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Management and Morbidity of Major Pelvic Hemorrhage in Complex Abdominopelvic Surgery

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Keywords
Hemorrhage · Bleeding · Pelvic bleeding · Complication · Pelvic Hemorrhage · Batson plexus

Abstract

Introduction: Hemorrhage is a challenging complication of pelvic surgery. This study aimed to analyze the causes, management, and factors associated with morbidity in patients experiencing major pelvic hemorrhage during complex abdominopelvic surgery. ***Methods:*** Patients who had major intraoperative pelvic hemorrhage during complex abdominopelvic surgery at 11 tertiary referral centers between 1997 and 2017 were included. Patient characteristics, management strategies to control bleeding, short- and long-term postoperative outcomes were evaluated retrospectively. ***Results:*** There were 120 patients with a mean age of 56.6 ± 2.4 years and a mean BMI of 28.3 ± 1 kg/m^2. While 104 (95%) of the patients were operated for malignancy, 16 (5%) of the patients had surgery for a benign disease. The most common bleeding site was the presacral venous plexus 90 (75%). Major pelvic hemorrhage was managed simultaneously in 114 (95%) patients. Electrocauterization 27 (23%), pelvic packing 26 (22%), suturing 7 (6%), thumbtacks application 7 (6%), muscle welding 4 (4%), use of energy devices 2 (2%), and topical hemostatic agents 2 (2%) were the management tools. Combined techniques were used in 43 (36%) patients. Short-term morbidity and mortality rates were 48 (40%) and 2 (2%), respectively. High preoperative CRP levels (p = 0.04), history of preoperative radiotherapy (p = 0.04), longer bleeding time (p = 0.006), and increased blood transfusion (p = 0.005) were the factors associated with postoperative morbidity. ***Conclusion:*** Postoperative morbidity related to major pelvic hemorrhage can be reduced by

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optimizing the risk factors. Prehabilitation prior to surgery to moderate inflammatory status and prompt action with proper technique to control major pelvic hemorrhage can prevent excessive blood loss in complex abdominopelvic surgery.

Introduction

Complex abdominopelvic surgery (CAPS) includes a wide variety of difficulties related to primary disease and hostile intrapelvic environment [1]. Any radical abdominopelvic operation which is not standardized is complex. Hence, radical oncologic operations for the primary advanced or recurrent carcinoma of pelvic organs, revisional operations for failed restorative operations for maintaining intestinal continuity are considered as CAPS [1].

Surgeons may encounter some severe intraoperative complications due to deep and narrow anatomical constraints of the pelvis during CAPS. Major pelvic hemorrhage (MPH) is one of the most challenging complications of CAPS with an incidence of 9% [2]. It may occur inadvertently during blunt or sharp dissection in the pelvis [3, 4]. In the setting of complex pelvic surgery, avoidance of MPH is mandatory. However, the anatomical features of the pelvis and its integral structure limit the maneuvers to control bleeding. Patient- and disease-related factors; surgeons' stamina, situational awareness and respect to the tissues have a role in development and management of MPH.

Proper management of the pelvic hemorrhage is crucial to prevent fatal outcomes. The bleeding control techniques and outcomes of patients having MPH during CAPS were described in case reports or series only [2, 5]. Definition of risks and management strategies for MPH during CAPS in large cohorts may provide valuable information to avoid further complications and improve final outcomes in future patients. This study aimed to analyze the causes, management, and factors associated with morbidity in patients experiencing MPH during CAPS.

