Ligating Internal Iliac Artery: Success beyond Hesitation

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Received: 15 October 2015 / Accepted: 9 February 2016 / Published online: 14 March 2016
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Abstract

Aim To study the outcomes, benefits and complications of internal iliac artery ligation in both obstetric and gynecological cases.

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Objective To study the outcomes, effectiveness and complications of internal iliac artery ligation (IHAL).

Method This is an analytical longitudinal study done among women who have undergone internal iliac artery ligation in Dr. BRAMH a tertiary referral center from July 2013 to June 2015. Follow-up was done through color Doppler analysis of pelvic arteries before discharge, after 6 weeks and after 6 months.

Result The efficacy of IHAL was 96.87 %. The mean shock index was 0.94 ± 0.26 . Sixty-four women underwent IHAL out of which placenta previa (21.8 %) was the major indication. There were four maternal deaths. There were no intraoperative or ischemic complications. The greater the time interval between onset of hemorrhage and IHAL, the graver the outcome. For all women in whom uterus could be salvaged, resumption of menstrual cycles was seen within 6 months of IHAL. There was a significant decrease in the RI and PI of uterine arteries. In the ovarian

arteries, there was a significant increase in RI and no significant change in PI initially. Flow in distal part of ligated internal iliac arteries could be detected in 54 (90 %) women out of 60 after 6 months of ligation of internal iliac arteries.

Conclusion IIAL is an effective life-saving method to control obstetric and gynecological hemorrhage, and a hysterectomy can often be avoided. Early resort to IIAL is vital for improving the patient outcome. Uterine perfusion is well maintained, while there may be a decrease in ovarian perfusion. Resumption of menstrual cycles and presence of distal flow in internal iliac artery within 6 months suggest the preservation of future fertility; in order to better understand the impact of IIAL on ovarian functions and future fertility, larger studies with longer follow-up periods need to be conducted.

Keywords Internal iliac artery ligation · Color Doppler · Pelvic hemorrhage

Introduction

Massive pelvic hemorrhage is a potential complication while undergoing obstetric and gynecological surgery. Pelvic hemorrhage, whether postpartum or related to gynecological surgery, is associated with a great degree of morbidity and mortality and has to be controlled immediately without compromising the rest of the pelvic blood supply.

Internal iliac artery ligation (IIAL) is a safe, rapid and very effective method of controlling bleeding from genital tract. Even in the most catastrophic situations, rapid alternatives to hysterectomy are needed for women wishing to preserve their reproductive potential and to prevent high surgical and anesthetic risk in an already compromised patient. Besides, it is the only answer in massive broad ligament hematoma, in torn vessels retracted within the broad ligament, and even in postoperative hemorrhage after abdominal or vaginal hysterectomy where no definitive bleeding point is detectable [1].

Bilateral internal iliac artery ligation (BIIAL) reduces pelvic flow by 49 % and pulse pressure by 85 % resulting in venous pressures in the arterial circuit, thus promoting hemostasis [2]. Within seconds of ligation, blood enters the collaterals in retrograde fashion. The practical effect is that pelvic ischemia does not occur.

The reported success rate of IIAL varies from 42 to 100 % [3], and it averts radical procedures like hysterectomy in substantial number of cases. It creates a relatively bloodless operative field for surgical procedures. Though an effective procedure, it is seldom attempted because it is thought to be technically difficult. IIAL has minimum operative complications and a short learning curve [4]. The

only pitfall with IIAL is surgeon's hesitation and waiting too long to perform it.

Little is known about the changes in spectral Doppler indices of the uterine and ovarian arteries in patients who undergo IIAL and its effect on pelvic perfusion. Present study aims to find out the efficacy of IIAL in controlling pelvic hemorrhage, potential changes over color Doppler patterns of post-ligation patients and its potential complications.

Materials and Methods

This is an analytical longitudinal study done among 64 women who underwent internal iliac artery ligation in a tertiary referral center Dr. BRAMH, Raipur, CG, from July 2013 to June 2015.

