Minimally-invasive correction of ureteropelvic junction obstruction: do retrograde endo-incision techniques still have a role in the era of laparoscopic pyeloplasty?

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Abstract:

Background: This study was designed to review the long-term results and complications of the two techniques of retrograde endopyelotomy; ureteroscopic holmium laser endopyelotomy *versus* Acucise endopyelotomy. The results were then compared with the laparoscopic pyeloplasty results from a recent publication.

Patients and methods: The study was conducted retrospectively from January 2004 to July 2007. Seventy-two patients with ureteropelvic junction obstruction (UPJO) underwent retrograde endopyelotomy using either ureteroscopic laser endoincision (42 patients) or fluoroscopic guided hot-wire balloon (Acucise) endoincision (30 patients). Preoperative radiological assessment included intravenous pyelogram (IVP), helical computerized tomography and diuretic renography. The follow-up period ranged from 12 to 42 months. Subjective success was guided by the change in the preoperative flank pain while objective success on radiological evaluation was documented by either nonobstructed curve of diuretic renogram and/or T1/2 less than 10 min.

Results: The mean patient age was 42.6 ± 7.5 years for the laser group and 39.2 ± 15.1 years for the Acucise group ($p = 0.24$). The operative time was 66.8 ± 22.2 min in the laser group and 59.8 ± 20.3 min in the Acucise group ($p = 0.84$). By objective standards (renal scan), a total of 56 (77.8%) cases were successful (nonobstructed curve). This number included 34 cases in the laser group (80.9%) and 22 cases in the Acucise group (73.3%) ($p = 0.2$). Overall 16 failure cases were evident clinically within 1 year of the procedure (eight cases in each group). Most of the failure cases (13/16) presented with clinical obstructive symptoms during the early follow-up period (within 3 months postoperatively) and were then confirmed radiologically (six cases in the laser group and seven cases in the Acucise group) while only three patients had failures at 6, 9 and 11 months postoperatively. There was no statistically significant difference as regards intra-operative complications between the two groups ($p = 0.4$). Intra-operative bleeding was seen in three cases in the Acucise group while postoperatively it was reported in one case.

Conclusion: The retrograde endopyelotomy approach is safe and effective for the treatment of patients with UPJO. Both ureteroscopic laser and the hot-wire balloon (Acucise) techniques have an important role in the management of UPJO, especially in secondary cases, and they provide comparable long-term objective and subjective outcomes. Laparoscopic pyeloplasty provides far better results but with higher costs, and requires well-equipped centers and involves a long learning curve.

Keywords: ureteropelvic junction obstruction, retrograde, endoscopy, laparoscopy

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Introduction

Open pyeloplasty is considered the gold-standard for the treatment of ureteropelvic junction obstruction (UPJO). In the last two decades modern endourological instrumentation and techniques have revolutionized the management of UPJO towards using minimally invasive procedures [El-Nahas *et al.* 2006]. All of these techniques share the advantages of short operative time, minimal morbidity, decreased postoperative analgesic requirements, shorter hospitalization, and early recovery and convalescence.

As the safety and efficacy of endopyelotomy techniques have been improved due to the refinement of the procedure and increased surgeon experience, many groups believe that endopyelotomy should be the primary choice for correcting UPJO in most clinical situations [Nakada and Johnson, 2000]. In addition, failure of endopyelotomy does not appear to jeopardize the success of subsequent open pyeloplasty [Tuncay *et al.* 1997]. Currently, the two most widely-used retrograde approaches are a fluoroscopically guided hot-wire balloon (Acucise; Applied Medical, Laguna Beach, CA, USA) incision and direct-vision ureteroscopic endopyelotomy, generally performed with a holmium laser [El-Nahas *et al.* 2006].

This study was performed in retrospective fashion, specifically to compare the immediate and long-term results, as well as complications of retrograde endopyelotomy using either the ureteroscopic laser technique or the Acucise hot balloon technique.

Patients and methods

The study extended from January 2004 to July 2007 in the Urology Department, Faculty of Medicine, Tanta University, Egypt and the Urology division in Barnes Jewish Hospital, Washington University, St Louis, MO, USA. Seventy-two patients underwent either ureteroscopic holmium laser (42 patients) or hot-wire balloon (Acucise) (30 patients) endopyelotomy.

