Int J Clin Exp Med 2016;9(8):16735-16740
www.ijcem.com /ISSN:1940-5901/IJCEM0019573

Original Article

Prophylactic hypogastric artery ligation in surgery for placental invasion disorders

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Received November 9, 2015; Accepted April 5, 2016; Epub August 15, 2016; Published August 30, 2016

Abstract: Objective: To determine the effectiveness of prophylactic hypogastric artery ligation (HAL) on the bleeding control in surgeries of placental invasion anomalies. Study design: In this study, an evaluation was made of the effects on bleeding of prophylactic HAL applied before hysterectomy in cases of placental invasion anomalies. A total of 45 pregnant patients with placental invasion anomalies were examined retrospectively. In Group 1 (n=19) hysterectomy alone was applied in the surgical treatment and in Group 2 (n=26), prophylactic HAL was applied before hysterectomy. The results were compared with evaluation of morbidities, particularly bleeding. Results: Statistically significantly higher values were determined in Group 1 compared to Group 2 in respect of estimated blood loss (3183 vs 2204 ml, P<0.001), amount of fluid drainage (2346 vs 700 ml, P<0.001), and mean units of packed red cells and thrombocytes transfused (5.8 vs 3.3 units, P<0.001 and 3.9 vs 2.5 units, P<0.001 respectively). The hCO3 level was statistically significantly lower in Group 1 (16.3 meq/L in Group 1, 19.2 meq/L in Group 2) (P=0.003). Conclusions: Prophylactic HAL has a protective effect on bleeding in operations of placental invasion anomalies and may be used in cases in which balloon occlusion of the hypogastric artery can not be performed.

Keywords: Hypogastric artery ligation, peripartum hysterectomy, haemorrhage

Introduction

Postpartum haemorrhage (PPH) is a major cause of maternal mortality and morbidity [1, 2]. In low income countries, there may be additional contributory factors which will lead to higher morbidity and mortality rates, such as poor nutritional status, difficulties in access to treatment and insufficient facilities for intensive care and blood banks [3]. In the failure of other treatment strategies for severe postpartum obstetric hemorrhage, peripartum hysterectomy, as first described by Porro in 1876 has been regarded as the gold standard and a life-saving procedure [4, 5].

The patient profile of PPH has changed dramatically over the past years. An increase in caserean rates, in the number of patients with previous cesarean sections (C/Ss) and advanced maternal age has led to an increase in the number and aggressiveness of invasive placental disease, thereby resulting in significant changes having to be made in daily practice [6]. Therefore, placenta praevia/accreta has become a leading cause of PPH cases [7].

Morbidly adherent placenta was first described in 1930 and was probably quite rare before that time [8]. A significant increase in the incidence of placenta accreta has occurred over the years and a 10-fold increase in the last 50 years has raised the incidence level to 1/2500 [9]. In recent years, incidence of 3/1000 has been reported [10]. Nowadays, the first-line treatment for haemorrhage due to placental invasion anomalies is mainly hysterectomy (in 58% of cases) while medical treatment and conservative surgery including uterine artery and/or hypogastric artery ligation (HAL) are the preferred treatment mode for other PPH cases [11]. The first cases of hypogastric artery ligation were published in the 1960s. Since then, it has been used as a conservative surgical procedure for severe PPH cases [12]. Uterine artery ligation and HAL have been proposed as

first-line methods in conservative surgical treatment with reported success rates of 60-70% [13].

According to observation of PPH cases in the postoperative period, it has also been observed that excessive postoperative fluid collection in the drain has resulted in suspected intra-abdominal bleeding and an associated increase in frequency of follow-ups for haemoglobin level and ultrasonogrophic evaluation. Based on the knowledge that HAL decreases uterine perfusion, the hypothesis of this current study was that prophylactic HAL in peripartum hysterectomy applied for placental invasion anomaly would decrease the intraoperative bleeding, thereby improving the operative outcomes and decreasing the need for transfusion.

Materials and methods

This retrospective study of HAL in PPH cases with placental invasive diseases was conducted at a level 3 referral hospital. The clinical records of the patients who underwent peripartum hysterectomy with a diagnosis of placenta accreta from January 2011 to December 2014 were reviewed. In our clinic all the patients with a previous diagnosis of placenta praevia were evaluated in respect of placenta accreta with two-dimensional gray-scale and colour Doppler ultrasonography. For cases with a high suspicion of placenta accreta, delivery was planned for gestational week 35-36, but if uterine contractions, bleeding or other complications developed, then delivery was made earlier [14]. Comprehensive information was given to the patients preoperatively on the severity of their clinical condition, treatment options, and the related risks.

