteman*[a], *Paul Carpentier*[a], *Mattia Sangalli*[a], *Vincenzo Ficarra*[a]

Mottrie et al. Eur Urol 58 (2010):127-133

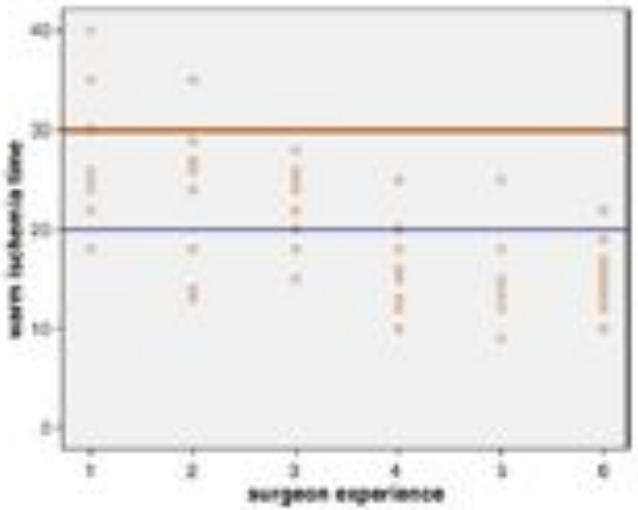


Fig. 1 – Warm ischemia time according to surgeon experience. The red line indicates the 30-min limit. The blue line indicates the 20-min limit. Group 1, cases 1–10; group 2, cases 11–20; group 3, cases 21–30; group 4, cases 31–40; group 5, cases 41–50; group 6, cases 51–62 ($p < 0.001$).

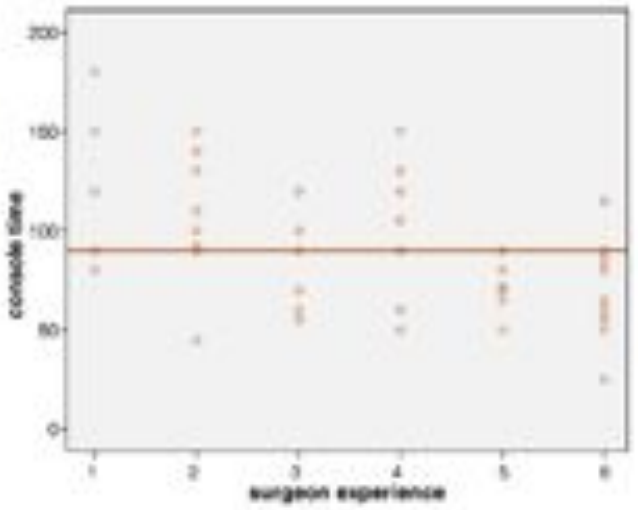


Fig. 2 – Console time according to surgeon experience. The red line indicates the median value. Group 1, cases 1–10; group 2, cases 11–20; group 3, cases 21–30; group 4, cases 31–40; group 5, cases 41–50; group 6, cases 51–62 ($p < 0.001$).

Mottrie et al. Eur Urol 58 (2010):127-133

Table 3 – Correlation of surgeon experience with console time, warm ischaemia time, blood loss, pelvicalyceal repair, and overall complication rates

Surgeon experience, cases	WIT, min	Console time, min	Blood loss, ml	Pelvicalyceal repair, %	Overall complications, no (%)
1–10	28 ± 6.8	125 ± 35	180 ± 266	18.2	1 (10)
11–20	24.2 ± 7	103.7 ± 30.4	169 ± 129	24.2	3 (30)
21–30	21.8 ± 3.9	82.5 ± 25	164 ± 260	15.2	2 (20)
31–40	16.4 ± 5.5	98.3 ± 32	116 ± 89	21.2	0
41–50	15.5 ± 4.4	70.2 ± 14.8	119 ± 137	5	3 (30)
>50	15.8 ± 3.7	67.5 ± 25.5	103 ± 90	18.2	1 (8.3)
All cases	20 ± 7	91 ± 33	140 ± 171	53.2	10 (16.1)
p value	<0.001	<0.001	0.86	0.03	0.33

WIT = warm ischaemia time.

LC of about 30 cases for WIT and OT

Mottrie et al. Eur Urol 58 (2010):127-133

Conclusion

- LC estimates for RARP, RAPN and RARC all draw on Level 4 evidence and variable definitions of competence.
- RAPN LC :about 15 to 30 cases to achieve minimum competency
  - operative time
  - WIT
  - perioperative complications
- RARC LC (based on the IRCC): about 30 cases considering
  - LN yield of 20
  - positive surgical margin prevalence < 5 %
  - operative time< 6.5 h
- RARP LC: more data available with trend towards long learning curve of 1000 procedures, especially for high risk PCa.

Recommendations

- Make any effort to shorten LC
  - Fellowships, courses, dry and wetlab training, simulators
  - ERUS *robotic structured training Program*
  - European robotic Master
  - ….
- Initiate your programs with
  - mentors/ proctor to avoid "sacrificing" the first patients.
  - Careful patient selection
- Urologic community/ ERUS should invest more in defining and evaluating LC for robotic procedures.