The indication for intervention in all patients was a functionally and significantly obstructed ipsilateral renal unit. Additionally, each patient had one or more clinical signs of functional obstruction, e.g. pain, ipsilateral infection, or causal hypertension. Patients with stones at the affected side were excluded.

Preoperative radiological assessment included IVP, helical computerized tomography to detect crossing vessels, and diuretic renography using ^{99m}technetium-mercaptoacetyltriglycine (MAG3) to estimate differential renal function and diagnose obstruction. The duration of follow-up ranged from 12 to 42 months. The first postoperative visit was usually at 4–6 weeks, at which time the ureteral stents were removed from the patients. The next postoperative visits were usually made at 3–6 months postoperatively and yearly thereafter.

Subjectively, the patient was considered cured if they showed complete disappearance of symptoms (preoperative pain); improved if they claimed >50% reduction of symptoms; or failed if there was persistence, worsening or reduction <50% of their preoperative symptoms.

Objective success on radiological evaluation was documented by either nonobstructed curve of diuretic renogram and/or T1/2 less than 10 min, or improvement of the morphology of the pelvicaliceal system with deflation of the minor calices compared with the preoperative study.

Technique of ureteroscopic laser endopyelotomy

Either a semi-rigid ureteroscope or a flexible ureteroscope was used with a 200 µm laser fiber. A Holmium: YAG laser was used at a power of 1.2 J and frequency of 10 Hz. Following retrograde pyelography, retrograde access to the collecting system was established by super-stiff guide wire. A balloon dilator was then passed over the super-stiff guide wire to dilate the UPJ or the stricture up to 24 F. The balloon dilator was then removed. A full-thickness lateral incision was started just below the UPJ and carried through the stenotic segment until the renal pelvis was reached. The incision was made all the way through the whole thickness of the ureteral wall. Visualization of the peri-ureteral fat was the sign for completing incision through the ureter. If there was doubt, a retrograde shot of dye was used to ensure extravasation.

Technique of Acucise endopyelotomy

Under fluoroscopic guidance the Acucise catheter was advanced over a guide wire up to the UPJ. The balloon was then gently inflated with 0.5 ml diluted contrast medium to ensure correct positioning (active wire is directed laterally/posterolaterally) as demonstrated by the

characteristic waist. The cutting wire was activated at 75–100 W (pure cutting power) for 5 s. Simultaneously 2 ml diluted contrast medium was instilled into the dilating balloon. As the balloon inflated, the stricture was incised and the waist of the stricture disappeared. If the waist persisted, the cutting current was reactivated for an additional 5 s. The balloon was kept inflated for 10 min to tamponade the incision site. After completing the incision, retrograde pyelography was performed through the catheter to confirm extravasation at the incision site. At the conclusion of the two procedures, the incised UPJ was stented with a 14-7Fr endopyelotomy or regular 7 Fr Double-J stent for 6 weeks, using super-stiff guide wire and fluoroscopy.

Statistical methods

The analysis of variance (ANOVA) test was used to compare quantitative data between the two groups. The Chi-square test was used to determine any significant difference in the nominal data between the two groups.

Results

The mean age was 42.6 ± 7.5 years for the laser group and 39.2 ± 15.1 for the Acucise group, with no statistically significant difference between the two groups ($p = 0.24$). The obstruction was considered primary in 52 cases (72.2%) including 31 cases in the laser group and 21 cases in the Acucise group. On the other hand, secondary obstruction was found in 11 cases in the laser group and nine cases in the Acucise group. These cases were secondary to previous Acucise endopyelotomy in five, open pyeloplasty in 10 and antegrade endopyelotomy in five cases. There was no statistically significant difference as regards the etiology between the two groups ($p = 0.9$; Table 1).

A spiral computerized tomography (CT) scan and intravenous urography (IVU) was done for all patients in the study. The degree of hydronephrosis was graded as mild in 21 cases, moderate in 26 cases and severe in 25 cases. The spiral CT scan showed significant vessels at the UPJ in 10 (13.8%) patients (six in the laser group and four in the Acucise group) with no statistically significant difference ($p = 0.7$). Retrograde pyelography was also performed as a routine examination both preoperatively and post-operatively (during double-J stent removal). A diuretic renal scan was also done in all cases as the basic study. Three main parameters were used: the shape of the renogram curve (whether obstructed or not),

Table 1. Preoperative findings among the 72 patients with ureteropelvic junction obstruction.

