

## Short Communication

# Study of ergonomics in terms of angle of manipulation and angle of azimuth in laparoscopic splenectomy

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### ABSTRACT

As per baseball diamond concept of port position, experimentally it is well known that putting camera port in the line of target organ and working port equidistant from camera port such that they form a 30° angle each gives optimum ergonomic advantage. However while performing laparoscopic surgeries in humans it is seldom possible to achieve such port position. No such study has ever been attempted to find out value of angle of manipulation and angle of azimuth while performing laparoscopic procedure. Purpose of our study was to measure such angles in our patients during laparoscopic splenectomy (LS) and to verify the concept of baseball position of ports in the procedure. This was a prospective observational study where angle of manipulation between right and left working port of surgeon and angle of azimuth of both working instruments with the camera were measured intraoperatively. In our series of 12 patients who underwent LS in lateral position, we found angle of manipulation ranging from 41-85°. The azimuth angle between first working port (epigastric) and camera port was in the range of 22-45° and the azimuth angle between camera port and second working port was in the range of 19-40°. This was a first study that gave valuable insight into the application of theoretical concept of triangulation in port placement in LS. This study may guide the surgeons to measure and to modify the port position to gain advantage of better ergonomics and better long term health

**Keywords:** Laparoscopic splenectomy, Angle of manipulation, Angle of azimuth

### INTRODUCTION

As the understanding and practice of laparoscopy grew among surgeons, the number of procedures as well as their complexities grew. LS required a relatively high muscular load, putting surgeons at risk for fatigue and injury.<sup>1</sup> With increased number of complex procedures, it becomes very important for surgeons to learn the ergonomics of laparoscopy which involves the art of laparoscopic instrument manipulation safely and effectively, so that they can perform laparoscopic procedures with minimal body fatigue and discomfort.

With increased number of laparoscopic procedures, the surgeons have started experiencing problems of spondylosis, carpal tunnel syndrome, chronic back and neck pain. These health issues among laparoscopic surgeons are avoidable upto certain extent by knowing the ergonomics of the procedure to be performed and practice of the same.

As per baseball diamond concept of port position, experimentally it is well known that putting camera port in the line of target organ and working port equidistant from camera port such that they form a 30 degree angle each, gives optimum ergonomic advantage.<sup>2</sup> However

while performing laparoscopic surgeries in humans it is not always possible to achieve such port position. Moreover there is no such study which has ever been conducted to find out value of angle of manipulation and angle of azimuth while performing laparoscopic procedures. Purpose of our study was to measure such angles in our patients during LS and to verify the concept of baseball position of ports while performing the procedure. If we can define the angles at which our instruments are working, we may introduce further modifications to improve the ergonomics of the procedure.

LS in lateral or angled position with respect to manipulation and azimuth angle of ergonomics has not been explained yet.

### **Objectives**

The objectives of the study was to study the ergonomics of port placement in laparoscopic splenectomy in terms of angle of manipulation and angle of azimuth.

## **METHODS**

### **Definitions**

#### *Manipulation angle*

Manipulation angle is the angle between two working ports of the surgeon.

#### *Azimuth angle*

Azimuth angle is the angle between one instrument and the optical axis of the endoscope.

### **Study design**

The study conducted was a prospective observational study.

### **Sample size**

Sample size of convenience was of 12 patients (N=12).

### **Study period**

The study was conducted from a period of April 2018 to December 2019.

The study has been carried out in the department of surgical disciplines at All India institute of medical sciences, New Delhi. All consecutive patients undergoing LS in the department of surgical disciplines who met the inclusion criteria and gave written consent for the procedures had been included.

While performing standard LS all details were as per Table 1 and 2.

### **Inclusion criteria**

All consecutive patients (male and females) of 15 years of age and above admitted for splenectomy, elective surgery and patients with normal to medium sized spleen (up to 20 cm) in ultrasound examination were included in the study.

### **Exclusion criteria**

Patients who do not give consent for the procedure, aged less than 15 years and marked splenomegaly (more than 20 cm) were excluded from the study.

We performed all surgeries in right lateral position, the patient is positioned in the right lateral decubitus position at an angle of approximately 60°.

Optical port site was marked 3 cm left and 3-5 cm superior to umbilicus. Closed pneumoperitoneum using Veress needle at the optical port site was created. Next left working port (5 mm) was placed at the epigastrium usually 8-10 cm away from optical port as shown in Figure 1. Right working port (10 mm) usually in the midclavicular line as shown in Figure 2. A 5 mm port for assistance was placed in the anterior axillary line.