The detailed data of all the participants were filled on a predecided proforma and then reviewed. Their demographic characteristics, i.e., age, parity, gestational age, mode of delivery, causes of PPH, duration of pregnancy in obstetric cases, pre- and postoperative blood values, diagnosis, applied surgical procedures, need of additional hysterectomy, intraoperative and postoperative number of blood transfused, length of hospital stay, need for ventilator support, and associated morbidity and mortality, were evaluated.

A standard ligation procedure was performed in all cases. The bifurcation of the common iliac artery was located in a triangle composed by the infundibulopelvic ligament, the lateral side of the uterus and the ureter. A small incision was made in the peritoneum lateral to and parallel with the ureter in such a way that the ureter remains attached to medial fold of peritoneal reflection. Double thread of an absorbable suture (Vicryl 1) was passed beneath the internal iliac artery from lateral to medial side about 4 cm distal to its origin with the help of Mixter forceps. The internal iliac artery was ligated doubly, placed 0.5 cm apart. The femoral and dorsalis pedis pulses were palpated and affirmed present at the completion of artery ligation.

The cases were followed up through color Doppler (the pulsatility index, the resistance index, the S/D ratio, the peak systolic velocity and the end diastolic velocity) of the pelvic arteries before discharge, after 6 weeks and after six months. Complications were noted.

Statistical Method

The collected data were entered in MS Excel for data analysis. For continuous data statistical test, Student's *t* test was used and *p* value < 0.05 was taken as statistically significant.

Results

IIAL was performed on 64 women with pelvic hemorrhage. 60.9 % of these women were referred from other hospitals, and the mean shock index of the study population was very high, i.e., 0.9 ± 0.25 (Table 1). Maximum no. of IIAL were performed for placenta previa (21.8 %) out of which 1 (7.6 %) had increta and 1 had accreta. The other accreta case mentioned in Fig. 1 was not associated with placenta previa. Two ligations were performed in cancer surgeries, i.e., yolk sac tumor, and choriocarcinoma for management of intractable bleeding (Fig. 1).

Subtotal hysterectomy was required in 6.25 % cases. Out of this, 3.1 % had non-salvageable rupture uterus. One woman had placenta increta invading up to the bladder, and another had intractable bleeding in atonic uterus in spite of IIAL. These two cases were deemed as failures. Thus, it was effective in 96.87 % of cases. In all cases in which uterine artery and ovarian artery ligation were done, it was performed before attempting to ligate internal iliac artery (Fig. 2). Twenty women needed only IIAL for checking pelvic hemorrhage (Fig. 3).

In none of the patients, procedural complications were seen during and after IIAL. There were no ischemic complications such as gluteal muscle ischemia or bladder ischemia in the postoperative period either during inpatient stay or up to 6 months. None of the patients needed relaparotomy for persistent hemorrhage once IIAL was done.

Time interval between onset of hemorrhage and IIAL affected the need for blood transfusion and outcome of the patients. The greater the time interval, the graver the outcome (Table 2).

There were four (6.25 %) maternal deaths. Two deaths were unrelated to PPH. Both of these women were having

acute hepatic failure with DIC. The remaining two deaths were due to the sequelae of PPH due to late referral.

For all women in whom uterus could be salvaged, resumption of menstrual cycles was seen within 6 months of IIAL. There was a significant decrease in the RI and PI of uterine arteries. In the ovarian arteries, there was a significant increase in RI. There was no significant change in PI initially. There was a progressive increase in RI and PI of uterine and ovarian arteries at 6 weeks and at 6 months. Furthermore, there was no significant difference between rt. and lt. uterine and ovarian arteries.

Flow in distal part of ligated internal iliac arteries could be detected in 54 (90 %) women out of 60 (excluding 4 deaths hence loss to follow-up) after 6 months ligation of internal iliac arteries. Among them, 35 (58.3 %) women had distal flow at 6 weeks only.