Methods

This is a multicentric retrospective study. After obtaining an approval from the main Ethical Committee (2018-6/17) following approved waiver of consents from the participating Local Ethical Committees, records of patients who had an intraoperative MPH in CAPS were evaluated. Clinical trials registry number of the study is NCT04264988. The study was performed in accordance with the Declaration of Helsinki. Patients were operated between 1997 and 2017 at 11 tertiary referral centers specialized on colorectal and pelvic surgery. Definition of MPH included: (1) symptomatic bleeding originating from the pelvic vessels, (2) bleeding leading to transfusion of ≥2 units of whole blood or packed red cells, (3) surgical site bleeding that requires a second intervention, or surgical site bleeding that is unexpected and prolonged and/or sufficiently large to cause hemodynamic instability with an associated decrease in hemoglobin ≥20 g/L [6]. The inclusion criteria were (1) radical oncologic operations for the primary advanced or recurrent carcinoma of pelvic organs, (2) pelvic cytoreduction, (3) revisional/redo operations for failed ileal/colonic pouches and (4) repair of the entero-enteral, entero-cutaneous, entero-vesical and entero-vaginal fistulas. All patients undergoing surgery for cancer were operated with curative intent. The patients with peritoneal carcinomatosis were meticulously selected for having cytoreductive surgery with hyperthermic intraperitoneal chemotherapy with curative intent. The exclusion criteria were (1) patients undergoing surgery for palliative intent, (2) pediatric patients, and (3) the patients who had no MPH.

Patients' demographics, American Society of Anesthesiology (ASA) score, use of anticoagulant/antithrombotic, preoperative levels of INR, hemoglobin, CRP and albumin, neutrophil to lymphocyte ratio, postoperative levels of CRP and albumin, presence of previous pelvic surgery, presence of preoperative chemo-radiotherapy, urgency of the procedure, indication for surgery, use of minimally invasive techniques, type of surgical intervention, location of MPH, type of bleeding, type of bleeding control, need for a vascular surgeon, time between onset and ending of bleeding, requirement of secondary operation, amount of blood transfusion and transfusion of fresh frozen plasma, development of hemorrhagic shock, length of hospital stay, presence of operative morbidity including risk factors for postoperative morbidity, short-term (up to 30 days after surgery or during the same hospital stay) outcomes, mortality and long-term oncological outcomes of cancer patients were analyzed descriptively. Factors associated with morbidity were analyzed by comparing patients who had morbidity versus patients who had no postoperative complications (up to 30 days after surgery or during the same hospital stay).

Anastomotic leak was defined as the occurrence of dehiscence in the integrity of the anastomosis as documented by the combination of clinical, radiologic, and/or operative means [7]. Prolonged ileus was defined as failure of the bowel functions to return to normal within 7 days [8]. The operative morbidity rate was calculated by considering the number of patients who had at least one postoperative complication. Discharge criteria were tolerance of foods without nausea or vomiting, established bowel or stoma function, adequate pain management with oral analgesia, and independent walking [9].

In preoperative work-up, all patients had a detailed assessment prior to CAPS. The severity, stage, and extent of the benign and malignant diseases were meticulously assessed and determined preoperatively. Nutritional assessment was evaluated according to stratification of nutritional depletion scale based on the percentage of weight loss and BMI. Besides CRP and albumin levels were

Table 1. Diagnoses and operations performed

Diagnosis
Mid or low rectal cancer (*n* = 71, 59%)
Recurrent cancers (rectum, *n* = 13, 11%; ovarian, *n* = 4, 3%; cervical, *n* = 1, 1%; colon, *n* = 3, 3%)
Endometrial cancer (*n* = 2, 2%)
Peritoneal carcinomatosis (ovarian, *n* = 5, 4%; rectum, *n* = 1, 1%; colon, *n* = 7, 6%, mesothelioma, *n* = 1, 1%)
Ulcerative colitis (*n* = 6, 5%)
Retroperitoneal sarcoma (*n* = 2, 2%)
Familial adenomatous polyposis (*n* = 1, 1%)
Synchronous colon and prostate cancer (*n* = 1, 1%)
Ovarian cancer (*n* = 1, 1%)
Ileal pouch carcinoma (*n* = 1, 1%)
Operations performed
Sphincter saving total mesorectal excision (*n* = 53, 44%)
Pelvic exenteration (*n* = 23, 19%)
Cytoreductive surgery with hyperthermic intraperitoneal chemotherapy (*n* = 14, 12%)
Abdominoperineal resection (*n* = 12, 10%)
Total proctocolectomy with ileal pouch (*n* = 7, 6%)
Anterior resection (*n* = 6, 5%)
Total proctocolectomy and pouch excision (*n* = 3, 3%)
Retroperitoneal sarcoma resection (*n* = 2, 2%)

checked to assess nutritional status of patients before surgery. History of present disease and previous operations were questioned. Records of previous operations and pathology results with slides if available were reviewed. The work has been reported in line with the STROCSS criteria [10].