Preoperative characteristics	Laser $n = 42$	Acucise $n = 30$
Mean age	42.6 ± 9.5	39.2 ± 15.1
Diuretic renal scan		
Mean GFR	34.5 ± 6.2	36.2 ± 6.3
Mean T $\frac{1}{2}$	48.3 ± 32.2	52.6 ± 36.5
Spiral CT		
Crossing vessel	6	4
Type of UPJO		
Primary	31	21
Secondary	11	9
Open pyeloplasty	5	5
Post-Acucise	4	1
Post-antegrade endopyelotomy	2	3

CT, computerized tomography; GFR, glomerular filtration rate; UPJO, ureteropelvic junction obstruction. All the preoperative characteristics were statistically insignificant between the two groups (proved by ANOVA test).

differential renal function and T1/2 measurement. All cases used MAG3 as the radiopharmaceutical of choice. The mean GFR was 34.5 ± 6.2 mg/ml in the laser group and 36.2 ± 6.3 mg/ml in the Acucise group and the mean half-time was 48.3 ± 32.2 for laser group and 52.6 ± 36.5 in Acucise group for the obstructed side. There were no statistically significant difference between the two groups as regards GFR and T1/2 ($p = 0.25, 0.59$ respectively).

The operative time ranged from 32 to 150 min with a mean of 63 ± 21.3 min. It was 66.8 ± 22.2 min in the laser group and 59.8 ± 20.3 min in the Acucise group ($p = 0.84$). Mean hospital stay was 0.96 ± 0.54 days in the laser group *versus* 1.03 ± 0.43 in the Acucise group with no statistically significant difference ($p = 0.5$). All patients had a ureteral stent for 4–6 weeks.

Subjectively, a total of 47 patients (65.3%; 30 patients in the laser group and 17 patients in the Acucise group) showed complete cure of their preoperative flank pain. Another six patients (8.3%; three patients in each group) claimed that their preoperative discomfort was reduced by 50–90%, giving a total subjective success rate of 73.6% (53 cases).

The final outcome of the procedures based on objective criteria including the diuretic renal isotope scanning and the morphology of the pelvicaliceal system as an indicator was as follows: a total of 56 (77.8%) cases were objectively successful (the clearance half time (T1/2) was less than 10 min). This number included 34 cases in the laser group

(80.9%) and 22 cases in the Acucise group (73.3%) with no statistically significant differences ($p = 0.2$). Evaluation according to the etiology, primary *versus* secondary, also showed no statistical significance between both groups (Table 2).

Failure was evident clinically in 16 cases within 1 year of the procedure (eight cases in each group). All these patients presented clinically and were confirmed radiologically. Of the 16 cases, 13 cases had their failure early at 3 months (six cases in the laser group and seven in the Acucise group), about 1 month after the removal of the stent, while three patients had their failure at 6, 9 and 11 months (at 6 months in the Acucise and at 9 and 11 months in the laser group).

The intra-operative complications encountered are given in Table 2. There was no statistically significant difference between the two groups ($p = 0.4$). A total of seven (9.7%) intra-operative complications occurred, including three patients in the laser group (4.2%) and four patients (13%) in the Acucise group. Access failure occurred in one laser procedure. Equipment damage occurred in two cases (one in each group) in the form of a ruptured balloon in one case and damage of the laser fiber in the other case. Minor unintended perforation of the ureter occurred in one laser case. The remaining intraoperative complications

included three cases of intra-operative moderate bleeding (in the Acucise group). These cases were managed conservatively with intravenous fluids and Lasix and there was no need for transfusion.