For every patient, 4 packed red blood cells and fresh frozen plasma were prepared and available in the operating room. A ureteral catheter was placed by a urologist in cases where placenta percreata was suspected. In all patients, the abdomen was entered with a midline incision. Following the clamping of the umbilical cord, placental invasion markers were examined, such as increased vascularisation in the uterine serosa. In cases where any marker was determined, thus confirming the diagnosis of placenta accreta, the uterine incision was sutured leaving the placenta in situ without making any attempt to expel or manually remove it. Hysterectomy was applied, preserving the adnexa and leaving the placenta in situ. No uterotonic agents were used in these patients. If there were no markers of placental invasion, an attempt was made to remove the placenta. In the event of failed placental detachment, the surgical procedures described above were applied.

An intra-abdominal drain was inserted before closure of the abdomen. Throughout the operation, Hb levels and blood gas values were monitored. Postoperatively, all the patients were followed up in the intensive care unit until they were stable and they were then transferred to the obstetrics and gynecology ward.

Failure to remove placenta and pathological examination of the removed placenta were used to confirm the prenatal diagnosis of placenta accreta.

The clinical records of a total of 45 patients who underwent hysterectomy for an indication of placenta accreta were available. The patients were recruited into 2 groups based on the time of admission to the clinic. Group 1 patients (n=19) were admitted with an indication of placental invasion disorder before September 2013 and hysterectomy alone was applied. Group 2 patients (n=26) were admitted after September 2013 with the same indication, and bilateral prophylactic HAL was applied after the delivery of the child and prior to the hysterectomy, with the aim of improving the operative outcomes and decreasing the need for transfusion.

Patient age, gestational weeeks, gravida, parity, number of previous cesarean sections (C/Ss) and curettages, preoperative hemoglobin (Hb) levels, duration of operation, estimated blood loss, daily amount of fluid drainage ,duration of drainage, units of packed red cells, fresh frozen plasma and thrombocytes transfused, hospital stay and complications were available in the clinical records. The parameters of blood gas analysis, pH, lactate level, base excess and hCO3 level were also available. The estimated blood loss was calculated from the amount of fluid in the aspirator and the weight of compresses and sponges. Groups were compared in respect of statistically significant differences.

Table 1. Demographic data of the patients

	Group 1 Hysterectomy (n=19)	Group 2 HAL+Hysterectomy (n=26)	*P*-value
Age	33.4 ± 2.6	31.5 ± 3.1	0.100
Gestational week	35.8 ± 0.9	35.1 ± 0.8	0.069
Gravida	3.6 ± 1.1	3.7 ± 0.4	0.569
Parity	2.0 ± 0.9	2.5 ± 0.5	0.072
Previous C/S	1.8 ± 0.7	2.3 ± 0.5	0.075
Previous curettages	0.7 ± 0.8	0.1 ± 0.4	0.061
Preoperative Hb level (mg/dL)	11.8 ± 1.2	11.1 ± 0.6	0.114
Pathology diagnosis			
Accreta/increta	8 (42.1%)	12 (46.1%)	0.790*
Percreta	11 (57.9%)	14 (53.9%)	

C/S: Caeserean section, Hb: Hemoglobin, HAL: Hypogastric artery ligation. *Chi-square test was used.

Table 2. The operative outcomes of both groups

	Group 1 Hysterectomy (n=19)	Group 2 HAL+Hysterectomy (n=26)	*P*-value
Duration of operation (minutes)	103.3 ± 24.9	112.7 ± 23.2	0.340
Estimated blood loss (mL)	3183 ± 429	2204 ± 445	<0.001
Fluid drainage (mL)	2346 ± 1169	700 ± 411	<0.001
Red cells transfused (units)	5.8 ± 1.8	3.3 ± 0.8	<0.001
FFP transfused (units)	3.9 ± 0.8	2.5 ± 0.8	<0.001
Thrombocyte level (K/uL)	134 ± 34	145 ± 10	0.246
INR	1.1 ± 0.1	1.0 ± 0.1	0.059
Hospitalization days	5.0 ± 1.0	4.3 ± 0.5	0.118
Thrombocytes transfused (units)	0.2 ± 0.4	-	0.068
Complications			
• Bladder perforation	8 (42%)	10 (38%)	0.396*
• Ureteral injury	0	0	
• Postoperative fever	6 (31%)	7 (27%)	
• Maternal mortality	0	0	
• Re-operation	0	0	
• Total	14 (73%)	17 (65%)	

HAL: Hypogastric artery ligation, FFP: Fresh frozen plasma, INR: International normalized ratio. *Chi-square test was used.