Statistical Analysis

Categorical variables are given as (%) and numeric variables are given as mean ± standard deviation or median (range) considering the normality. Categorical variables were compared with χ^2 test or Fisher's exact test. Numeric variables were compared with independent *t* test or Mann-Whitney U test. After univariate analyses were performed, variables with *p* value less than 0.05 were used in logistic regression to detect factors associated with mortality and morbidity. The statistical evaluation was conducted by *IBM's SPSS* software.

Results

The minimum number of colorectal, non-urologic, and non-gynecologic pelvic cases was 225 patients annually at the centers participating in the study. Among those patients, 120 patients (75 males/45 females) undergoing CAPS and developed MPH per the study criteria were included. The mean age was 57 ± 2 years. The BMI of patients was 28 ± 1 kg/m^2. The median ASA score was 2 (1–3). Sixteen (13%) patients were on anticoagulant medications. The preoperative INR and hemoglobin levels were 1 ± 0.1, 15 ± 1 g/dL, respectively. The preoperative CRP level was 15 ± 4 whereas the postoperative CRP level was 82 ± 18 ($p < 0.001$). The preoperative albumin level was 4 ± 0.4 whereas postoperative albumin level was 3 ± 0.1 ($p < 0.001$). 38 (32%) patients had previous abdominal surgery, 35 (29%) of them had rectal surgery and 4 (3%) of them had hysterectomy with bilateral salpingo-oophorectomy. A preoperative chemoradiotherapy was performed in 71 (59%) patients.

The indications for surgery as primary diagnoses and the operations performed are listed in Table 1. Open (*n* = 99, 83%), laparoscopic (*n* = 20, 17%), and robotic (*n* = 1, 1%) techniques were the types of operations. Ten (50%) patients undergoing laparoscopic surgery experienced operative morbidity, whereas 99 patients have undergone open surgery of whom 38 (38%) experienced morbidity ($p = 0.433$). 20 (17%) patients were operated for emergent conditions. The blood loss was 440 (290–3,750) mL. The main sites (Table 2) of MPH were the presacral Batson venous plexus (*n* = 90, 75%) followed by the internal iliac vein (*n* = 17, 14%), the internal iliac artery (*n* = 14, 12%), the obturator artery (*n* = 4, 3%), and the inferior hemorrhoidal artery (*n* = 2, 2%). 7 (6%) patients had bleeding from multiple sites. MPH developed during sharp dissection (*n* = 51, 43%), electrocautery (*n* = 29, 24%), blunt dissection (*n* = 15, 13%), and uncontrolled traction (*n* = 25, 21%).

MPH was controlled simultaneously in 114 (95%) patients, whereas in a reoperation was required in 5 (4%) and multiple reoperations were needed in 1 patient. A vascular surgeon was involved in 2 (2%) operations. Sixteen (13%) patients required further interventions due to morbidities caused by MPH.

Table 2. The main sites of bleeding

	n, %
Presacral Batson venous plexus	90, 75
Internal iliac vein	17, 14
Internal iliac artery	14, 12
Obturator artery	4, 3
Inferior hemorrhoidal artery	2, 2

Table 3. Postoperative complications

	n, %
Surgical site infection	14, 12
Anastomotic leakage	9, 8
Urinary tract infection	10, 8
Neurogenic bladder	6, 5
Acute kidney failure	4, 3
Ureter injury	2, 2
Bladder injury	1, 1
Mortality	2, 2

