Robotic surgery training

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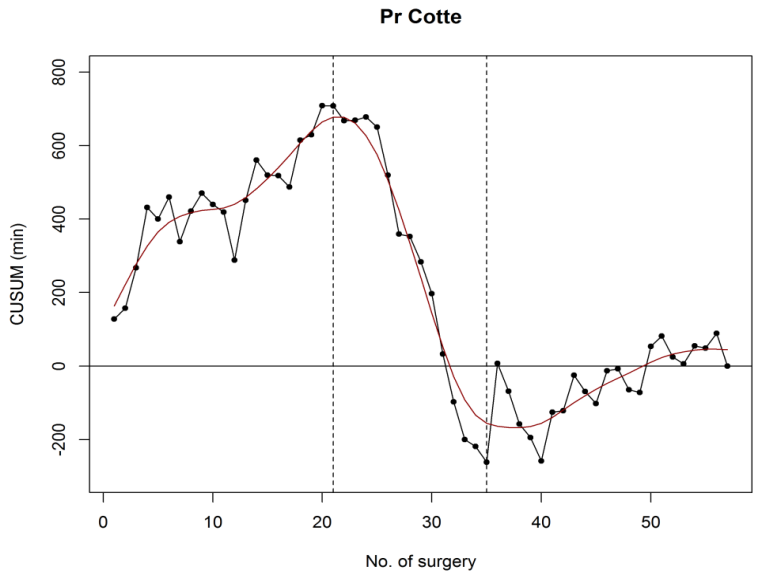
The learning curve

- **Learning curve of a new technique :**
  - Sometimes frightening
    - Length ?
    - Difficulty ?
    - Worth clinical results at the beginning ?



- **Especially for surgeon expert in other technique : laparoscopy**

Learning process

- **3 phases :**
  - Simulator
  - Animal / cadaveric lab
  - Clinical phase
- **Each phases are essential**
- **Learning process is now well codified and supported by Intuitive**

Learning process

- **Simulator**
  - Allows to train directly with the machine
  - Allows to already have automatism with the different buttons, pedals and functions at the beginning of clinical phase
  - Avoids to “fight” with the machine during the first cases
  - At least 8-10 h before starting human case

- **It is Essential +++**

Learning process

- **Animal/cadaveric lab**
  - *Port placement*
    - Seems a difficulty at the beginning
    - Easy with Xi
  - *Force feedback*
    - Absent with the robot
    - Need to be careful during the first cases
    - Rapidly not a problem
    - Visual force feedback ++++

Learning process

- **Clinical phase**
  - ***Key term = regularity***
  - ***2 philosophies***
    - *Do all consecutive cases with robot*
    - *Select easy cases at the beginning*
  - ***Aim** : at least 1 case/week*

Clinical phase

	All consecutive cases	Select cases
Advantages	**Go rapidly** through learning curve	**Learn progressively**
	See faster the advantages of robotic approach with difficult cases	**Not be disapointed** at the beginning by **difficult cases**
		Not be disapointed by long intervention at the beginning (you and your team)
Disadvantages	Have **long intervention** at the beginning	**Have only « easy cases »** at the beginning wich are normally done easily and rapidly by laparoscopy and now with some difficulty and slowly with robot
	Be d**isapointed** by difficult cases	
	Think robotic learning is difficult although it is the case that is difficult	**Do not see any advantages** of the robot vs lapaoscopy

Clinical phase

- **If you are the first robotic surgeon in your team :**
  - *You don't have so much colorectal surgery*

    -> Do all consecutive cases to have 1 case/week at least
  - *You have enough colorectal cases*

    -> Do what you suppose will be the best for you AND your team

- **If you are not the first, a good option would be :**
  - Do your ***easy cases by yourself***
  - Learn difficult cases by ***modular approach*** with your robotic colleague : performing only a part of the operation: splenic flexure, vessels division, TME, … (interest +++ of dual console)

My philosophy

- I was the first robotic surgeon of my team
- We had enough colorectal cases (>300/year)

- **My choice** :
  - Do all consecutive cases
  - To go rapidly through the learning curve
  - And because we were involved in a prospective trial with Intuitive
  - My first case : low anterior resection with intersphincteric resection !!