All the postoperative complications in the two groups were detected early. The overall rate of postoperative complications was 11.1% (eight patients) with no statistically significant difference between the two groups; laser four cases (9.5 %) and Acucise four cases (13.3%), ($p = 0.7$) (Table 2). Early postoperative complications included fever in four cases. Three out of the four cases had documented urinary tract infection. They were managed by intravenous antibiotics, antipyretics, and encouragement of hydration. Three patients reported postoperative voiding symptoms related to stents (one in the laser group and two in the Acucise group). All of them were improved on α -blocker treatment, and the symptoms cleared after stent removal. Postoperative bleeding was reported in one case in the Acucise group who had a crossing vessel at the UPJ in the preoperative spiral CT. The bleeding was significant and 2 units of blood were required to replace his blood loss and correct the haematocrit defect (5%). Successful tamponade was done with a large (24 F) ureteral balloon. After removal of the tamponading balloon, the case was managed with intravenous fluid, Lasix, vitamin K and Kapron.

Table 2. Surgical outcome after retrograde laser and Acucise endopyelotomy.

	Laser		Acucise		Total		<i>p</i>
	<i>n</i> = 42	%	<i>n</i> = 30	%	<i>n</i> = 72	%	
Preoperative pain:							
Completely relieved	30	71.4%	17	56.6%	47	65%	
Improved > 50%	3	7.1%	3	10%	6	8.3%	
Success rate: total	34/42	80.9%	22/30	73.3%	56	77.8%	
primary	26/31	83.9%	16/21	72.7%	42	80.8%	0.4
secondary	8/11	72.7%	6/9	66.6%	14	70%	
Complications							
Intra-operative							
Access failure	1						0.4
Perforation	1						
Equipment damage	1		1				
Bleeding			3				
Postoperative							
Stent problems	1		2				
Fever with UTI	2		1				
Fever without UTI	1						0.7
Bleeding			1				
Total complications rate	7/42 [16.7%]		8/30 [26.7%]		15/72 [20.8%]		0.4
UTI, urinary tract infection. No statistically significant results were found between either groups as regards success rate, complications (Chi-square) or mean hospital stay (ANOVA test).							

The data from this retrospective study were compared with data for laparoscopic pyeloplasty from a similar study by Calvert and his group from the UK [Calvert *et al.* 2008]. In their study, they compared open (as a gold standard technique) *versus* laparoscopic pyeloplasty on a retrospective basis. The main findings from the present data are compared to their counterparts from that study in Table 3.

The success rate was higher in both groups undergoing primary pyeloplasty in the Calvert series (96% in the open and 98% in the laparoscopy group) when compared with both groups of endoincision for primary UPJO in our series (84% in the laser group and 73% in the Acucise group).

The success rate in both groups of endoincision for secondary UPJO in our series (73% in the laser and 67% in the Acucise group) was higher than the success rate in secondary cases in the Calvert series (66% for open and 57% for laparoscopic pyeloplasty).

Discussion

Open pyeloplasty has been considered the gold standard surgical procedure for the correction of ureteropelvic junction obstruction. For a new surgical procedure to be assessed, its effectiveness and safety should be compared with the gold standard technique. All endoscopic techniques share the advantages of short operative time, minimal morbidity, decreased postoperative analgesic requirements, shorter hospitalization, and early recovery and convalescence. In spite of a lower success rate, the advantages of being minimally invasive make the endourologic procedure

an acceptable and competitive option for the treatment of patients with UPJO. Also, the procedure itself does not affect the outcome of the subsequent open pyeloplasty in cases of unsuccessful endoscopic correction, in contrast to cases with failure of first pyeloplasty.

In the present study, we have attempted to evaluate the long-term results in 72 patients who underwent retrograde endopyelotomy for the treatment of ureteropelvic junction obstruction. Also, we have aimed to address the role of such a procedure in an era where the use of laparoscopic pyeloplasty is growing.

In the present review, 30 cases underwent fluoroscopic guided endopyelotomy with Acucise and 42 cases had ureteroscopic endopyelotomy using Holmium laser for endoincision. The overall objective success rate was 77.8% based on diuretic radioisotope study. On the other hand, a successful outcome based on the subjective data (pain relief/improvement) was 73.6%. Three patients had postoperative flank discomfort in spite of having a nonobstructive curve on their follow-up diuretic renograms and patent UPJ during retrograde studies. Both techniques achieved better success rates among cases with primary than with secondary UPJO; 80.8% *versus* 70% respectively. However, this difference was not statistically significant ($p = 0.4$).

