The “boatman´s knot”: a new option for renal hilum ligation during laparoscopic nephrectomy[1]

O “nó de barqueiro”: nova opção para ligadura do hilo renal durante a nefrectomia laparoscópica

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ABSTRACT

Purpose: The authors present and describe an original adaptation for the use of “boatman’s knot” in renal vein ligation during laparoscopic nephrectomy. This procedure may replace the need for the endovascular stapler, which is considered the standard of care, but not available in several institutions in Brazil. The knot presented is also known as the “ pig’s knot” in several farms in Brazil. **Methods**: Fourteen laparoscopic nephrectomies were performed by the same surgeon in a standard fashion in seven female pigs. Both the renal artery and vein were ligated using the “boatman’s knot” as the only method for hemostasis with conventional intracorporeal technique. Two knots were applied in each artery and vein; one knot was tied proximally and the other distally. The vessels were then sectioned in between both knots. This technique is based on the intracorporeal confection of two loops by the right hand pair of dissectors with the help of the left hand. The arteries and the veins were then sectioned and the capability to accomplish full hemostasis was observed. **Results:** All the laparoscopic nephrectomies were performed successfully. The “boatman’s knot” was performed by the same surgeon with neither complications nor difficulties during the confection of the knot. In all cases hemostasis was fully achieved using only the “boatman’s knot” as the hemostatic method. **Conclusion:** The “boatman’s knot” is feasible and safe for hilum control during laparoscopic nephrectomy in pigs and total hemostasis can be achieved using it as the only method of hemostasis. However, the safety and the capacity of others to learn how to apply it should be tested before it may be advised to use it routinely.

Key words: Surgical Procedures, Laparoscopic. Nephrectomy. Hemostasis, Surgical. Hemostatic Techniques.

RESUMO

Objetivo: Os autores apresentam e descrevem uma adaptação original para o uso do nó de barqueiro na ligadura da veia renal durante a nefrectomia laparoscópica. O procedimento pode substituir a necessidade da sutura mecânica endovascular, considerada o tratamento padrão, mas não disponível em muitas instituições no Brasil. Este nó é tembém conhecidocomo “nó de porco” em várias fazendas no Brasil. **Métodos**: Quatorze nefrectomias laparoscópicas foram realizadas pou um único cirurgião utilizando a técnica padrão em sete porcas. A veia e a artéria renal foram ligadas utilizando o “nó de barqueiro” como o único método de hemostasia. Dois nós foram colocados tanto na artéria quanto na veia renal, um deles proximal e o outro distal, e os vasos seccionados entre os nós. Esta técnica é baseada a confecção intra-corpórea de duas alças pela mão direito com um par de pinças, com o auxílio da mão esquerda. Após a secção dos vasos, as condições da hemostasia foram observadas. **Resultados:** Todas as nefrectomias laparoscópicas foram realizadas com sucesso. O “nó de barqueiro” foi realizado pelo mesmo cirurgião sem complicações nem dificuldades, obtendohemostasia completa em todos os casos como técnica única. **Conclusão**: O nó de barqueiro é uma técnica factível e segura para o controle do hilo renal durante a nefrectomia laparoscópica em porcos. Entretanto, a eficácia e segurança desta técnica deve ser avaliada por outros cirurgiões antes da recomendadção do emprego na prática clínica.

Descritores: Procedimentos Cirúrgicos por Laparoscopia. Nefrectomia . Hemostasia cirúrgica. Técnicas Hemostáticas.

Introduction

Since the first laparoscopic nephrectomy was carried out by Clayman in 1990,[1] recommendations for such procedure have been gradually increasing worldwide for benign and malignant diseases; many institutions consider this technique as the standard treatment for surgical removal of renal diseases. [2,3]

A key point during laparoscopic nephrectomy is the dissection and control of the renal pedicle, when an inadvertent lesion can lead to great blood loss and this complication is an important cause of conversion to the open technique. Several surgeons involved in surgical urology development have elected the vascular stapler as the standard practice.[4] It has been widely accepted, because the clips commonly used during laparoscopy are not long enough to perform the renal vein ligation in a human adult. A reasonable alternative could be the Hem-o-lock clips as recently reported as a means of replacing the endovascular stapler.[5] However, our institution, as well as many others in Brazil, have limited availability for either endovascular staplers or Hem-o-lock clips.

Aiming at a safe, cheap and easy renal vein suture method during laparoscopic nephrectomy in our midst, the authors have tested the feasibility during the laparoscopic renal hilum ligation and herein report an original application for the use of *"boatman's knot"* as described by the Brazilian War Ministry in 1955. [6] The "boatman's knot" is also known as "pig knot", and is already very commonly used to immobilize pigs legs in hog farms in Brazil and, interestingly, several urologists whom have their practice in the Brazilian Midwest know very well how to perform this kind of knot, which bears a great potential for becoming a popular technique in this kind of environment.

Methods

Seven female Landrace pigs (20-25 Kg) underwent bilateral laparoscopic nephrectomy under general anesthesia after approval of the Ethics and Research Committee of the University as a means of using the "boatman's knot" as the only method for achieving hemostasis during renal hilum ligation.

