

## Evaluation of Clipless Laparoscopic Cholecystectomy with the Aid of Extracorporeal Mishra's Knot

**Mohamed Elsayed Seifalyazal, MD; Sameh Said Mohamed, MD; Ahmed Elnabil-Mortada, MD**  
Department of General Surgery, Faculty of Medicine, Ain Shams University, Egypt

**Introduction:** Routinely in laparoscopic cholecystectomy, titanium clips were utilized to secure cystic duct and artery. Lately, there are lot of advances in sealing cystic duct and artery as Harmonic Scalpel, Plasma Kinetic sealer, intracorporeal and extracorporeal suturing. Although some of these methods are effective, they are expensive with low availability.

**Aim of the study:** To evaluate the use of extracorporeal Mishra's knot in securing cystic duct and artery in laparoscopic cholecystectomy regarding operative time, cost effectiveness and post operative complications.

**Patients and methods:** This prospective hospital-based study was conducted between October 2017 and November 2019 at Al-Jedaani hospitals, KSA. Thirty patients who underwent laparoscopic cholecystectomy were included. Cystic duct and artery were secured with extracorporeal Mishra's knot.

**Results:** The mean operative time was 61.81 minutes  $\pm$ 3.31. Postoperative bile leak and superficial surgical site infection were reported in 3.3% and 6.7% respectively. The cost of used suture material was (10-14 \$).

**Conclusion:** Using extracorporeal Mishra's knot to secure cystic duct and artery is feasible, economic and safe.

**Key words:** Laparoscopic cholecystectomy, extracorporeal knotting, Mishra's Knot.

### Introduction

In 1985, the German Prof Dr Erich Mühe performed the first laparoscopic cholecystectomy.<sup>1</sup> That has become the treatment modality for symptomatic gall stones.<sup>2</sup>

The classic four-port technique has been adjusted to three ports, two ports and single incision laparoscopic surgery. Many methods such as; metallic clips, Harmonic scalpel, plasma kinetic energy and intracorporeal or extracorporeal suturing techniques have been utilized to secure cystic duct and artery with satisfying results.<sup>3</sup>

Although clip application has the advantage of reducing the operative time in comparison to extracorporeal knotting, it has the disadvantages of migration or slippage leading to leakage and being difficult to apply in case of dilated cystic duct. In such cases, applying extracorporeal knotting is a better alternative.<sup>4</sup>

Therefore, the present study was undertaken to evaluate the use of extracorporeal Mishra's knot

in securing cystic duct and artery in laparoscopic cholecystectomy regarding operative time, cost effectiveness and post operative complications.

### Patients and methods

This prospective hospital-based study was conducted between October 2017 and November 2019 at Al-Jedaani group of hospitals, KSA by the same surgical team to evaluate the use of extracorporeal Mishra's knot in laparoscopic cholecystectomy.

Thirty patients in the age group 23-61 years constituted the study population. It is shown that the disease is predominant (53.3%) in the fourth decade of life (**Table 1**). Also, the disease is more common (76.7%) in females (**Table 2**).

Extracorporeal Mishra's knot using polyglactin 910 suture was used to secure the cystic duct and the artery in all cases. Ethical approval was obtained from the concerned ethics committee and the study was done in accordance with the protocol. All participants were consented before enrolment.

**Table 1: Age distribution**

Age (Years)	Number of patients (N=30)	Percentage
23-30	4	13.3%
31-40	8	26.7%
41-50	16	53.3%
51-61	2	6.7%