Ureteroscopic endopyelotomy has a success rate ranging from 75 to 100% [Biyani *et al.* 2000; Giddens and Grasso, 2000; Matin *et al.* 2000; Conlin and Bagley, 1998; Tawfik *et al.* 1998; Thomas *et al.* 1996]. In one of the largest series, ureteroscopic endopyelotomy showed a success

Table 3. The operative and postoperative data for retrograde endoincision *versus* laparoscopic and open pyeloplasty [Calvert *et al.* 2008].

	Patients (n)/secondary cases	Operative time (min)	Hospital stay (days)	Follow-up time (months)	Objective outcome	Complication rate
Open pyeloplasty	51/3	95	5	6	1ry: 96% 2ry: 66%	24%
Laparoscopic pyeloplasty	49/7	159	5	6	1ry: 98% 2ry: 57%	17%
Laser endopyelotomy	42/11	66	<1	23	1ry: 84% 2ry: 73%	17%
Acucise endopyelotomy	30/9	60	1	23	1ry: 73% 2ry: 67%	27%
1ry, cases with primary UPJ obstruction; 2ry, cases with secondary UPJ obstruction.						

rate of 94% [Cheung *et al.* 2001]. In our series, by objective standards (renal scan), a total of 34 out of 42 cases (80.9%) were considered successful following retrograde ureteroscopic endopyelotomy using Holmium: YAG laser to make the incision.

The success rates of retrograde Acucise endopyelotomy ranged from 75 to 81% in different series [Walz *et al.* 2003; Echazarian *et al.* 1999; Combe *et al.* 1997]. A group from Loyola University has recently published the results of a large Acucise endopyelotomy series. They reported a total success rate of 78%. The mean operative time was 65 min and the mean hospital stay was 1.8 days [Rao *et al.* 1996]. In the present study, our objective results for Acucise endopyelotomy were similar with a 73.3% success rate (22 out of 30 cases).

When both techniques were compared, laser endopyelotomy was found to achieve better success than Acucise (85% *versus* 65%, respectively) [El-Nahas *et al.* 2006]. The reason for the inferior results of Acucise endopyelotomy may relate to its blind nature in contrast to ureteroscopic endopyelotomy, during which the operator can see the site and depth of the incision, and decide its adequacy. In our series, laser endopyelotomy has a marginally better success rate than Acucise endopyelotomy (81% *versus* 73%). Although complications were fewer in the laser group, subjective and objective outcome parameters were better than in the Acucise group; the difference did not reach statistical significance. The same findings have been observed and documented by other authors [El-Nahas *et al.* 2006].

The complication rate in general was noticed to be higher among the Acucise group than the laser group (25% *versus* 10%). Moreover, significant operative and postoperative bleeding developed only in the Acucise group. In the El-Nahas *et al.* series [2006], mean operative time of 65 min and mean hospital stay of 1.1 days were comparable to those in previous reports. The complication rate of 10% among their patients was comparable to the 3–11% complication rates in other laser endopyelotomy series [Matin *et al.* 2003; Biyani *et al.* 2000; Tawfik *et al.* 1998].

This is similar to the data from the present study, where the overall incidence of complication was higher in the Acucise group compared with the laser group (26.7% *versus* 16.7%). The most

significant complication was intra-operative bleeding which occurred in three patients in the Acucise group (10%).

Being a blind procedure, our data support the theoretical claim that Acucise carries a higher risk of bleeding from crossing vessels [Goldfischer *et al.* 1998]. Kim *et al.* [1998] reported that bleeding was encountered in three (4%) out of 76 cases. All patients required blood transfusion and two required angiography and embolization. Schwartz and Stoller [1999] reported four (7.6%) cases of significant hemorrhage as a result of vascular injury among 52 cases of UPJO treated with Acucise endopyelotomy. Wagner *et al.* [1996] have also reported two cases of delayed arterial hemorrhage at 3 and 4 days postoperatively, and so the authors emphasize the need to perform angiography directly if there is evidence of hemorrhage.

In the present study, bleeding was encountered in four cases (13%) after Acucise endopyelotomy. Significant postoperative hemorrhage occurred in only one case (3.3%). This case was managed with tamponade with a 24F balloon, and required a transfusion of 2 units of blood. The other three cases developed moderate intra-operative bleeding and all were managed conservatively with no need for transfusion.

