The Learning Curve in Surgical Practice and Its Applicability to Rhinoplasty

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Abstract The learning curve as a concept has been considered, discussed and debated in medical education and healthcare for over two decades. The precise usage has been recognised in surgical disciplines both broad specialties and sub-specialties. Rollin Daniel in his book stated that, rhinoplasty is the most difficult of all cosmetic operations for three reasons, (a) nasal anatomy is highly variable, (b) the procedure must correct form and function and (c) the final result must meet the patients expectations. With this in mind a study was carried on the perception of learning curve in rhinoplasty based on a surgeon questionnaire at Marien Hospital, Stuttgart, Germany under Prof. Gubisch. Aims of the study were, (1) to extract the perception of learning curve of Rhinoplasty from surgeons across a spectrum of experience, i.e. less experienced to experienced, (2) To calculate the perception of learning curve in rhinoplasty as for other surgical procedures i.e. minimum number, interquartile range, surgical time, accelerators, (3) To chart-out a road-map for a novice rhinoplasty surgeon for continued improvement in surgical skills and ability. The conclusion derived was the concept of learning curve in rhinoplasty cannot be applied to the operation of Septo-Rhinoplasty as a whole because the two factors i.e. interquartile range and minimum number to achieve proficiency have a wide range and cannot be generalized. It is thought that each type of Rhinoplasty should be dealt with separately and learning curve

calculated accordingly, i.e. hump reduction, crooked nose and augmentation rhinoplasty.

Keywords Learning curve · Rhinoplasty · Surgeon questionnaire · Learning curve accelerators

Introduction

Hermann Ebbinghaus first described the learning curve in 1885. The learning curve is a graphical representation of the increase of learning (vertical axis) with experience (horizontal axis) (Fig. 1). It was also known as experience curve, efficiency curve or productivity curve in management studies. It is now defined as an improvement in technical performance over time or with increased experience and training [1–6]. The concept is used in situations where some task is repeated in a series of trials or where a body of knowledge is learnt over time.

The surgical learning curve when plotted, has four phases (Fig. 2). Phase A is commencement of training. Phase B is step-wise ascent in which individual gradually becomes competent, Phase C is very little improvement. This is followed by Phase D, a plateau where experience improves progress by only smaller fractions. This is followed by downward sloping curve due to advancing age-Phase E [7, 8]. An alternative curve has also been described (dotted line) [9], which exhibits temporary performance deterioration after technical competence has been achieved. The reasons postulated are case mix effect (undertaking more difficult cases), or over confidence resulting in lapses in technique or judgment.

The steep learning curve misnomer: A procedure with difficult and complex steps is often termed as having a steep learning curve. However, steepness can equally relate

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Fig. 1 The learning curve

to climbing and gaining height rapidly. Similarly, it may be argued that a steep learning curve implies that skills are acquired rapidly, usually because the procedure is simple. Complicated and technically demanding procedures are often described erroneously as having a steep learning curve. In fact, complex procedures are more likely to have gradual learning curves, with small improvements in outcome associated with each passing case, such that expertise is achieved only after large experience or not at all [10].

An important aspect of measuring the learning curve is choosing the right variables. There are two main types of variables: measuring the surgical process or measuring patient outcomes [11, 12]. Measures of surgical process includes variables such as time to complete the procedure or completion rate of the procedure, conversion rate from laparoscopic to open surgery, resection and margin involvement in cancer surgery etc. [13, 14]. Measures of patient outcomes include amount of blood loss, length of

hospital stay, intraoperative/postoperative complications, mortality etc [15, 16].

Examples in literature of surgical learning curve in Otorhinolaryngology: (1) About 30 for cochlear implantation [17]. (2) Endoscopic Trans sphenoidal skull base surgery does exist with results plateauing between 18 and 34 cases, [18], (3) For Septoplasty for deviated nasal septum (DNS):12–23 [19] and 4) Learning curve of Sialendoscopy was achieved at 30 cases [20].

Similarly a study was planned for Rhinoplasty.

Aims

1. To extract the perception of learning curve of Rhinoplasty from surgeons across a spectrum of experience based on a surgeon questionnaire.
2. To calculate the perception of learning curve in rhinoplasty as for other surgical procedures i.e. minimum number, interquartile range, surgical time, accelerators.
3. To chart-out a road-map for a novice rhinoplasty surgeon for continued improvement in surgical skills and ability.