**Table 2: Sex distribution**

Sex	Number of patients (N=30)	Percentage
Male	7	23.3%
Female	23	76.7%

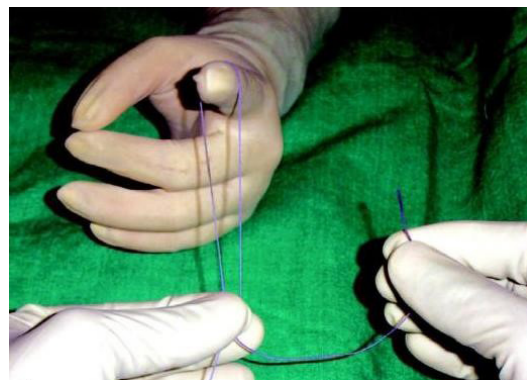
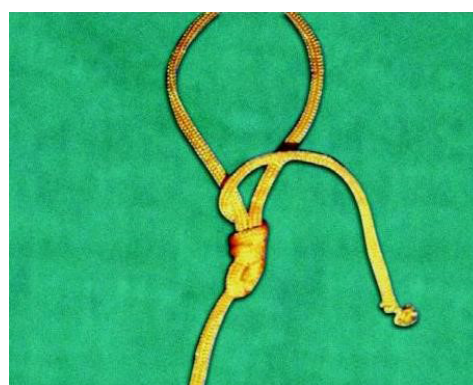
The study included all cases diagnosed with chronic calcular cholecystitis. Patients Unfit for general anaesthesia and those diagnosed with calcular obstructive jaundice, gall bladder malignancy and acute cholecystitis or having coagulation disorders were excluded. Detailed history, thorough clinical examination, cholelithiasis related routine blood tests (Bilirubin, amino-transferases, alkaline phosphatase and gama glutamyltransferase levels) and abdominal ultrasonography were done for all cases. After the evaluation, laparoscopic cholecystectomy was performed by the same surgical team and the time taken to complete the entire procedure and also the time taken to apply Mishra's knot were calculated. The cost of the used suture material was estimated. A follow-up period of six months was scheduled to detect any postoperative complication.

### Technique

A standard technique of laparoscopic cholecystectomy was performed using four ports with a maximized pressure of 15mmHg. A thirty-degree scope was used. A subhepatic drain was kept in some cases.

### Configuration of Mishra's knot

Extracorporeal Mishra's knot was used to close the proximal cystic duct stump and the cystic artery in all patients. Polyglactin 910 (Vicryl 1) suture material was introduced through the epigastric port. Intraabdominally, the thread was fed many times to avoid any traction while pulling the tail out. Extra-abdominally, the left hand held the short limb and the right hand held the long limb of the thread, Then the short limb was crossed over the longer one. The assistant's index finger was used to make the knot by taking a single hitch then one wind followed by one half knot then a second wind followed by a second half knot then last wind and to be terminated by a third half knot. The left hand was used only to hold the intersection point, while the right hand made the necessary hitches and loops. After that, the thread was pushed into-abdominally and secured by the help of knot pusher. Traction on Hartmann's pouch was mildly released on securing the knot. Mishra's knot is very secured and stable knot that can secure structures up to 18 mm in diameter.<sup>5</sup>

**Fig 1: Knot configuration.****Fig 2: Secured knot.****Fig 3: Knot shape.**

### Statistical analysis

Data were analyzed and evaluated using Statistical Package for Social Sciences, version 21 (SPSS Inc., Chicago, IL). Results for continuous variables are shown as mean  $\pm$  standard deviation, whereas results for categorical variables are shown as number and percentage.

## Results

A total number of 30 patients were enrolled in this study, their age ranged from 23 to 61 years (mean 41.8 years  $\pm$  11.47). Out of these 30 patients, 23(76.7%) were females and 7 (23.3%) were males.

The mean time taken to complete the entire procedure was 61.81 minutes  $\pm$ 3.31with maximum time of 110 minutes and minimum time of 41 minutes. The time taken to ligate cystic duct and artery was 3.1 minutes  $\pm$ 0.41 and 1.9 minutes  $\pm$  0.27 respectively. Conversion rate to open cholecystectomy was 0%.

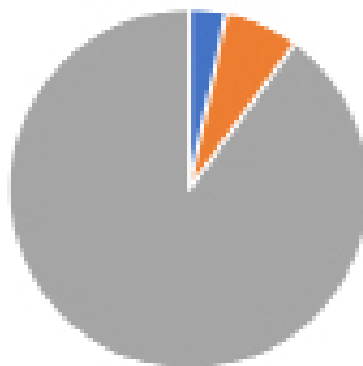
The cost of used suture material was (10-14 \$). Two patients (6.7%) had Perforated gall bladder with intraabdominal stone spillage during dissection from the liver bed that was easily managed by stone retrieval and suction irrigation with normal saline.

Overall postoperative complication rate was 10 % as one patient (3.3%) experienced postoperative bile leak due to slipped cystic duct ligature which was successfully treated by ultrasound guided therapeutic aspiration and ERCP stenting and a total number of 2 patients (6.7%) developed postoperative superficial surgical site infection (SSI). There was no incidence of deep surgical site infection. All patients demonstrated no clinical evidence of postoperative bleeding.