Surgical Procedure. After obtaining airway control by orotracheal intubation and general anesthesia with isoflurane. The animals were fixed to the operation table in lateral position and a bilateral laparoscopic nephrectomies were performed in a standard fashion. After the abdominal cavity was entered, the kidney hilum was dissected, and the vein and the main branches of the renal artery were individualized using standard laparoscopic techniques. Both the renal artery and the renal vein were sutured with 2-0 cotton thread with the "boatman's knot". All the cases were performed by the surgeon (ACB), who learned this knot as the "pig's knot" from his practice in a farm. Both renal artery and vein were ligated using the "boatman's knot" as the only method for hemostasis with conventional intracorporeal technique. Two knots were applied in each artery and vein; one knot was tied proximally and the other distally, and then the vessel was sectioned in the middle of both knots. The surgeon's ability to completely carry out the knot was analyzed, as well as the presence of technical difficulties. The capability to achieve full hemostasia after the section of both renal vein and artery was observed.

The "boatman's knot" technique. A cotton 2-0 suture measuring 15 cm is previously sectioned and inserted through one of the trocars. A small loop is made in one of the ends of the suture (Figure 1) with the objective of making easier to catch its end by the left hand as it emerges from behind the renal vein. Next, the thread is introduced held by a grasper through the trocar in the peritoneal cavity. The technique is based on the intracorporeal confection of two loops around the renal vein by the right hand with the help of the left hand. The first step is to make the suture pass behind the renal vein (Figure 1).

After holding the thread with the left hand, the grasper on the right hand passes underneath the suture, take the thread and lead it to its half, ending the first loop (Figure 2).

The second loop is carried out identical to the first; the thread is passed behind the renal vein again (Figure 3) and, passing the grasper below this loop (Figure 4), we pull it to finish the last loop. The knot is carried out by maintaining the thread held by both graspers, constantly leading its right end until total vein light occlusion and by maintaining constant parallelism between the suture ends (Figure 5).

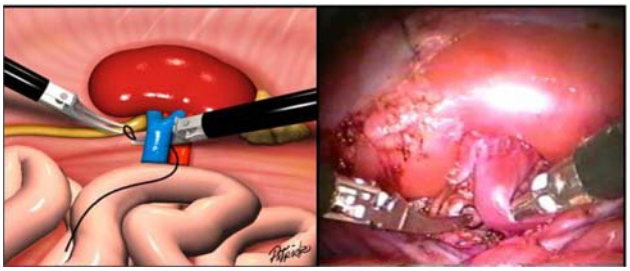

FIGURE 1 - The suture is passed behind the renal vein; the loop at the end of the thread helps the grasper on the left hand to hold the suture.

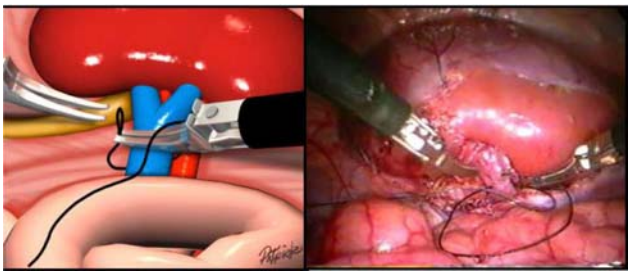

FIGURE 2 - The right hand grasper goes behind the suture that is pulled and then ending the first loop.

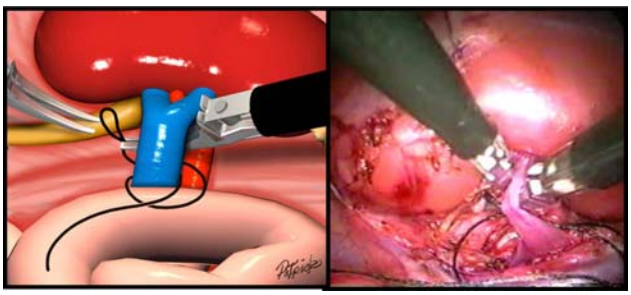

FIGURE 3 - The suture is passed again behind the renal vein.

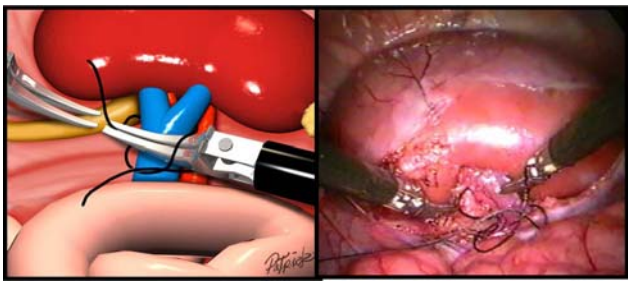

FIGURE 4 - The right hand grasper goes below the second loop and it catches the suture held by the left hand.

