

## Reusable single-port access device shortens operative time and reduces operative costs

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### Abstract

**Background** In recent years, single-port laparoscopy (SPL) has become an attractive approach for performing surgical procedures. The pitfalls of this approach are technical and financial. Financial concerns are due to the increased cost of dedicated devices and prolonged operating room time. Our aim was to calculate the cost of SPL using a reusable port and instruments in order to evaluate the cost difference between this approach to SPL using the available disposable ports and standard laparoscopy.

**Methods** We performed 22 laparoscopic procedures via the SPL approach using a reusable single-port access system and reusable laparoscopic instruments. These included 17 cholecystectomies and five other procedures. Operative time, postoperative length of stay (LOS) and complications were prospectively recorded and were compared with similar data from our SPL database. Student's *t* test was used for statistical analysis.

**Results** SPL was successfully performed in all cases. Mean operative time for cholecystectomy was 72 min (range 40–116). Postoperative LOS was not changed from our standard protocols and was 1.1 days for cholecystectomy. The postoperative course was within normal limits for all patients and perioperative morbidity was recorded. Both operative time and length of hospital stay were shorter for the 17 patients who underwent cholecystectomy using a reusable port than for the matched previous 17 SPL cholecystectomies we performed ( $p < 0.001$ ). Prices of disposable SPL instruments and multiport access devices as

well as extraction bags from different manufacturers were used to calculate the cost difference. Operating with a reusable port ended up with an average cost savings of US\$388 compared with using disposable ports, and US\$240 compared with standard laparoscopy.

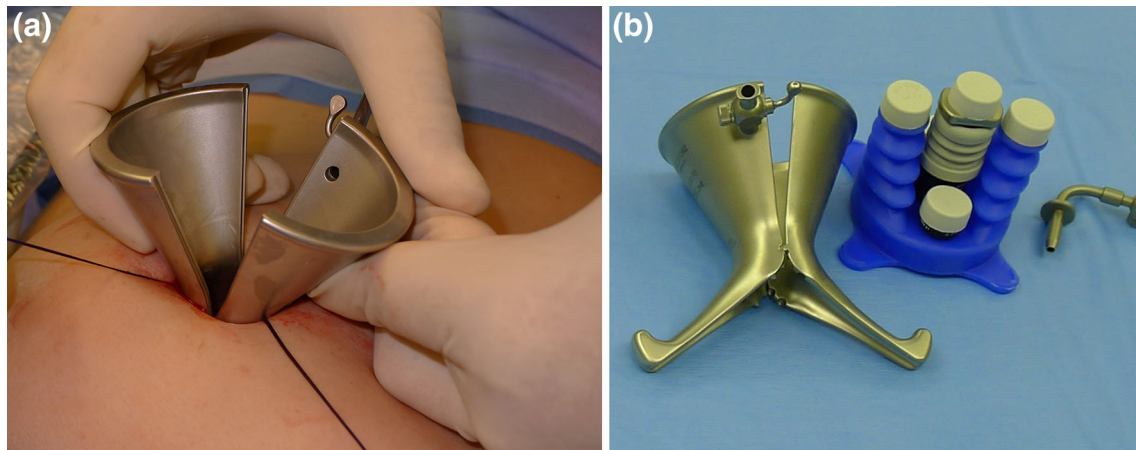
**Conclusion** Single-port laparoscopic surgery is a technically challenging and expensive surgical approach. Financial concerns among others have been advocated against this approach; however, we demonstrate herein that using a reusable port and instruments reduces operative time and overall operative costs, even beyond the cost of standard laparoscopy.

**Keywords** Single port laparoscopy · Operative costs · Reusable tools · Access device

Since being introduced almost 25 years ago, laparoscopic cholecystectomy has rapidly become the treatment of choice for symptomatic cholelithiasis [1–3]. Conventional laparoscopic cholecystectomy is generally performed through four small incisions through the abdominal wall [4]. A technique for performing the surgery via three incisions was also described almost 15 years ago [5]. In recent years, an approach of single-port laparoscopic surgery for cholecystectomy has been introduced in an effort to reduce postoperative pain and incision-related morbidities while further enhancing the cosmetic results [6–10]. There are two pitfalls of single-port laparoscopy (SPL) cholecystectomy that prevent this approach becoming routine—technical and financial.