All patients were given injectable analgesia in the immediate postoperative period and oral analgesia from the first postoperative day if they complained of pain. The mean Visual Analogue Scale (VAS) (0=no pain to 10=most intense pain) on the first and second postoperative days was 3.1  $\pm$  0.8 ranging from 1 to 4. The current study reported no cases of postoperative obstructive jaundice due to accidental CBD ligation. Postoperative hospital stay was 36-72 hours. There was no mortality in all patients included in the study.

**Table 3: postoperative complications**

Postoperative complications	Number of patients	Percentage
Bile leak	1	3.3%
Superficial surgical site infection (SSI)	2	6.7%
No complications	27	90%



**Figure 4: postoperative complications**

■ Bile leak ■ Superficial SSI ■ No complications

**Fig 4: Postoperative complications.**

## Discussion

Laparoscopic cholecystectomy is considered the gold standard treatment for symptomatic gall stone disease as it yields good results and has better prognosis on post-operative pain, cosmesis, hospital stay and recovery. Many alternatives to titanium clips such as different types of intracorporeal or extracorporeal suturing techniques or recently ultrasonic dissectors have been used for cystic duct occlusion.<sup>6</sup>

Few studies have evaluated the use of extracorporeal

knotting in terms of safety, cost effectiveness and postoperative complications thus generating this study.

In the present study, the mean age of enrolled patients was 41.8 years  $\pm$  11.4.<sup>7</sup> This is similar to a study done by Riaz et al.<sup>7</sup> in which the mean age of the patients was 40.3 $\pm$ 11.9 years. Rajnish et al.<sup>8</sup> revealed that the mean age was 46.6 years  $\pm$  11.39, ranging from 29 to 65 years. Nidoni et al. and Singh et al.<sup>9,10</sup> reported that the age-group (30–50 years) was the most predominant in their study and this is comparable to our results(41-50 years).

In this study, the majority of patients (76.7%) were females. Similar finding was reported by Singh et al.<sup>10</sup> as 88.33% of their patients were females. Additional study done by Rajnish et al. 8 showed that 62.5% of their patients were females and 37.5% were males

The mean time taken to complete the entire procedure was 61.81 minutes  $\pm$  3.31 that was much longer than the time taken by Kumar et al.<sup>6</sup> as their time of laparoscopic cholecystectomy by using knotting was 43.32  $\pm$  4.44 minutes. Different suturing skills and unsimilar learning curve could be the justification.

on the other hand, our time was comparable to Mukesh et al.<sup>11</sup> as their mean operative time by using extracorporeal knotting was 67.37 minutes and 61.83 minutes by clipping. Another study found that the average operative time was 61.29 minutes which is similar to our findings.<sup>12</sup> on the other hand, our time was much shorter than the time (70.7 minutes) reported by Sharma et al.<sup>13</sup>

Our time range(41-110 minutes) indicates that continuous practicing of extracorporeal knotting has led to improved performance resulting in less time consuming procedure and this was evident in our last few cases included in the study.

Jain et al.<sup>14</sup> and Kandil et al.<sup>15</sup> stated that the mean operative time by using Harmonic scalpel was 50  $\pm$  9.36 and 52.14  $\pm$  9.8 respectively which is shorter than our time. And they explained why Harmonic is superior in terms of shorter operative time by many reasons: The first; is the statistically significant fewer cases of perforated gallbladder in the Harmonic group that avoids wasting time in abdominal lavage and spilled stones retrieval. The second; Harmonic scalpel could replace four routinely used instruments, namely, the dissector, clip applicator, scissors, and electrosurgical hook/spatula. Hence, there is no change of instruments repeatedly. The third; no smoke is produced; thus, the operative field is clear without the need to frequently clean the camera.

Bulus et al.<sup>16</sup> reported that the duration was 34.1  $\pm$  10 minutes by using clips, 30.5  $\pm$  11.1 minutes for Harmonic, and 36.5  $\pm$  9.9 for bipolar vessel sealer. Gurusamy et al.<sup>17</sup> showed that the operative time was statistically significant 12 minutes longer in the suture ligation group than in the clip group. Although clipping needs repeated insertion of clip applicator, its operative time is much shorter than knotting as the latter needs more technical skills that surgeons do not commonly practice.