**Figure 1: Left working port (5 mm) was placed in the epigastrium usually 8-10 cm away from optical port.**

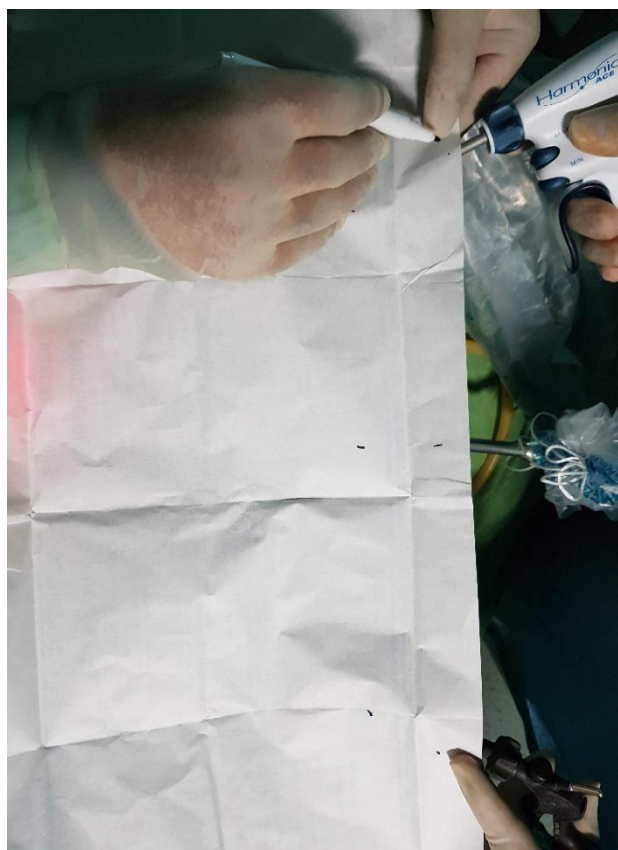


**Figure 2: Right working port (10 mm) usually in the midclavicular line.**

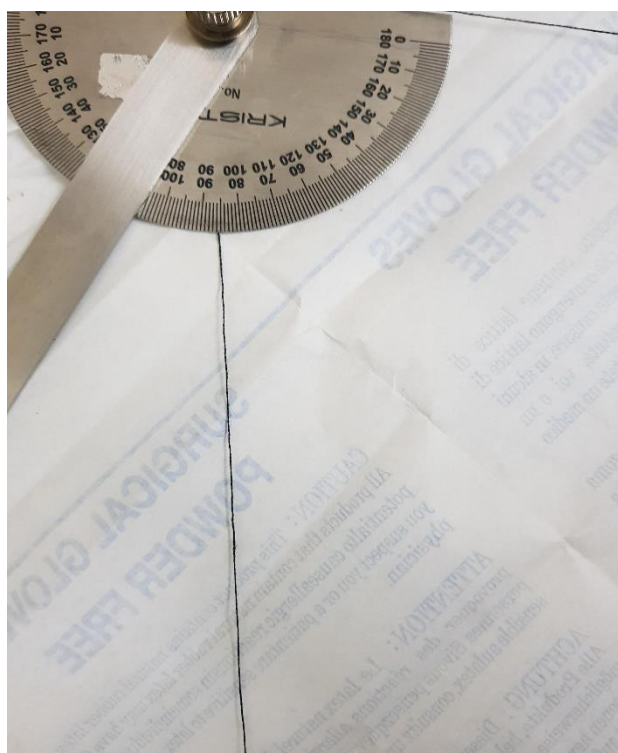
Dissection begins by picking up gastrocolic ligament and dividing it by ultrasonic device, lesser sac is entered. Dissection is continued cephalad upto gastrosplenic ligament. We preferred to clip short gastric vessels before dividing them with ultrasonic device. Upper border of pancreas was identified and following it we tried to appreciate pulsation of splenic artery. Using a dissector the artery was isolated and space was created to put two hem-o-locks so that we can ligate the artery in continuity.

By dividing phrenicocolic and phrenicosplenic ligament lower pole of spleen is made free and mobile so that assistant can retract or lift lower pole of spleen to expose the splenic hilum.

During dissection of lienorenal ligament and isolation of hilum we measured angles of ergonomics. Over the shaft of instruments a sterile plain paper (cover of sterile hand gloves) was placed. Two points are marked along the shaft of the instruments as well as camera scope on the paper as shown in Figure 3. Two points can be joined and line can be drawn. These lines represented direction of instruments with respect to each other as well as camera. These lines were extended. Point where two lines intersected each other marked the angle between two lines, that is, angle between two instruments. Thus angles of ergonomics can be measured outside the body as shown in Figure 4.