The technical complexity of the procedure includes inadequate triangulation, compromised field of view, inadequate exposure, and instruments' collision, all as a result of the common entry point for the camera and

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**Fig. 1** **A** Xcone™ single port access device (Storz Endoscopy, Tuttlingen, Germany) is a mostly metallic device which is being assembled of two parts which together form an hourglass shape.

**B** The metallic parts of the single port access device are sealed with a silicone cap containing five individual ports

instruments. Several approaches have evolved to overcome the technical difficulties, including the use of dedicated tools and new techniques [7, 9, 10]. However, these expensive disposable tools substantially increase the cost of the procedures. This, among other factors, led to debate regarding the operative costs of SPL, especially in these times when healthcare is cost-driven [11–13]. Two recent studies pointed to an increase of \$746–\$2,100 in the total cost of SPL cholecystectomy compared with standard laparoscopy [11, 12].

Taking into consideration the fact that the true benefits of SPL over standard laparoscopy are still not defined, hospital management and insurance providers are reluctant to cover the extra costs for SPL. Herein we present our experience using a reusable single-port access system which provides improvement in technical issues as well as reduction in the total operating room (OR) cost.

## Methods

Some 22 patients were operated on using a reusable single-port access system. Of these, 17 were cholecystectomies for symptomatic gallstones, two were sleeve gastrectomies for morbid obesity, two were colectomies (a right hemicolectomy for carcinoma and a sigmoidectomy for recurrent diverticulitis), and one splenectomy for immune thrombocytopenic purpura (ITP). The exclusion criteria for SPL cholecystectomy were body mass index (BMI) >35, acute cholecystitis (although during some elective operations the gallbladder was found to be acutely inflamed), and previous upper abdominal laparotomy.

We used the reusable Xcone™ port and two reusable pre-shaped graspers (Storz Endoscopy, Tuttlingen, Germany), together with a standard dissector and a standard

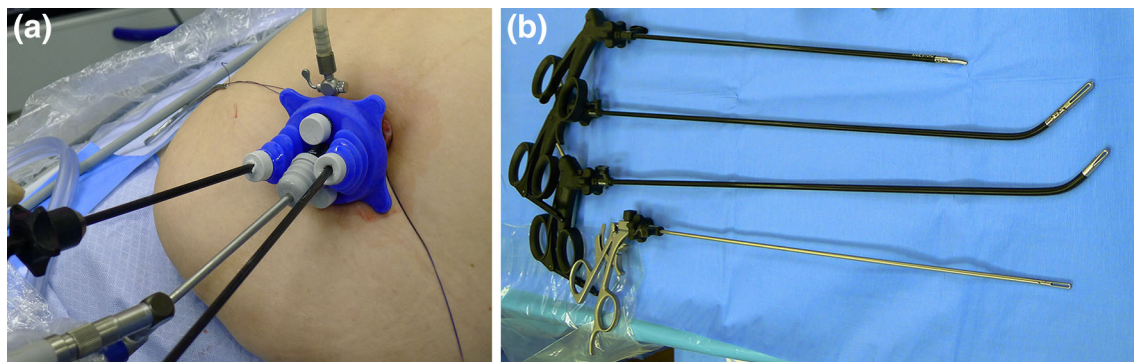
hook. The Xcone™ port is a mostly metallic device, which is being assembled during the procedure itself. The metallic component consists of two parts, which together form an hourglass figure (Fig. 1). Each of these parts is introduced separately through the same 15–20 mm skin and fascial incision. When the two halves are positioned correctly they are adjusted together to form an hourglass shape. Thus, while a small intraperitoneal expansion holds the device's narrow neck anchored to the abdominal wall, an external cone forms. Through this cone, after being sealed with a silicone cap containing five individual access ports, laparoscopic instruments, as described above, were introduced to the abdominal cavity (Fig. 2). Retraction was achieved with either the Endograb™ endo-retractor (Virtual Ports Ltd. Misgav, Israel) or with the second reusable pre-shaped grasper.