Also in the present study, The time taken to ligate the cystic duct and the artery was 3.1 minutes  $\pm$  0.41 and 1.9 minutes  $\pm$  0.27 respectively, that resembled Tega et al.<sup>18</sup> findings as their time to ligate the

cystic duct and the artery was 2.50  $\pm$  0.25 minutes and 1.50 minutes respectively. The justification is; repeated insertion of the suture was not required to secure the artery, unlike the duct, reinsertion of the suture and the applicator was required at least twice. That's why the time taken to ligate the artery was shorter than that needed for the duct.

Sharadendu et al.<sup>19</sup> proved that the time required for cystic pedicle knotting (6.5  $\pm$  1.3 minutes) was longer than clip application time (4  $\pm$  1.1 minutes).

In the current study, the mean Visual Analogue Scale (VAS) on the first and the second postoperative days was 3.1  $\pm$  0.8 (Ranging from 1 to 4), that resembled Kumar et al.<sup>6</sup> findings as their VAS was 3.69 $\pm$ 0.77. Additionally, Singal et al.<sup>20</sup> found no significant difference in postoperative pain between suture ligation group and clip group. Rajnish et al.<sup>8</sup> showed similarity of VAS between clip group (2.3  $\pm$  0.8) and harmonic group (2.25  $\pm$  0.78).

In the present study, only one patient (3.3%) experienced postoperative bile leak due to slipped cystic duct ligature that was successfully managed by ultrasound guided therapeutic aspiration and ERCP stenting. Kumar et al.<sup>6</sup> reported 2.7% bile leak (2 patients) in clipping group and 0% in knotting group. Intraabdominal bile leak occurred in one patient (0.8%) in suture ligation group who was fully recovered by conservative measures. Huscher et al.<sup>21</sup> found 2.1% bile leak (7 out of 331 patients) having their cystic duct closed solely by Harmonic scalpel compared to 2.3% (3 out of 130 patients) in whom closure of cystic duct was obtained by Harmonic plus endo-loop. Our relatively higher percentage could be attributed to smaller sample size.

This study reported no cases of obstructive jaundice due to accidental ligation of Common bile duct which is similar to Kumar et al.<sup>6</sup> findings who reported 2 patients (2.7%) with obstructive jaundice in clip group compared to 0% in suture ligation group. Singal et al.<sup>20</sup> concluded that silk suture can be tied near the common bile duct as its risk to involve the duct wall is very minimal in comparison to clips.

In our study, the cost of used suture material was (10-14 \$) which is much more cheaper than the cost of using clips and uncomparable to the cost of using Harmonic scalpel. Singal et al.<sup>20</sup> concluded that the cost of silk suture is much cheaper (0.62–0.92 \$) than that of titanium clips (12.28-15.55 \$). Also he found that the total cost is 900\$ for clips, 2900 \$ for Harmonic and 1800\$ for bipolar devices respectively.

Despite relatively prolonged intraoperative time, extracorporeal knotting eliminates the drawbacks of clipping as: Clip migration, slippage, internalization and cat eye stones. Ghavidel,<sup>22</sup> stated that cat eye stones due to clip migration can occur mostly after a

median period of two years post cholecystectomy. Rawal,<sup>23</sup> noted the migration of two clips into the common bile duct resulting in stone formation. Photi et al.<sup>24</sup> reported a case of cholangitis secondary to clip migration into the common bile duct. Another case of postoperative Mirizzi syndrome due to migration of four polymer clips was published in a study done by Nagorni et al.<sup>25</sup> Furthermore, Labuski and Wise showed that metallic clips might fall from the applicator resulting in recurrent abdominal abscesses.<sup>26</sup>

Also complications related to the use of energy sources to secure the cystic duct as: remote injury and collateral damage were kept away in this study. Humes et al.<sup>27</sup> stated that the transferred energy can result in electrothermal injuries as bile leak and biliary stricture. Huscher et al.<sup>28</sup> reported effective histologic sealing of cystic duct stump by Harmonic scalpel alone but its morphologic changes were found within 2 mm of the cutting edge. A study reported that Harmonic sealing of dilated cystic duct (more than 6mm) is not recommended.<sup>29</sup> Also Mukesh et al.<sup>11</sup> found two patients in their study, for whom clipping was planned, extracorporeal knotting was used due to dilated cystic duct. Mishra's knot is the best alternative in case of dilated cystic duct as it secures structures up to 18mm in diameter.<sup>5</sup>

Nandalan and Vanner,<sup>30</sup> reported that Harmonic scalpel could be applied safely in patients with pacemaker avoiding electrical interference of conventional surgical diathermy, and this is the same advantage of Mishra's knot.