Materials and methods

A preliminary questionnaire was prepared. It was distributed at a tertiary care hospital, centre of excellence in facial plastic surgery, at a workshop attended by rhinoplasty surgeons (ENT, PLastic and Maxillofacial) around the

Fig. 2 The surgical learning curve

world at Marien Hospital, Stuttgart, Germany under Prof Gubisch. It was completely voluntary and no personal details pertaining to name and place of practice were obtained. The questionnaire was distributed among 70 participants. A total of 30 completely filled questionnaires were obtained and further analysed.

Questionnaire

The aim of this questionnaire is for you to express *your* belief about the learning curve in Rhinoplasty (both open and closed rhinoplasty). This questionnaire will help the novice rhinoplasty surgeon understanding the learning curve and help to accelerate his/her learning curve. The responses shall be kept confidential.

General Information

1. What is your clinical position?

2. Do you carry out both open and closed rhinoplasty?
Both/Open only /Closed only (more than 90%)
(*please circle your choice*)
3. How many cases of rhinoplasty would you typically perform in a year?
(a) Open _____ cases
(b) Closed _____ cases
4. How many cases of rhinoplasty surgery have you performed in your career?
(a) Open rhinoplasty _____ cases
(b) Closed rhinoplasty _____ cases

Surgical Training

5. How many procedures' experience do you think is required to acquire proficiency in this surgical operation?
(a) Open _____ cases
(b) Closed _____ cases
6. How much percentage of these cases should be under direct observation/supervision of a senior surgeon:
7. Interquartile range: An interquartile range of 5–10 procedures' experience would imply you believed that 25% of trainees needed 5 or less procedures' experience and 75% of trainees would require 10 or less procedures' experience. Similarly an interval of 25–50 procedures means 75% of trainees need no

more than 50 procedures' experience whereas 25% required 25 or less.

- (a) open rhinoplasty: interquartile range: ____ to ____ cases.
- (b) Closed rhinoplasty :interquartile range: ____ to ____ cases.

8. As experience grows the time for the procedure reduces. In your experience how much time in minutes is reduced after,
100 rhinoplasties from ____ minutes to ____ minutes,
1000 rhinoplasties from ____ minutes to ____ minutes.
9. Following are the factors considered to be the learning curve accelerators.
Kindly give rating for each option on a scale of 1 to 10

1 being less likely and 10 being most important

A Cadaveric dissection:

Observe:

Perform:

B Attending workshops/conferences:

C Analysis of own cases:

By Self:

By Expert colleague:

D Writing article/publication:

E Observership under Expert Surgeon:

F Structured Fellowship under :

G Total work experience (number):

- 10 What cases according to you shall be better avoided by a Rhinoplasty Surgeon who has,
Performed less than 10 rhinoplasties:
Performed more than 10 but less than 100 rhinoplasties:

Observations and Results

Among 30 surgeons ranging from resident doctors, assistant surgeons, specialist surgeons, private practitioners (Plastic/ENT/Maxillofacial), Open approach was preferred by 20 whereas both open and closed were preferred by 10.

The surgeons were divided into four groups according to their level of experience (Table 1). The lowest number was 0 (resident doctor) and the highest was 3000.

The number of procedures required to achieve proficiency in open rhinoplasty was studied (Table 2). This shows that less experienced surgeons thought that it would

Table 1 Surgeon groups based on surgical experience

Group	No. of open rhinoplasties performed	Number of surgeons
A	0–10	6
B	11–100	11
C	101–500	7
D	More than 500	6

Table 2 Number of procedures required to achieve proficiency

Group	Range	Mean
A (0–10)	75–100	86.66
B (11–100)	25–80	48.18
C (101–500)	20–100	65.71
D (more than 500)	50–200	108.33

Table 3 Interquartile range in various groups

Group	Mean (25%)	Mean (75%)
A (0–10)	45	90
B (11–100)	27	83.18
C (101–500)	28.33	100
D (more than 500)	45	103

Table 4 Mean operating time in various groups over a period of time

Group	Mean (minutes) before	Mean (minutes) after
A (0–10)	186	125
B (11–100)	194	133
C (101–500)	187	135
D (more than 500)	180	120

take about 86 procedures to achieve proficiency (I.e. the operation is difficult). The mid-level thought it would take them 48–65 procedures to achieve proficiency. The masters with experience say- indeed minimum 100 procedures are required to achieve proficiency, again implying complexity of the operative procedure.