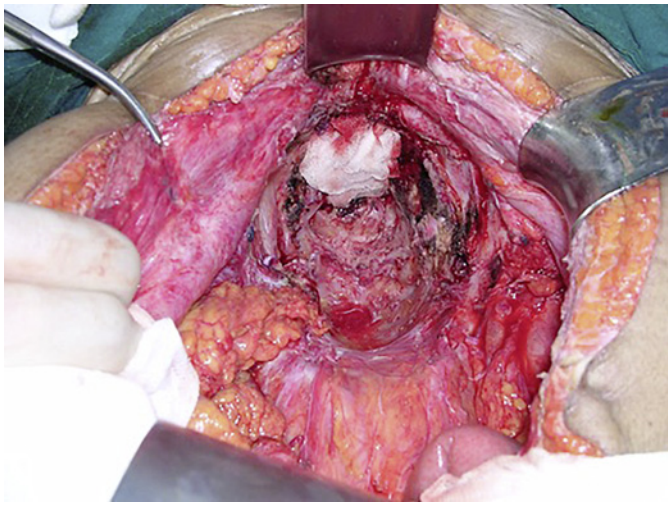

Fig. 1. Performing "pelvic packing" for unstoppable presacral venous bleeding after anterior exenteration for distal rectal cancer that has invaded the posterior vaginal wall.

Fig. 2. Transvaginal removal of pelvic packing at 36 h postoperatively.

Pelvic packing (Fig. 1, 2) was needed in 26 (22%) patients. 6 (5%) of those patients left the operating room with pelvic packing. MPH was controlled by using the techniques as following: electrocautery alone (n = 27, 23%), energy devices (n = 2, 2%), suturing alone (n = 7, 6%), fastener alone (n = 7, 6%), muscle welding alone (n = 5, 4%), and procoagulant chemicals (n = 2, 2%). Combination of these techniques was used in 44 (37%) patients. The combined techniques were suturing following pelvic packing (n = 24) and cauterization following pelvic packing (n = 20).

All patients experiencing an MPH had intraoperative blood transfusion. The mean numbers of packs of erythrocyte suspension and fresh frozen plasma transfused to the patients were 3 ± 0.4 and 7 ± 1, respectively. Hemorrhagic shock occurred in 16 (13%) patients. The length of hospital stay was 17 ± 2 days. Operative morbidity was seen in 48 (40%) patients. Postoperative complications (Table 3) were as follows: surgical site infection (n = 14, 12%), anastomotic leakage (n = 9, 8%), and urogenital disorders (n = 23, 19%). The urogenital disorders were urinary tract infection (n = 10, 8%), neurogenic bladder (n = 6, 5%), acute kidney failure (n = 4, 3%), ureter injury (n = 2, 2%), and bladder injury (n = 1, 1%). Two patients died. One of them was operated for peritoneal carcinomatosis due to ovarian cancer. The bleeding was from the Batson plexus; it was moderate and was stopped in 90 min. The patient was followed at the ICU postoperatively and passed away on postoperative day 25 due to pulmonary sepsis. The other mortality occurred in a patient who had undergone surgery for intestinal obstruction due to peritoneal carcinomatosis. The patient developed disseminated intravascular coagulopathy and died on postoperative day 7.

The preoperative CRP levels were higher (p = 0.04), the use of preoperative chemo-radiotherapy was more frequent (p = 0.04), the bleeding time was longer (p = 0.006), and the number of packs of erythrocyte suspension

Table 4. Univariate analysis of factors associated with morbidity

	Morbidity (+) (n = 48)	Morbidity (–) (n = 72)	p value
Age, mean±SD, years	56.5±3.1	55.7±3.5	0.076
Sex (males/females), n (%)	26 (54)/22 (46)	47 (65)/25 (35)	0.222
ASA score (I/II/III), %	37/56/17	57/36/7	0.07
BMI, mean±SD, kg/m^2	29.3±1.9	27.8±1.2	0.182
Anticoagulant use, %	18	10	0.154
Preoperative INR level, mean±SD	1.04±0.05	1.1±0.11	0.33
Preoperative hemoglobin level, mean±SD, g/dL	11.7±0.6	11.4±0.6	0.403
Preoperative CRP level, mean±SD, mg/L	19.98±7.8	12.31±4.1	*0.04*
Preoperative albumin level, mean±SD, g/dL	3.6±0.2	3.9±0.6	0.435
Neutrophil to lymphocyte ratio, mean±SD	3.17±1.1	4±1.1	0.325
Preoperative chemo-radiotherapy, %	75	48	*0.004*
Emergency status, %	12	8	0.456
Laparoscopic approach, %	21	15	0.433
Narrow pelvis±bulky tumor, %	66	55	0.224
Origin of bleeding (Batson plexus), %	75	64	0.657
Cause of bleeding (dissection), %	70	83	0.196
Time between onset and ending of bleeding, mean±SD, min	66.8±23.9	21.8±12.3	*0.006*
Need for extra surgical team, %	8.3	5.6	0.550
Packs of blood used, mean±SD	3.4±0.6	2.3±0.5	*0.005*
Packs of fresh frozen plasma used, mean±SD	2.15±0.6	2.04±0.8	0.849
Presence of hemorrhagic shock, %	12	13	0.826