In this study, 2 patients (6.7%) had intraoperative gall bladder perforation with intra-abdominal stone spillage during dissection from the liver bed that was easily managed by stone retrieval and suction irrigation with normal saline. Rajnish et al.<sup>8</sup> found five patients (12.5%) with intraoperative GB perforation.

In our study, 2 patients (6.7%) got superficial SSI and these 2 patients were diabetic. Despite our small sample size, this percentage is less than other studies. As Rajnish et al.<sup>8</sup> found three patients (15%) with superficial SSI in clipping group, two of them were diabetic and two patients (10%) in Harmonic group and both patients were diabetic.

### Limitations of the study

**The current study, like any other hospital-based study, has some limitations as:**

1. The number of included patients was less in comparison to other studies. So, it's suggested that long-term trials with increased sample size are still needed to establish the absolute benefit.

2. Because of short follow-up period, it was difficult to highlight any remote complication.

### Conclusion

Using extracorporeal Mishra's knot to secure both cystic duct and artery in laparoscopic cholecystectomy is feasible, economic and safe as well with the only restriction of longer operative time.

### Disclosure statement

No conflict of interest exists.

### References

1. Svanvik J; Litynski GS Highlights in the history of laparoscopy. Frankfurt/ Main: Barbara Bernert Verlag, (360 pages). *DM 249*. ISBN 3-9804740-62.
2. Dubois F, Icard P, Berthelot GA, Levard H: Coelioscopic cholecystectomy. Preliminary report of 36 cases. *Annals of Surgery*. 1990; 211(1): 60.
3. Seenu V, Shridhar D, Bal C, Kumar A: Laparoscopic cholecystectomy: Cystic duct occlusion with titanium clips or ligature? A prospective randomized study. *Tropical Gastroenterology: Official Journal of the Digestive Diseases Foundation*. 2004; 25(4): 180-183.
4. Leo XJ, Saravanan S, Muthukumar RP, Aishwarya CV: Comparing the efficacy of clipping versus suture ligation of the cystic duct in laparoscopic cholecystectomy: A prospective study. *International Journal of Scientific Study*. 2016; 4(6): 130-132.
5. Wexner D, Green L: laparoscopic tissue approximation techniques. In RK Mishra (ed.): Textbook of practical laparoscopic surgery. Dhaka, Bangladesh: *Jaypee Brothers Medical Publishers Third Edition*. 2013; 120-140.
6. Kumar H, Seth S, Sharma OK: Clip occlusion versus extracorporeal suture ligation (Roeder Knot) of the cystic duct in laparoscopic cholecystectomy – A comparative study. *International Journal of Contemporary Medical Research*. 2020; 7(3): C6-C9.
7. Riaz O, Riaz MF, Rehan A: Metal clips versus intracorporeal ligation for cystic duct occlusion in laparoscopic cholecystectomy. *Annals of Punjab Medical College (APMC)*. 2017; 11(2): 165-168.
8. Rajnish K, Sureshkumar S, Ali MS, Sudharsanan S, Palanivel C: Harmonic scalpel-assisted laparoscopic cholecystectomy vs. conventional laparoscopic cholecystectomy-a non-