The rest of the procedures' stages were performed exactly in the same manner of every other laparoscopic surgery—multiport or single port. In all procedures we used a 5 mm, 30°, angled rigid laparoscope. Specimen extraction was performed through the operative incision in all cases.

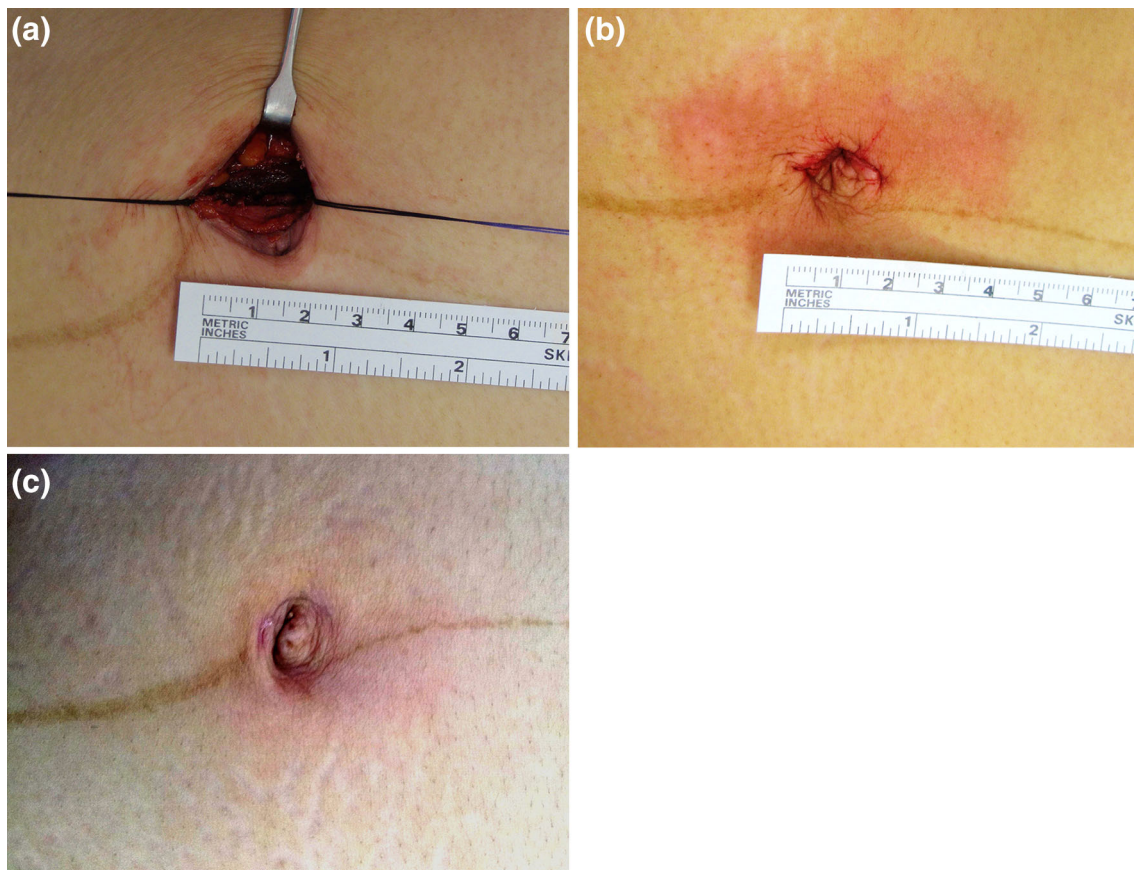
Operative time, postoperative length of stay (LOS) and complications were prospectively recorded and compared with similar data from our SPL database. Student's *t* test was used for statistical analysis.

## Results

All 22 patients were operated on by members of the same surgical team and under the supervision of the same attending surgeon (YM), but the data are not from a single-surgeon experience. SPL was successfully performed in all cases through a peri-umbilical incision (cholecystectomy



**Fig. 2** **A** The single port access device while anchored to the abdominal wall with laparoscopic instruments inserted into the abdominal cavity. **B** Curved pre-shaped graspers may facilitate retraction in single port laparoscopic surgery



**Fig. 3** **A** Skin and fascial incision as measured prior to fascial closure. The length measures 2 cm and remains constant due to the metallic rigid neck of the Xcone port. **B** The immediate post op

appearance of the skin incision. The curvilinear scar is hidden in the umbilical fold. **C** The cosmetic result 2 months post op

and colectomy), a supra-umbilical incision (sleeve gastrectomy), or a left upper quadrant incision (splenectomy). There was no need to convert to standard laparoscopy or to open surgery in any of the cases. In one operation (sigmoidectomy), one extra 5 mm incision was performed after completion of the procedure for drain positioning.