**Figure 3: Marking the two points along the shaft of the instruments as well as scope on the sterile glove wrapper.**



**Figure 4: Angles of ergonomics were measured outside the body using a sterile metallic protractor.**

**Table 1: Demography and clinical details of the patients.**

S. no.	Age (in years)/sex	Diagnosis	Size of spleen in USG (in cm)
1.	60/male	Chronic ITP	12
2.	30/female	Chronic ITP	11
3.	38/female	Chronic ITP	12
4.	23/female	NCPF and hypersplenism	18
5.	32/female	Chronic ITP	10
6.	32/male	Hypersplenism	16
7.	19/female	Hereditary spherocytosis	17
8.	43/male	Splenic abscess	12
9.	15/female	Chronic ITP	11
10.	22/female	Hereditary spherocytosis	16
11.	25/female	Hereditary spherocytosis	14
12.	28/male	Hereditary spherocytosis	16

**Table 2: Intraoperative details; angles of ergonomics.**

Sr. No.	Angle of azimuth port 1	Angle of azimuth port 2	Angle of manipulation
1.	40	30	70
2.	38	22	60
3.	36	20	56
4.	45	40	85
5.	22	19	41
6.	38	27	65
7.	26	20	46
8.	22	18	40
9.	42	30	72
10.	40	32	72
11.	34	22	56
12.	45	38	83
<b>Range</b>	22-45	19-40	41-85

Following marking of the points, 60 mm or 45 mm (depending on width of the hilum) Echelon gun with white cartridge was introduced and hilum was secured and divided. Rest of the splenic attachments usually the posterior one was divided and specimen was put in a sterile bag and delivered through a Pfannenstiel incision.

#### *Statistical analysis*

The study was a prospective observational study. Quantitative variable followed normal distribution expressed as mean and SD.

#### **RESULTS**

We performed and studied 12 LS. Demographic details are shown in Table 1.

A total of 12 patients (n=12) of age group nineteen to sixty years were studied. Out of 12, most of the patients (75%) were females (n=9). Out of five patients of chronic ITP four (80%) were chronic drug resistant ITP and one (20%) had poor steroid tolerance. All had normal sized

spleen. There were four patients of hereditary spherocytosis two male and two female (male:female, 1:1) of young age (19 to 32 years). All patients of hereditary spherocytosis had moderate splenomegaly (15 to 17 cm). There was one patient each of splenic abscess, hypersplenism and NCPF (non-cirrhotic portal fibrosis).

Intraoperatively measured angle of manipulation and angle of azimuth is shown in Table 2.

Angle of azimuth port 1 is between epigastric port and optical port.

Angle of azimuth port 2 is between optical port and right hand 12 mm working port.

Angle of manipulation is between left and right working port.

We followed principle of baseball diamond concept of port position, with target organ in the centre of the two working ports. With this port position, angles of manipulation between two working ports were in the

range of 41 to 85 degrees. The azimuth angle between first working port (epigastric) and camera port was in the range of 22-45 degrees and the azimuth angle between camera port and second working port was in the range of 19-40 degrees.

## DISCUSSION

In our study of twelve consecutive LS cases we attempted, for the first time, measurements of manipulation and azimuth angles during the surgery. Baseball diamond concept of triangulation gives good idea of placing ports while performing LS, by following same principle we studied the port placement in the LS. In all the procedures, the surgeon stands on the right side of the patient along with assistant holding the camera.

Manasnayakorn et al have studied in animal tissue models and have found that the best task efficiency and performance quality are obtained with an ideal manipulation angle between 45° and 60°. This can be achieved by correct placement of the ports. The 90 manipulation angle had the greatest muscle workload by the deltoid and trapezius of the extracorporeal and intracorporeal limbs and the extracorporeal dominant arm extensor and flexor groups. Manipulation angle ranging from 45° to 75° with equal azimuth angles of 30° is recommended.<sup>2</sup> In another review by Supe et al optimal angle of manipulation and azimuth were validated.<sup>3</sup>

In our study, angle of manipulation calculated was between 41 to 85 degrees. This range of manipulation fairly coincides with described range of angle of manipulation. We could achieve recommended angle of manipulation (45-75 degrees) in 8/12 patients. In two patients, angle of manipulation came out to be 40 and 41 degrees respectively, are fairly close to recommended range. In remaining two we achieved 83 and 85 degrees. Optimal (30 degrees) angle of azimuth 1 (working angle between camera port and epigastric port) and angle of azimuth 2 (working angle between surgeons right hand port and camera port) is described in the literature on the basis of task studies in endotrainer, we could not achieve exact 30 degree mark in all cases.<sup>4</sup>

Based on our study, we may change the medial port's location and compare them in further studies. What has been learnt as baseball diamond concept of triangulation through experimental studies with endotrainer tasks, we tried to validate it as well as measure it while performing surgery. Limitation of our study was small sample size. In future, similar studies may gather more information

and provide better objective criteria to place ports while performing advanced laparoscopic surgeries.

## CONCLUSION

This is the first study, where measurement of angle of manipulation and angle of azimuth have been attempted while performing LS. It is feasible and safe to measure these angles. In right semilateral position, optimum working angles for instruments may be achieved in most of the patients. Principles of triangulation of port placement holds good in this position. The study gives valuable insight into the application of theoretical concept of triangulation in port placement. Any surgeon can measure these angles during laparoscopic procedures, which may guide them to modify the port position to gain advantages of better ergonomics. This may help surgeons for better long term health.

## ACKNOWLEDGEMENTS

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