Proctors can help you

During the clinical phase, it's important :

- **To see expert robotic surgeons in their hospitals**
  - At the biggining (ports placement, tips and tricks, …)
  - With some members of your team : nurses, assitant, …
  - Each time you want to start a new procedure (right colectomy with CME,…)

- **To do some procedures in your hospital with the help of a proctor**
  - After few cases
  - Or if you have some difficulties (splenic flexure, …)
  - Dual consols +++

- Proctoring is part of the learning process and supported by Intuitive

How to go safely through the learning curve

2 key points :

- **Simulator +++**
- **Regularity during the clinical phase**

Learning curve study

- **4 centers in France :**

  Clermont-Ferrand; Bordeaux; Lyon; Montpellier

- **Prospective robotic colorectal studies : ROBOT-CR studies**

- **1324 patients included from jan 2018 to Feb 2021**

Learning curve study

Selection of an homogeneous population :

- *Inclusion criteria*:
  - LAR with TME for rectal adenocarcinoma
  - With low colorectal or coloanal anastomosis

- *Exclusion criteria*:
  - Rectal cancer reccurence
  - Any associated resection
  - LAR after local excision
  - Surgeon already expert in robotic surgery

- **3 centres**
- 991 robotic colorectal procedures
- 483 for rectal cancer

► **174 patients selected**

Methods

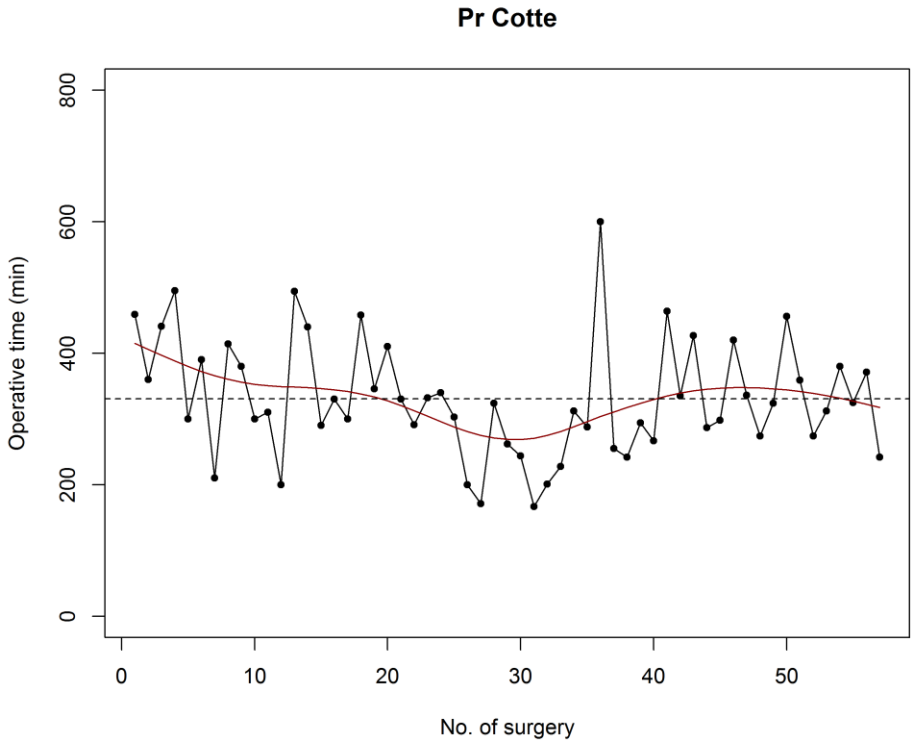
- **2 endpoints for the learning curve**:
  - **Operative time** (skin to skin, min)
  - **Conversion rate**
- **Learning curves estimation → 2 methods**
  - Continuous criteria: **CUSUM**
  - Binary criteria: **RA-CUSUM**