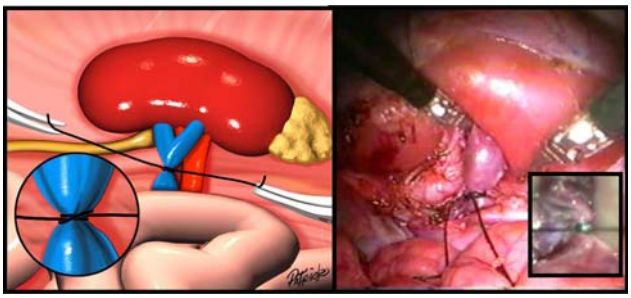

FIGURE 5 - Both graspers pull the suture constantly until venal occlusion is accomplished.

Results

There was no anesthetic complication and all the animals remained hemodynamically stable during the entire procedure. All 14 nephrectomies were successfully carried out; with proper control of renal hilum vessels, free from complications and with minimal intra-operative bleeding.

The surgeon was able to tie the "boatman's knot" successfully in all cases. No major difficulty was reported by the surgeon (ACB), who observed that the knot accomplishment becomes easier when the suture is pulled toward to the right after passing behind the renal vein for the first time, leaving a good thread length for better identification and spacing between the two loops, in order to allow that one can pass the right hand grasper between the two (figure 4).

After renal vein and renal artery section, there was complete hemostasis in all cases using the "boatman's knot" as the only method for vascular ligation and the knots were kept intact on both ends of the stumps.

Discussion

The intracorporeal "boatman's knot" is feasible as the only method for renal vein ligation during total laparoscopic nephrectomy in pigs without evidence of immediate bleeding. The completion of knots used for tying has been, for a long time, a reason of study and consideration on the part of Campaign Engineering of the Brazilian Armed Forces.

In 1955, it described the knot herein tested as *"boatman's knot"*, as it was used for fixing cables, pipes, stalks, bollards and stakes. [6] The knot has some important characteristics: it can be performed with just one hand; it is easy, simple, and quick to make. Its safety and firmness have made it become popular, and, because it has been used to hold pigs (with slippery legs) during orchiectomy procedures, it has been called "*pig knot*".

This study also reveals that is a knot easy to be carried out and not often used in surgery originally – the "boatman's knot" – can be employed in laparoscopic surgery and can also be quickly learned by a beginner in laparoscopy who did not even know how to perform it before. The boatman's knot may eventually replace the use of endovascular staplers during laparoscopic nephrectomy, which would make the procedure cheaper and more accessible in developing countries as well as eventually reestablish a fair reimbursement for laparoscopic procedures because of reduced expenses. However, it has not been tested in humans yet.

Even though the endovascular staplers are the standard of care, this device has limitations. Deng et al reported 60 cases of malfunctions during laparoscopy in urological procedures with significant morbidity (45%) and 2 deaths [7] and Chan reported 10 cases of malfunctions.[8] Even though there was rarely primary device malfunction, there are other disadvantages, such as the need for a 12 mm trocar to apply the endovascular stapler, a perpendicular port can make the stapler deployment too difficult, the vein should be dissected widely because of the device is bulky and the added cost. [5] It should be emphasized, however, that most cases of reported endovascular staplers malfunction were preventable. Kadirkamanathan et al [9] reported on a comparison of knots tied by hand and through laparoscopy and observed that the intracorporeal knots by laparoscopy are unreliable and may be weaker than those tied by hand. Moreover, the intracorporeal knots were time-consuming. On the other hand, Amortegui observed that laparoscopic knots are as secure as conventional knots performed during open surgery.[10]

The renal artery is ligated using routinely laparoscopic clips and they have been proved to be safe[11] and it is performed routinely even in developing countries because they are widely available. However, routine use of clips for renal vein control is not common because usually the length is not enough to occlude the entire vein and they also may be dislodged afterwards and cause severe bleeding. This drawback may be overcome by using clips with a locking mechanism (Hem-o-lock). Janetschek et al reported a combined technique of Hem-o-lock and extracorporeal knot using a specially designed knot pusher allowing a safe and rapid renal vein ligation during nephrectomy. [5]

Tested in twenty cases, it resulted in savings of up to $280.00 per procedure in that Institution in Austria. However, "Hemo-o-lock" is not available in our Institution, and it would cost us about US$2600.00 just to acquire the laparoscopic applier and nearly US$30 for each box. At our institution, an endovascular stapler costs approximately US$1000.00, and is available only for occasional use. Even in private practice, only some health insurances allow routine use of such equipment. On the other hand, a 2-0 cotton suture costs US$0,5 and it comes with 24 threads. Even with the safety obtained by the "boatman's knot" carried out in this study, there is a need for other studies to prove its effectiveness and safety before it can be clinically applied. Then it could become a simple alternative for renal

vein suture in laparoscopic nephrectomy. Furthermore, the “boatman’s knot” may also be applied in other laparoscopic and open procedures when a knot is required such as for suture of the penis dorsal vein complex during radical prostatectomy, for instance.

Conclusions

The “boatman’s knot” is feasible and safe for renal hilum control during laparoscopic nephrectomy in pigs and total hemostasis can be achieved using it as the only method of hemostasis. However, the safety and the capacity of others to learn how to apply it should be tested before it may be advised to use it routinely. The clinical application of the boatman’s knot is yet to be determined.

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