Collected data were analyzed by Statistical Package for Social Sciences version 18.0 (SPSS IBM Software, Armonk, NY, USA). Continuous variables were expressed as mean ± SD; categoric variables were expressed as number (percentage). The normality of the distribution of continuous variables was assessed with the Kolmogorov-Smirnov test. All numerical variables were normally distributed and the mean values were compared by independent sample t test. The Chi-square test was used to analyze categorical variables. A value of $P<0.05$ was accepted as statistically significant.

Results

No statistically significant difference was determined between the groups in respect of mean age, gestational week, gravida, parity, previous C/S, previous curettage and preoperative Hb values (**Table 1**).

When the diagnosis was evaluated postoperatively from pathology, placenta accreta/increta was observed in 8 (42.1%) patients and placenta percreata in 11 (57.9%) patients of Group 1. In Group 2, placenta accreta/increta was observed in 12 (46.1%) patients and placenta percreata in 14 (53.9%) patients (P=0.790). No statistically significant difference was determined between the groups in respect of these parameters (**Table 1**).

The values for the mean operating time, thrombocytes, INR, duration of hospitalisation, thrombocyte transfusion and total complications were similar in the 2 groups (**Table 2**). A statistically significantly higher level of estimated blood loss was determined in Group 1 (Group 1, 3083 ml and Group 2, 2204 ml) (P<0.001). The postoperative fluid drainage was measured as 2346 ml in Group 1 and 700 ml in Group 2 (P<0.001). The number of mean units of packed red cells transfused was calculated as 5.8 units in Group 1 and 3.3 units in Group 2 (P<0.001). The number of mean units of fresh frozen plasma transfused was 3.9 in Group 1 and 2.5 in Group 2 (P<0.001).

Table 3. The results of blood gas analysis

	Group 1 Hysterectomy (n=19)	Group 2 HAL+Hysterectomy (n=26)	*P*-value
pH	7.28 ± 0.10	7.33 ± 0.05	0.180
Lactate level (mmol/L)	3.7 ± 3.2	2.7 ± 2.2	0.176
Base excess	9.5 ± 4.9	7.5 ± 1.6	0.167
hCO3 (meq/L)	16.3 ± 3.1	19.2 ± 1.3	0.003

The mean arterial blood pH value was 7.28 in Group 1 and 7.33 in Group 2 (P=0.180). The mean base excess was 9.5 in Group 1 and 7.5 in Group 2 (P=0.167). No statistically significant differences were determined in these findings. The mean hCO3 level was determined as statistically significantly higher in Group 2 (Group 1: 16.3 meq/L, Group 2: 19.2 meq/L, P=0.003) (**Table 3**).

Discussion

The inability to remove placenta normally in placental invasion disorders is a major risk factor for PPH, which is the leading complication of this disorder. Any efforts to remove the adherent tissue may result in further bleeding and subsequent hemorrhage, shock, and coagulopathy. With increased invasion, there is an increased risk of bleeding and consequently, maternal morbidity and mortality [15].

There is an ongoing bleeding risk during and after hysterectomy. In a review by Clausen et al., it was reported that the mean blood loss and the mean units of packed red cells, fresh frozen plasma and thrombocytes transfused, were 4800 ml, 9.5, 4.6 and 2.9 units respectively [8].

Nowadays, PPH due to placental invasion anomalies is not a rare event and may be encountered several times in routine obstetric practice. Although previous reports have stated mortality rates of up to 30%, there has been a significant reduction in recent years with some publications reporting no maternal mortality [16-18].

The decrease in maternal mortality in placental invasion anomalies may be explained by 3 factors:

1) Increased knowledge and experience of placenta accreta, in particular being prepared for the risk of massive haemorrhage; 2) The easy of decision-making for hysterectomy in situations of inability to remove the placenta; 3) The increase in the range of radiologically invasive procedures and surgical operations (balloon occlusion of iliac artery and ligation of hypogastric artery).