Learning curves LAR /TME – Operative time

- 57 procedures
- Mean operative time : 330 min

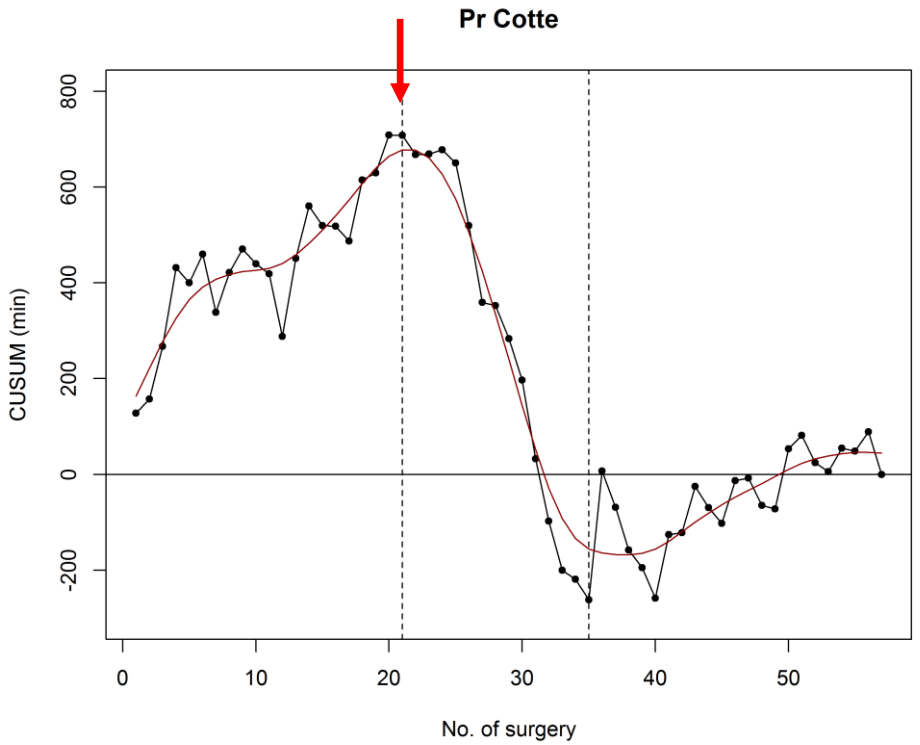
Distribution of operative time for Pr Cotte's surgeries (N=57)

	N=57
Operative time	
N	57
Mean (Std)	330.9 (89.2)
Median (Q1;Q3)	324.0 (274.0; 380.0)



Operative time evolution

Operative time– CUSUM



1 – 21st : procedures longer than mean
22 – 35th : procedures faster than mean
36 - 57th : stabilisation phase

Patient features:

► no difference between each phases

Surgical features

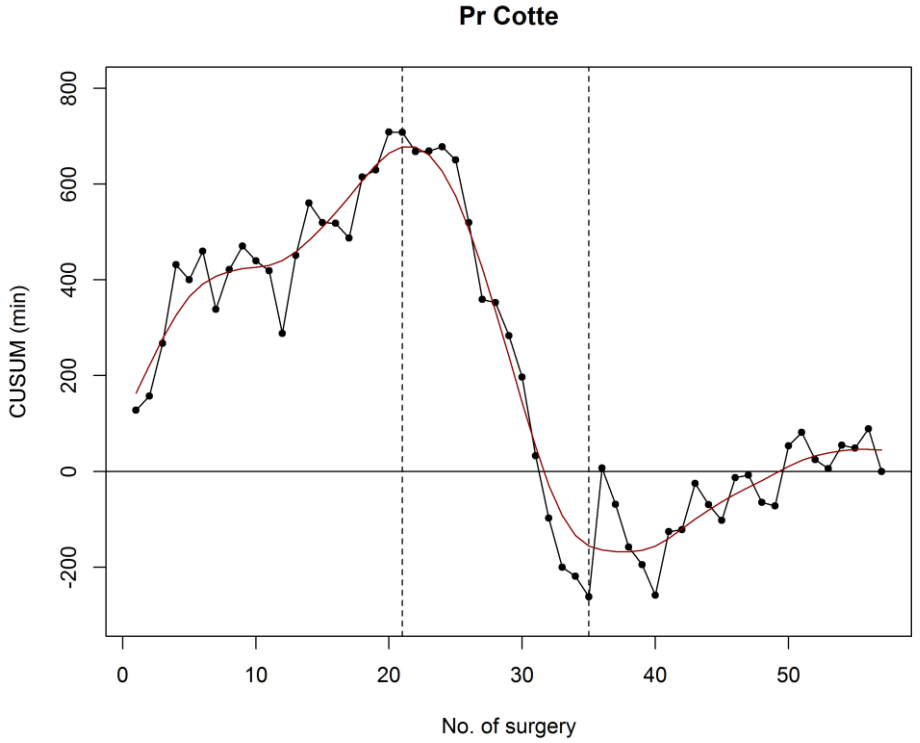
- Operative time (p<0.002)