Discussion

Bilateral internal iliac artery ligation is an effective life-saving method to control obstetric and gynecological hemorrhage, and a hysterectomy can often be avoided.

In our study, the efficacy of IIAL was found to be 96.87 %. This was comparable to Yavuz Simsek et al. [5] who found it to be 84.7 %, Patil et al. [6] 93 %, Naithani et al. [7] 95.83 % and Domingo et al. [8] 81 %. The mean shock index (heart rate/systolic blood pressure) of the women in our study was very high (0.94 ± 0.26), while normal SI was 0.5–0.7 [9, 10]. The higher the shock index, the greater the severity of shock. Thus, most of the women in our study were hemodynamically unstable. Our study center being a tertiary referral center received 60.9 % of referred cases. This may be the reason for patient population mostly with impaired hemodynamics (Table 1).

Maximum no. of IIAL were performed for placenta previa followed by atonic PPH, abruptio placentae and rupture uterus in that order (Fig. 1). In complete placenta previa, the placental site receives a significant proportion of its arterial blood supply from the descending cervical and vaginal arteries. These arteries continue to perfuse the lower segment even after uterine artery ligation, which may fail to control hemorrhage [11]. In these circumstances, IIAL is effective by diminishing the blood flow in the uterine, cervical and vaginal vessels. In most of the other studies, the major indication for IIAL was atonic PPH [11–13]. IIAL was especially useful to save uterus in cases of cervical pregnancy, placenta increta and HELLP syndrome in our study. Data from Papp et al. [14] suggest that ligation might be effective in preventing hysterectomy for cervical pregnancy in 40 % of cases.

In uterine trauma, where it is difficult to catch avulsed uterine artery because of its retraction into the broad

Table 1 Sociodemographic and clinical characteristics

Characteristics	Mean $\pm$ SD (range)
Age (years)	26.89 ± 6.06 (14–58)
Rural (no.)	37 (57.8 %)
Gravidity	2.21 ± 1.16 (0–5)
Parity	1.23 ± 1.07 (0–4)
No. of abortions	0.13 ± 0.38 (0–2)
No. of living children	0.85 ± 1 (0–4)
History of uterine surgery (no.)	16 (25 %)
Shock index	0.94 ± 0.26 (0.61–1.77)
Preoperative hemoglobin values (g/dl)	7.47 ± 2.66 (2.7–11.3)
Postoperative hemoglobin values (g/dl)	8.09 ± 1.97 (4.6–11.6)
Intraoperative blood transfused (unit)	1.64 ± 0.89 (0–4)
Total blood transfused (unit)	2.83 ± 1.63 (0–10)
Postoperative length of stay (days)	9.03 ± 5.66 (5–31)
No. of referred cases	39 (60.9 %)

Fig. 1 Indications of IIAL **Fig. 2** Others procedures along with IIAL **Fig. 3** Indications in which only IIAL was done

ligament, IIAL plays a significant role in combating hemorrhage and thus avoiding hysterectomy. In the present study, 8 out of 10 rupture uteri could be salvaged. In 20 % of the cases, anatomy was grossly distorted and uteri were non-salvageable. IIAL at the outset of the procedure helped in creating a relatively bloodless operative field for performing hysterectomy. It enabled the surgeons to avoid blindly clamping and ligating tissues submerged in a pool of blood. This was particularly helpful in reducing the risk

of ureteric injury. Apart from this, IIAL was the only method available to combat hemorrhage in two women with post-hysterectomy bleeding from vault and 5 women with supravator hematomas in the present study.