In the past, stepwise uterine devascularisation was recommended first for peripartum haemorrhage [19]. However, this treatment modality is not valid for placental invasion anomalies. Currently, treatment modalities such as hysterectomy, balloon occlusion, local excision and embolisation are used for placental invasion anomalies [11]. To reduce the risk of bleeding risk in hysterectomies for placental invasion anomalies, prophylactic iliac artery balloon occlusion has been suggested. This is a procedure in which an inflated catheter is placed into the internal iliac artery preoperatively by radiologists to occlude the artery after delivery. A significant decrease in haemorrhaging has been reported with the use of this procedure [20-22]. However, in a study by Shrivastava et al. comparing the surgical outcomes of patients who underwent caesarean hysterectomy for placenta accreta with and without the use of prophylactic occlusive balloon catheters, no differences were determined between the groups in terms of estimated blood loss (2.7 ml versus 3.l ml), transfused blood products (10 versus 6.5 units) or postoperative hospital days (5 versus 4 days) [23]. In a study by Tan et al., better outcomes were reported with the use of this technique in patients with placenta accreta or variants thereof. Significantly lower levels of intra-operative blood loss (2011 versus 3316 ml; P=0.042) and the volume of blood transfused (1058 versus 2211 ml; P=0.005) were determined in the study group compared to the control group, although there were similar values for hospitalization (6.7 versus 4.9 days; P=0.203) and intensive care unit (ICU) stay (1.7 versus 1.4 days; P=0.614) [24].

The prophylactic balloon occlusion procedure can not always be performed in all centers as it requires specific equipment and experience. In addition, in emergency cases, there is not sufficient time to apply this procedure. Therefore, prophylactic HAL has been preferred in our clin-

ic before hysterectomy rather than the prophylactic balloon catheter procedure. However, in cases where the involution of the uterus has been prevented because the placenta could not be removed, and the large uterus fills the abdomen, it can be difficult to explore the hypogastric artery. Thus in the first case of prophylactic HAL of this study, the common iliac artery was ligated instead of the hypogastric artery. The error was immediately realised and the ligation suture was carefully removed. No postoperative complications developed in that case. Prophylactic HAL was successfully applied to the other patients.

In the current trial, in Group 2, the estimated blood loss (2204 vs 3183 ml), the mean amount of fluid drainage (700 vs 2346 ml), the mean units of packed red cells transfused (3.3 vs 5.8 units) and fresh frozen plasma (2.5 vs 3.9 units) were statistically significantly lower compared to Group 1. These results showed the protective effect of prophylactic HAL on bleeding. Of the blood gas analysis parameters, only the mean hCO3 level was determined as statistically significantly lower in Group 2 (16 vs 19 meq/L). No statistically significant difference was determined between the groups in respect of any other parameters. However, it could be that the low number of cases in this study was not sufficient to demonstrate a significant difference. Therefore, there is a need for further research with a greater number of cases (**Table 2**).

To the best of our knowledge, there has been no previous study in literature of prophylactic HAL application in obstetric cases. In a prospective randomized study of patients with stage 1B cervical cancer undergoing Wertheim's surgery, hypogastric artery ligation was not observed to have any beneficial effect [25]. However, it was emphasised that in advanced-stage trophoblastic diseases, hypogastric artery ligation was extremely important to be able to achieve a reduction in pelvic blood flow. Smith et al. successfully applied prophylactic hypogastric artery ligation to patients with advanced (mainly stage IIB) rather than stage IB cervical cancer [26]. Subsequent to that study, Papp et al. recommended prophylactic hypogastric artery ligation to reduce blood flow in the surgical site, especially in cases where intense hemorrhage is expected, such as in advanced-stage pelvic malignancies and also for patients who refused a blood transfusion [27].

A study evaluating the effects of HAL on haemorrhage was published in 2015. In that study by Garcia et al., HAL was applied for diagnostic or therapeutic purposes to 41 patients with gynaecological or obstetric indications and it was reported to have a protective effect on the uterus in 62% of the patients. Complications were reported as internal iliac artery laceration in only 1 patient, which was minor and of no clinical importance. In that study, it was concluded that HAL for prophylactic or therapeutic purposes is an effective surgical procedure which may be safely applied [28]. However, there are still potential complications in the HAL procedure, such as internal iliac vein haemorrhage, ureter injury and external iliac artery ligation. A limitation of the current study is that it was non-randomised and retrospective with a low number of cases. There is a need for further research on this subject with more extensive case series.

In routine daily practice obstetricians do not acquire sufficient experience of HAL ligation. However, as placenta invasion anomalies are operated on in tertiary level centres, the staff of those centres do not generally have a problem with lack of experience. Therefore, it can be recommended that cases of placenta invasion anomalies, as they are the most important haemmorrhage cases, should be operated on at tertiary centres with prophylactic hypogastric artery ligation applied by experienced surgeons. This should be considered especially in cases where the balloon occlusion method cannot be applied.

One of the most important factors in the limited application of HAL is that surgeons have a fear of major complications. The determination of low complication rates in this and other recent studies should encourage surgeons towards this application.

Disclosure of conflict of interest

None.

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