Operative time	Phase 1	Phase 2	Phase 3
N	21	14	22
Median (Q1-Q3)	360.0 (300; 440)	275.0 (201; 312)	324.5 (274; 380)

- Splenic flexure mobilisation(p=0.008)

Splenic flexure mobilization	Phase 1 (N=21)	Phase 2 (N=14)	Phase 3 (N=22)
Yes	95%	79%	36%

Operative time– CUSUM



1 – 21st : procedures longer than mean
22 – 35th : procedures faster than mean
36 - 57th : stabilisation phase

No difference during the different phases for :

- **Pathological results : TME grade or CRM**
- **Post-operative outcomes : LOS, morbidity**

TME Grade									P = 0.189
Incomplete	2	(9.5%)	0	(0.0%)	0	(0.0%)	2	(3.5%)	
Complete	19	(90.5%)	14	(100.0%)	22	(100.0%)	55	(96.5%)	
CRM									P = 1.000
<=1mm	1	(4.8%)	1	(7.1%)	1	(4.5%)	3	(5.3%)	
>1mm	20	(95.2%)	13	(92.9%)	21	(95.5%)	54	(94.7%)	
Number of postoperative days prior to discharge									P = 0.905
N	21		14		22		57		
Mean (Std)	10.2 (4.8)		8.6 (3.1)		10.2 (6.9)		9.8 (5.4)		
Median (Q1;Q3)	7.0 (7.0; 13.0)		8.0 (7.0; 8.0)		9.0 (5.0; 12.0)		8.0 (7.0; 13.0)		
Grade 3 + morbidity at 30 days									P = 0.090
No	15	(71.4%)	14	(100.0%)	17	(77.3%)	46	(80.7%)	
Yes	6	(28.6%)	0	(0.0%)	5	(22.7%)	11	(19.3%)	

Operative time– Conclusion

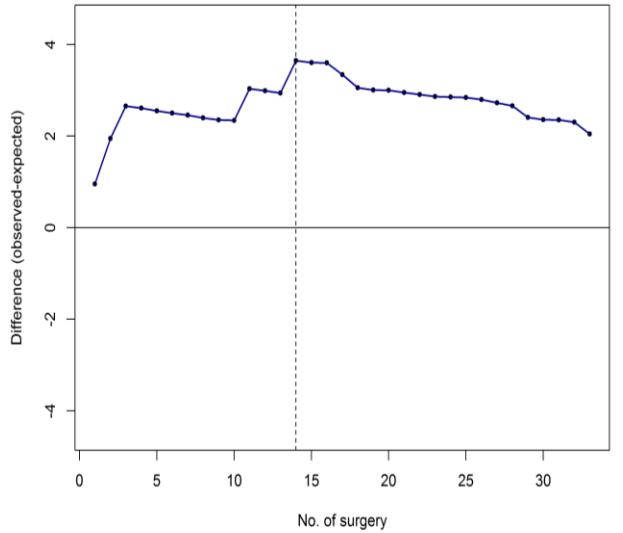
- **3 phases**
- **1st phase was achieved after 21 procedures**
- **No degradation of safety and quality criteria (TME grade, CRM, nodes count, morbidity)**
- **One point doesn’t take in account :** the number of other procedure (colectomies, rectopexy, …) performed during the learning curve (for me 55 during the 1st phase)

Conversion – Method

Logistic model for conversion risk estimation (n=174):

- **Risk factors in the final model :** Obesity, male sex, metastasis and previous history of cancer

	Conversion risk	
	Low	**High**
Conversion	Strongly ↗	Faintly ↗
No conversion	Faintly ↘	Strongly ↘