In our study, 31.2 % cases needed only IIAL for checking pelvic hemorrhage (Fig. 3). Primary IIAL was done in two atonic PPH cases in whom severe pelvic hemorrhage was anticipated. One woman had post-vaginal delivery atonic PPH with coagulopathy, and another had

Table 2 Timing of IIAL and patient outcomes

Time of hemorrhage	Total no. of patients	Time interval before IIAL Mean $\pm$ SD (range)	Mean shock index	Units of blood transfused	Units of FFP transfused	No. of patients needing ventilator support	Mortality
At cesarean section	49	1.02 $\pm$ 0.5	0.91 $\pm$ 0.26	2.55 $\pm$ 1.31	2.95 $\pm$ 4.05	2 (4.08 %)	1 (2.04 %)
At hysterectomy/ gynecological Procedures	4	1.8 $\pm$ 0.5 h	0.82 $\pm$ 0.16	3.33 $\pm$ 1.52	1.33 $\pm$ 2.3	None	None
PPH following vaginal delivery	9	9.7 $\pm$ 10.6 h (1.5–28 h)	1.11 $\pm$ 0.27	3.86 $\pm$ 2.85	8.86 $\pm$ 10.2	4 (44.44 %)	3 (33 %)
a. Atonic PPH	6	2.5 $\pm$ 1.6	1.12 $\pm$ 0.28	5 $\pm$ 3.46	14.5 $\pm$ 10.2	4 (100 %)	3 (50 %)
b. Broad ligament hematoma	3	24.3 $\pm$ 6.03	1.09 $\pm$ 0.29	2.33 $\pm$ 0.58	1.33 $\pm$ 2.3	None	None
Post-evacuation perforation of uterus	1	7 h	1.06	4	4	None	None
Relaparotomy after cesarean section	1	5 h	0.78	5	5	1 (100 %)	None

HELLP syndrome with platelet count 47,000/cumm. Early decision of IIAL led to earlier achievement of hemostasis in several high risk cases and also helped in clearing the operative field. Prophylactic internal iliac artery ligations have been advocated in various other studies [15, 16].

None of our patients who underwent IIAL had recurrence of hemorrhage after either a cesarean section or after hysterectomy. None of the cases needed relaparotomy after IIAL was done.

In our study, we did not encounter any serious intra-operative complications such as injury to the internal iliac vein or ureter during ligation of internal iliac artery, inadvertent ligation of external iliac artery, post-procedural vesical necrosis, development of perineal and gluteal necrosis as cited in the literature [5]. This might be related to availability of experienced surgeons with good training for IIAL in our hospital. Similarly, no such complications were noted in various other studies [4, 6, 12, 13, 16, 17]. While Gandhi et al. [18] have reported a case of accidental injury to the internal iliac vein, Mehmet et al. [19] have reported one case of ureter ligation and 1 external iliac vein laceration during IIAL.

Postoperatively, 7 women needed ventilatory support out of which 4 later on succumbed to death. Two maternal deaths were unrelated to PPH. In these women, hemorrhage could be controlled after IIAL, but they succumbed due to hepatic failure and DIC. Two women died due to delayed control of PPH due to delayed referral. One developed acute renal failure and DIC, while other had pulmonary embolism. ARF and DIC were also the reasons for maternal mortality in the study by Mehmet et al. [19]. In the postoperative period, two women developed surgical site infection, 2 had burst abdomen, and 2 had bed sore, while 7 women had febrile illness. All could be well

managed. Similar postoperative morbidity was recorded by Mehmet et al. [19] and Parveen et al. [12].

In India, obstetric hemorrhage constitutes 38 % of maternal deaths [20]. PPH can cause exsanguination rapid enough to be fatal in spite of the immediate availability of blood products. One of the reasons for this could be the delay in resorting to surgical techniques once conservative measures have failed. In our study, we found a direct correlation between the time taken for IIAL and the graver outcome of the patients. The need for blood products and ventilator support was directly proportional to the time interval between onset of hemorrhage and IIAL (Table 3). Kalburgi et al. [4] also found similar results, while Joshi et al. [11] found that time interval between the onset of hemorrhage due to uterine atony and IIAL influenced the uterine salvage rate. Thus, an early IIAL has been emphasized, as a delay leads to an irreversible hemorrhagic shock and multiorgan failure, as it was observed in one of our cases.