- randomized control trial. *Cureus*. 2018; 10(1).
9. Nidoni R, Vudachan T, Sasnur P, et al: Predicting difficult laparoscopic cholecystectomy based on clinicoradiological assessment. *J Clin Diagn Res*. 2015; 9(12): PC09–PC12.
  10. Singh K, Bhatia A, Singh DP: Extra corporeal knotting with silk versus liga clips for ligating cystic duct in laparoscopic cholecystectomy: A comparative study. *International Journal of Scientific Research*. 2017; 6 (8).
  11. Mukesh KS, Vijayata S, Mohinder KG, Deepak S: Triple ligation technique of clipless laparoscopic cholecystectomy: a spanner especially for complicated cholecystitis. *Int J Adv Med*. 2017; 4: 1358-1363.
  12. Jongsiri N: How to secure cystic duct ligation for laparoscopic cholecystectomy-back to simple basic. *The Thai Journal of Surgery*. 2009; 30(1-2).
  13. Sharma D, Sharma B, Solanki M: Laparoscopic cholecystectomy: Cystic duct occlusion with titanium clip or ligature. *J Sci Res*. 2016; 11: 1909-1912.
  14. Jain SK, Tanwar R, Kaza RC, Agarwal PN: A prospective, randomized study of comparison of clipless cholecystectomy with conventional laparoscopic cholecystectomy. *Journal of Laparoendoscopic & Advanced Surgical Techniques*. 2011; 21(3): 203-208.
  15. Kandil T, El Nakeeb A, El Hefnawy E: Comparative study between clipless laparoscopic cholecystectomy by harmonic scalpel versus conventional method: a prospective randomized study. *Journal of Gastrointestinal Surgery*. 2010; 14(2): 323-328.
  16. Bulus H, Basar O, Tas A, Yavuz A, Akkoca M: Evaluation of three instruments for laparoscopic cholecystectomy: Harmonic scalpel, bipolar vessel sealer, and conventional technique. *Minerva Chirurgica*. 2013; 68(6): 537-542.
  17. Gurusamy KS, Bong JJ, Fusai G, Davidson BR: Methods of cystic duct occlusion during laparoscopic cholecystectomy. *Cochrane Database of Systematic Reviews*. 2010; (10).
  18. Teja HV, Chavan DR, Kullolli G: A Comparative Study of Extracorporeal Knotting vs Clips for Ligating Cystic Duct in Laparoscopic Cholecystectomy. *World J Lap Surg*. 2022; 15(1): 14–17.
  19. Sharadendu B, Rikki S: Laparoscopic suturing versus clip application in cholecystectomy: Tips and strategies for improving efficiency and safety. *Acta Gastroenterológica Latinoamericana*. 2018; 48(1): 35-40.
  20. Singal R, Zaman M, Mittal A, Singal S: The safety and efficacy of clipless versus conventional laparoscopic cholecystectomy—our experience in an Indian rural center. *Maedica*. 2018; 13(1): 44.
  21. Hüscher CG, Lirici MM, Di Paola M: Laparoscopic cholecystectomy by ultrasonic dissection without cystic duct and artery ligation. *Surgical Endoscopy And Other Interventional Techniques*. 2003; 17(3): 442-451.
  22. Ghavidel A: Migration of clips after laparoscopic cholecystectomy; a case report and literature review. *Middle East Journal of Digestive Diseases*. 2015; 7(1): 45.
  23. Rawal KK: Migration of surgical clips into the common bile duct after laparoscopic cholecystectomy. *Case Reports in Gastroenterology*. 2016; 10(3): 787-792.
  24. Photi ES, Partridge G, Rhodes M, Lewis MP: Surgical clip migration following laparoscopic cholecystectomy as a cause of cholangitis. *Journal of Surgical Case Reports*. 2014; 2014(4): rju026.
  25. Nagorni EA, Kouklakis G, Tsaroucha A, Foutziti S: Post-laparoscopic cholecystectomy Mirizzi syndrome induced by polymeric surgical clips: a case report and review of the literature. *Journal of Medical Case Reports*. 2016; 10(1): 1-7.
  26. Labuski MR, Wise SW: Recurrent abdominal abscess secondary to a dropped laparoscopic clip: CT imaging. *Abdominal Imaging*. 1999; 24(2): 191-192.
  27. Humes DJ, Ahmed I, Lobo DN: The pedicle effect and direct coupling: delayed thermal injuries to the bile duct after laparoscopic cholecystectomy. *Archives of Surgery*. 2010; 145(1): 96-98.
  28. Hüscher CG, Lirici MM, Anastasi A, Sansonetti A, Amini M: Laparoscopic cholecystectomy by harmonic dissection. *Surgical Endoscopy*. 1999; 13(12): 1256-1257.
  29. Vu T, Aguilo R, Marshall NC: Clipless technique of laparoscopic cholecystectomy using the harmonic scalpel. *The Annals of The Royal College of Surgeons of England*. 2008; 90(7): 612.
  30. Nandalan SP, Vanner RG: Use of the harmonic scalpel in a patient with a permanent pacemaker. *Anaesthesia*. 2004; 59(6): 621.