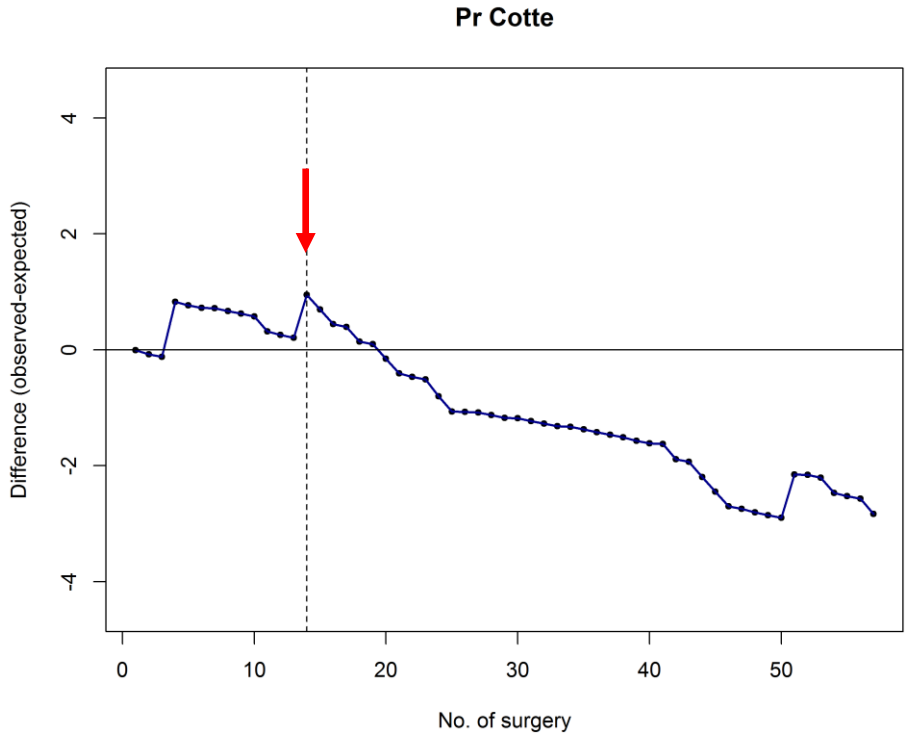
Learning curves LAR /TME – Conversion – Pr Cotte

Distribution of conversion for Pr Cotte's surgeries (N=57).

	N=57	
Conversion		
No	54	(94.7%)
Yes	3	(5.3%)

- 3 Conversion out of 57 LAR (5 %)

Conversion – Pr Cotte



1 – 14ème procedures: Initial phase : 2 conversions

15 - 57ème procedures: Descending phase with low rate of conversion

3/57 conversions (5 %)

Patients features:

- Previous abdominal surgery (p=0.049)

	Phase 1 (N=14)	Phase 2 (N=43)
Yes	14%	49%

- Obesity (p=0.049)

	Phase 1 (N=14)	Phase 2(N=43)
Yes	0%	26%

Surgical features:

- Conversion (p=0.146)

	Phase 1 (N=14)	Phase 2 (N=43)
Yes	14%	2.3%

- Splenic flexure mobilisation(p=0.023)

	Phase 1 (N=14)	Phase 2 (N=43)
Yes	93%	59%

Conversion – Conclusion

- **2 phases**
- **Learning curve was achieved after 14 procedures**
- **No degradation of safety and quality criteria (TME grade, CRM, nodes count, morbidity)**
- Low number of conversion: learning phases are difficult to identify
- But conversion became exceptional after the 1st phase

What was the more difficult at the beginning during LAR ?

- **The splenic flexure !!**
  - Needs several times of exposition
  - Small bowel sometimes makes things difficult coming back all the time in surgical site
  - At the upper limit of working zone (one docking with Xi) : sometimes some instruments conflicts

- Needs a systematic approach
- Splenic flexure mobilization each time at the beginning even if not mandatory

Today

- Nearly 300 robotic procedures
- Robotic operative time has became lower than laparoscopic time for LAR
- LOS for LAR has decreased (9.6 days for robot vs 11.3 days for laparoscopy)
- Robotic surgery is now a routine procedure for surgeons and for all the team (nurses, anesthesiologists,…)

CONCLUSIONS

- **Robotic surgery can be learned safely (vs TaTME)**
- **Simulator is essential**
- **Regularity during the clinical phase is the most important**
- **Do not neglect the help of proctors**
- **After around 20 procedures the learning curve is achieved for LAR**