Skin incision length was up to 2 cm in all cases, usually concealed along the umbilical fold (Fig. 3). Mean

operative time (skin-to-skin) was 72 min (range 40–116) for cholecystectomy, 191 min (range 173–209) for sleeve gastrectomy, 235 min for colectomy (178 min for right hemicolectomy; 292 min for sigmoidectomy), and 154 min for splenectomy.

Postoperative LOS was not changed from our standard protocols due to operative technique. LOS was 1 day for 15 of the 17 patients who underwent cholecystectomy, and

**Table 1** Single-port laparoscopic cholecystectomy using reusable and disposable ports

	Reusable port	Disposable port	Last 17 disposable ports	<i>p</i> value
No. of patients	17	60	17	
Average BMI	24.6	25.8	25.9	0.38
Operative time (min)	72	104	95	0.0001
Length of stay (days)	1.1	1.7	1.7	0.001
Conversion (%)	0	3.3	5.8	0.16

Comparison of operative time and length of stay for three patient populations: the 17 SPL cholecystectomies that were performed using the reusable single-port access device, 60 SPL cholecystectomies we performed previously with other (disposable) access devices, and the last 17 of the previous 60 SPL cholecystectomies. ‘Conversion’ represents conversion to multiport laparoscopy. Student’s *t*-test was used to calculate *p* values

*BMI* body mass index, *SPL* single-port laparoscopy

2 days for the last two. LOS for sleeve gastrectomy was 4 and 5 days, 7 days for colectomy (both patients), and 3 days for splenectomy. There were no surgical site infections or any other early postoperative complications. The postoperative course was within normal limits for all patients.

For comparison, the above-mentioned data for SPL cholecystectomy using a reusable port is presented in Table 1, along with the corresponding data for all previous single-port laparoscopic cholecystectomies performed by our team using a disposable port, and compared with the last 17 cholecystectomies performed using disposable ports (LDP) in order to eliminate any learning curve at the beginning of our experience. The operative time improved from an average of 95 min for the LDP group to an average of 72 min for the surgeries performed with the reusable SPL access device ( $p < 0.0001$ ). LOS also decreased from 1.7 to 1.1 days ( $p < 0.001$ ).

Upon outpatient follow-up, the self-assessed cosmetic result was reported as excellent by all of the patients, and all reported an uneventful return to usual daily activities. One of the 22 patients developed an incisional hernia at the peri-umbilical incision of the SPL cholecystectomy. She was operated on and the hernia was repaired. The other 21 patients did not suffer from postoperative incisional hernias.

In order to assess the cost of a SPL cholecystectomy using either a disposable or reusable port, we assumed that all OR costs are equivalent, except for the port, trocars, extraction bag, and OR time. Although we used disposable instruments such as articulating dissectors and graspers in

our early experience and only in cases operated on with disposable ports, we did not calculate their cost due to the fact that these operations can also be carried out with standard rigid reusable instruments. Including these instruments in the calculation will only accentuate the results in favor of reusable instruments.

In an attempt to quantify the cost saved by using a reusable device, we evaluated the costs of disposable single-port and multiport access devices as well as the cost of extraction bags from different manufacturers. This way we could evaluate the cost of disposable surgical equipment saved by the use of a reusable access device (Table 2). The average cost savings are \$388 compared with the disposable SPL access device, and \$240 compared with the disposable multiport surgical equipment.