The interquartile range was studied. (Table 3-Interquartile Range. The interquartile range varied drastically among all groups showing a lot of individual variation.

Change in operation time as surgical experience increases was studied (Table 4). All groups thought that as experience grows you perform the procedure about 60 min faster once you achieve proficiency.

Learning curve accelerators are methods by which one can accelerate the learning curve (Table 5-Learning curve

Table 5 Learning curve accelerators

Accelerator	Mean
Cadaveric dissection (self)	8.06
Cadaveric dissection (observe)	5.79
Attending workshop/conference	8.1
Analysis of own cases-self	8.26
Analysis of own cases-expert colleague	8.6
Writing article/publication	5.1
Observership under expert	9.66
Structured fellowship	9.43
Total no. of rhinoplasties	9.56

accelerators). Participants were asked to rate the importance of each on a scale of 0–10 (10 being most important).

Cases to be avoided by Rhinoplasty Surgeon of experience of less than 10 cases was asked. The uniform opinions of participants were; Extracorporeal septoplasty, tip Plasty, Cleft Nose, Extreme Bony deviations, Saddle Nose, Revision Cases, pure aesthetic, Ethnic Nose, Multiple Deformities, Unrealistic expectation.

Cases to be avoided by surgeon with experience of more than 10 but less than 100 rhinoplasties was asked. Majority rated the following: Saddle nose, Cleft nose, Ethnic nose, Revision cases, secondary skinny nose.

Conclusion

The minimum number of procedures required to achieve proficiency in open rhinoplasty ranged from 20 to 100 with mean of 76.66 and in closed rhinoplasty from 40 to 200 with mean of 106 (not showing uniformity). The interquartile range was approximately 30–100, a very wide range. An average surgical time of rhinoplasty uniformly reduces by approximately 60 min as experience grows. One can accelerate the learning curve by various ways, the most important being observership under an expert, structured fellowship, doing more number of rhinoplasties.

Discussion

Septo-Rhinoplasty is an extremely difficult surgery in terms of understanding patient's expectations and delivering consistent results. As per the senior author, what works in one surgeon's hands might not work in others. It is a highly individualised surgery. Multiple plans and strategies have to be chalked out preoperatively and intraoperatively. It has various types: Hump, Dorsal deviation, Tip plasty, Cleft, Radix. The more experienced surgeon will do the best possible for the patient, i.e. additional tip work, add on grafts that

will increase the surgical time or remain static over his career. Factors like temperament, personality of surgeon might also affect the results. According to P.J.F.M Lohius in his book on Advanced Caucasian and Mediterranean Rhinoplasty the learning curve depends on genes, luck and repetitive exercise [21]. Accordingly to Rollin Daniel few principles that can improve your learning curve are Pre-op Photo Analysis, Write Out the Op Plan, Nasal Aesthetics Analysis and Anatomy, Intraop Instruments and Photos, Op Diagrams and Questions, Frequent post op Visits and Photos, Revisions, Reading and Meetings, Visit other surgeons/find a mentor, and give a presentation/write a paper [22].

Inference

The concept of learning curve in rhinoplasty cannot be applied to the operation of Septo-Rhinoplasty as a whole because the two factors i.e. interquartile range and minimum number to achieve proficiency have a wide range and cannot be generalised.

It is surmised that each type of Rhinoplasty should be dealt with separately (i.e. hump nose/crooked nose/tip plasty, revision) and learning curve calculated accordingly.

In any environment if a person is assigned to do the same task (exercise), then after a certain period of time, there is improvement in his performance. Overall the learning curve can be improved and accelerated by watching live operations by experts, surgical videos by stalwarts, assisting actively at surgery, specialised training in form of observerships, fellowships, cadaver dissections and simple/advanced simulators.

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Compliance with Ethical Standards

Conflict of interest Author A declares that he/she has no conflict of interest. Author B declares that he/she has no conflict of interest.

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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