This is comparable with the results reported by many authors for intra-operative hemorrhage during Acucise endopyelotomy in big series (more than 20 patients) ranging from 3 to 14% [Kim *et al.* 1998; Grasso *et al.* 1996; Rao *et al.* 1996]. Interestingly enough, review of the results of the published series of antegrade and ureteroscopic endopyelotomy showed that although both techniques are not blind procedures, they still carry nearly the same risk of intra-operative bleeding ranging between 1% and 23% [Thomas and Monga, 1998].

Similarly, Thomas and colleagues [Thomas *et al.* 1996] in their series of ureteroscopic endopyelotomy, reported one case of acute postoperative hemorrhage that required nephrectomy. In the present study among 42 cases that underwent ureteroscopic laser endopyelotomy, no single case had significant intra-operative or postoperative hematuria following the procedure.

In the present study, other postoperative complications were encountered in the form of urinary

tract infection (UTI) in three cases, fever in only one case and stent related complications in three cases. Similar complications have been reported in all published series of Acucise endopyelotomy. Walz *et al.* [2003] reported 14 cases of UTI, including two cases of pyelonephritis (4%) and one case of septicemia (2%). Nine patients experienced severe discomfort due to the double-J stent [Biyani *et al.* 2000]. A European study cited a 34% complication rate in a series of 44 patients undergoing Acucise endopyelotomy in the form of ureteral avulsion (1) fever (2), hemorrhage (2), infected urinoma (2), a middle third ureteral stricture (1), ureteral diverticulum (1), and stent related problems (6) [Combe *et al.* 1997].

During follow up, a total of 16 (22%) cases (eight in each group) were considered to have failed after retrograde endopyelotomy. The first failure was discovered at 1.5 months after removal of the ureteral stent. Most of the other cases (12; 75%) were reported during the first 3 months post-operatively. We did not encounter any failures after 1 year. These findings are in accordance with other published series which report that the majority of failures (90%) occur within the first year after endopyelotomy and that late failures, later than 1 year, occurred in only 8.5% of cases [Kim *et al.* 1998].

On the other hand, Dimarco *et al.* [2006] found an estimated recurrence-free survival after 3, 5 and 10 years for endopyelotomy to be 63%, 55%, and 41% respectively, and they recommended that long-term follow up should be beyond 1 year.

In one large series reported by Yanke *et al.* [2008], comparison between laser endopyelotomy and laparoscopic pyeloplasty has been made with long-term follow up of about 20 months. They reported a lower success rate after endopyelotomy than our series (60.2% *versus* 77.8%) while they had higher success rate in their laparoscopic pyeloplasty group (88.8%) and therefore, they recommend endopyelotomy only in selected patients.

When the data from the present retrospective study were compared with data from a similar study design, which compared laparoscopic with open pyeloplasty [Calvert *et al.* 2008], the difference in the overall outcome as well as complication rate was not large. However, for cases with

primary UPJO higher success rates following laparoscopic pyeloplasty favored that technique, which attained a 98% success rate in the work of Calvert *et al.* compared with 80.8% among similar cases after retrograde endopyelotomy in our study. On the other hand, cases with secondary UPJO in the present work have had better results after retrograde endoincision compared to the results after laparoscopic pyeloplasty from the same Calvert study (70% *versus* 57%). However, a prospective, randomized study with long-term follow up of a large number of cases will be needed before making strong statements in this regard.

Conclusion

The retrograde approach for an endopyelotomy has proved to be safe and effective for the treatment of ureteropelvic junction obstruction. The hot-wire balloon and ureteroscopic laser techniques provide similar long-term success rates, but incision under direct vision is preferred for cases with crossing vessels documented by spiral CT. The techniques enjoy the benefit of simplicity as well as an acceptable success rate, especially among cases with secondary UPJ obstruction. Moreover, they are less technically challenging and easily be performed by the endourologist at a lower cost than laparoscopic pyeloplasty, with acceptable overall results. The excellent results from laparoscopic pyeloplasty require a long learning curve and well-equipped centers, which makes it more common in US and western European centers.

Conflict of interest statement

None declared.

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