## Discussion

Single-incision laparoscopic surgery is an attractive approach for cholecystectomy; however, technical obstacles and cost differences must be sorted out before widespread application can be expected. Different technical solutions were suggested in recent years to overcome the technical obstacles [7, 9, 10, 14–16]. The various techniques were all described as feasible but it is hard, if not impossible, to objectively determine superiority of one technique over the other. In our experience, using the Xcone™ reusable port and reusable pre-shaped graspers, the technique of cholecystectomy became straightforward and reproducible. The rigidity of the port contributed to the easiness of placement, predictability of instrument insertion angles, and constant length of fascial incision. The silicone cap enables insertion of pre-shaped graspers for retraction, which allows adequate retraction of the gallbladder to be achieved, similar to standard laparoscopy, and at the same time achieving triangulation and avoidance of sword fighting of instruments. A rigid 30° laparoscope was used in all cases without the need for a flexible tip laparoscope to achieve superior fields of view. In our practice of standard laparoscopic cholecystectomy we always use an extraction bag to retrieve the gallbladder in order to avoid wound infections and possible accidental gallstone fallout into the abdominal cavity. With the port in place, the gallbladder was retrieved through the port itself, thereby avoiding the need for the extra cost of an extraction bag.

Costs are difficult to calculate and it is almost impossible to compare costs in different countries and different healthcare systems. The different hospital reimbursement mechanisms around the world, as well as the use of various surgical techniques, create differences in the studies’ conclusions regarding cost analysis [11–13, 16]. The costs of

**Table 2** Comparison of the cost (US\$) of disposable single-port access devices, multiport trocars (each number represents the cost of a 5-mm trocar with two sleeves plus an 11-mm trocar with two sleeves) and extraction bags from different manufacturers (titled company A, B, C, and D)

	Company A	Company B	Company C	Company D	Xcone™	Average cost per surgery
Disposable SPL access device	469.2	155	450	515		397
Disposable multiport set	202.82	170.39	115	253		185
Extraction bag	73.23	72.68		42.43		63
Disposables for reusable SPL ( $\geq 20$ uses)					170	8.5

Averaging the costs of single-port access devices yields an average cost of \$397. The sum of the average costs of multiport trocars and extraction bags yields an average cost of \$248 for multiport cholecystectomy. When subtracting the \$8.50 cost per surgery of the disposable parts of the reusable SPL access device (silicone seal and caps, which last at least 20 surgeries), the use of the reusable SPL access device is \$388 cheaper than that of a disposable SPL access device, and \$240 cheaper than that of a disposable multiport set

SPL single-port laparoscopy

instruments provided herein are an example from one large academic institute in the east coast of the US. We assume that due to the high volume of cases performed in this institute, the contracts and costs of instruments are lower than in other institutes in the US and hospitals around the world. Therefore, the conclusions of these calculations will even be accentuated if performed using any other institution's costs. Nevertheless, it is obvious that the use of reusable equipment is cost saving.

Our experience with the reusable single-port access device included versatile procedures, with the majority of surgeries being cholecystectomies. When comparing our SPL cholecystectomy operative time using the reusable device versus operative time when using all other access devices we used previously, operative time was 23 min shorter ( $p < 0.0001$ ). This factor by itself might contribute to reducing operative costs. We believe that the shorter OR time is due to several factors. The ease of the port insertion, the ease and standardization of achieving triangulation and retraction using the specific rigid shape of the port, and the constant small fascial incision that could be easily sutured. The evaluation of the cost of disposable equipment suggests average savings of \$240–\$388 per case on equipment relative to multiport and single-port laparoscopic cholecystectomy. Reduced operative time and the application of reusable devices necessarily lead to reduced overall operative costs.

## Conclusion

Single-port laparoscopic surgery is a technically challenging and expensive surgical approach. Increased operative times are secondary to technical complexity and contribute to elevated costs. Hence efforts should be made to improve surgical techniques and simplicity, as well as to reduce operative time and costs. Reduction of costs might be achieved by the application of reusable devices, as our

initial experience suggests. The application of the specific device we used decreased technical complexity, hence decreased operative time, and reduced the cost of the procedure to be even lower than a standard multiport operation using disposable trocars.

**Disclosures** Yoav Mintz is a consultant to the following companies: Virtual Ports, EasyLap, EasyNOTES, MST medical, Saturix Surgical. Noam Shussman, Asaf Kedar, Ram Elazary, Mahmoud Abu Gazala, and Avraham I. Rivkind have no conflicts of interest or financial ties to disclose.

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