Good collateral circulation allows interruption of one or both hypogastric arteries to be performed relatively safely without severe complications, even in an atherosclerotic patient [21]. In our study, we found that the uterine arterial perfusion was well maintained after ligation as denoted by a decrease in RI and PI. In fact, there was a decrease in impedance of the uterine arteries. Fu et al. [22] found that RI values decreased from postoperative day 1 until 1 month after surgery and then increased slowly to the baseline level by 10.1 months after surgery.

In case of ovarian arteries, there was an increase in RI and no significant difference in PI. So, it may detect a decrease in ovarian perfusion. However, the ovarian function was maintained as suggested by spontaneous resumption of menstrual cycles within 6 months of IIAL in

Table 3 Doppler indices of the uterine and ovarian arteries

Doppler indices	Artery	Rt./Lt.	Standard value	Just before discharge	<i>P</i> value	At 6 weeks	<i>P</i> value	At 6 months	<i>P</i> value
RI	Uterine artery	Right	0.78 ± 0.1	0.54 ± 0.3	S	0.74 ± 0.2	NS	0.67 ± 0.06	NS
		Left	0.91 ± 0.3	0.56 ± 0.14	S	0.79 ± 0.52	NS	0.70 ± 0.07	NS
PI		Right	2.11 ± 0.4	0.91 ± 0.42	S	1.34 ± 0.55	NS	1.37 ± 0.39	NS
		Left	2.05 ± 0.5	0.95 ± 0.47	S	1.39 ± 0.48	NS	1.48 ± 0.40	NS
RI	Ovarian artery	Right	0.46 ± 0.1	0.55 ± 0.11	S	0.69 ± 0.2	S	0.65 ± 0.07	S
		Left	0.49 ± 0.1	0.59 ± 0.14	S	0.62 ± 0.1	S	0.67 ± 0.12	S
PI		Right	0.94 ± 0.3	0.88 ± 0.33	NS	1.23 ± 0.58	S	1.13 ± 0.26	S
		Left	0.91 ± 0.3	0.98 ± 0.48	NS	1.1 ± 0.34	S	1.33 ± 0.63	S

all women with uterus. In order to better understand the impact of IIAL on ovarian functions and future fertility, studies with longer follow-up periods need to be conducted. Yildirim et al. and Raba G et al. have claimed that this procedure has no unfavorable effect on ovarian functions, and complete consensus has not been reached on this issue [23, 24].

In our series, flow was detected in distal part of ligated internal iliac arteries at 6th month follow-up in 90 % of cases. In other studies also, recanalization of vessels is known to occur [25]. Khelifi et al. [26] reported that first Doppler examinations showed an effective collateral circulation developing in all cases. Monthly Doppler examinations showed recanalization of IAL after an average of 5 months. This may suggest that future fertility and long-term clinical outcomes may remain unaffected to IIAL.

Conclusion

IIAL is an effective fertility preserving and sometimes the only available life-saving procedure for combating pelvic hemorrhage. The procedure of IIAL can be very safe and simple in practiced hands with no major intraoperative complications. Meticulous understanding of retroperitoneal anatomy is mandatory to prevent inadvertent injury to the adjoining structures. Timely decision making is crucial to improve patient outcome. IIAL combats pelvic hemorrhage while maintaining the uterine perfusion. Ovarian perfusion may decrease following IIAL although no apparent effect on ovarian functions was observed. In conclusion, all obstetricians and gynecologists must be trained and familiarized in IIAL to include this tool in their arsenal against pelvic hemorrhage and surgeons must lower their threshold for its use in emergent situations.

Compliance with Ethical Standards

Conflict of interest Abha Singh, Ruchi Kishore and Saveri Sarbhai Saxena declared that they have no conflict of interests.

Ethical Approval All procedures followed were in accordance with ethical standard of the responsible committee on human experiments (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent Informed consent from human subjects was obtained.

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