SD, standard deviation; ASA, American Society of Anesthesiologists.

required was higher (p = 0.005) for patients who experienced short-term postoperative morbidity (Table 4). However, no factors were associated with morbidity in logistic regression analysis (Table 5).

The patients who experienced morbidity had longer hospital stay (21 ± 4 vs. 15 ± 2 days, p = 0.002) and higher rates of readmission (35.4% vs. 8.3%, p = 0.002). The final oncological outcomes in cancer patients were as follows: local recurrence (n = 6) and systemic metastases (n = 15) of whom 13 died. Time to recurrence was 22 months (range, 4–60 months). Median follow-up was 40 months (range, 12–132 months).

Discussion

High inflammation, high rates of patients underwent preoperative chemo-radiotherapy, long bleeding time and subsequent excessive blood loss are the major risk factors related to postoperative morbidity in patients experiencing MPH in CAPS. In our series, a mean of 66.8 min of pelvic bleeding resulted with high morbidity. Prompt decision-making, precise action, and anatomy knowledge seem to be the key factors to control MPH in CAPS and its related postoperative morbidity.

Traction and type of dissection preferences are directly related to bleeding process. The main source of major bleeding during pelvic surgery was the Batson's venous plexus in our series. The Batson's plexus (the presacral venous plexus) has valveless veins which are a part of a huge venous plexus going all around the vertebral system. Bleeding from these vessels may reach severe amounts within minutes due to its valveless nature and difficult to reach anatomical location [11]. Baque et al. [12] described the avascular tetragonal areas on the inner surface of the sacrum and recommended to place staples or sutures in the avascular areas to avoid injuries to the presacral venous plexus. While those areas can be approached during CAPS as the critical borders of the problematic fields, manipulations for any place on the inner surface of the sacrum can be needed especially due to disease-related factors. As the nature of the surgery, vascular resections or bleeding from the inflamed tissues can be inevitable. Approaching from known areas with less risk of bleeding to unknown regions may facilitate salvaging and terminating the intraoperative hemorrhage. Control of bleeding from the internal iliac veins and arteries is relatively less complicated. Suturing and/or ligation of the internal vessels usually stops a major hemorrhage from vascular origin. In case of injury of the Batson's plexus, temporary pelvic packing and applying local pressure on

Table 5. Multivariate analysis of variables associated with morbidity

Covariate	Odds ratio	CI
Preoperative CRP level	0.979	0.951–1.007
Preoperative chemo-radiotherapy	0.323	0.102–1.027
Time between onset and ending of bleeding	0.996	0.981–1.011
Packs of blood required	0.705	0.496–1.001 $p = 0.13$

CI, confidential interval; SD, standard deviation.

the bleeding site are mandatory as the index step. Following maneuvers including cauterization, suturing, applying thumb tacks, use of chemical stoppers or a muscle welding flap can be consecutively used intraoperatively based on the degree of bleeding, availability of the utilizers, and the surgeon's experience [13].

Muscle welding (Fig. 3) is one of the most effective intraoperative maneuvers to control intractable pelvic bleeding originating from the Batson's plexus [14]. Creation of a barrier via cauterization of a muscle fragment pressed on the bleeding vein is the main principle of the technique [13, 15]. The donor site of the muscle pedicle is the rectus abdominis [13]. In our study, this technique was successfully applied in 5 patients. Neither recurrent bleeding occurred nor an extra intervention was necessary in those patients. This technique has been validated by some other authors, too [13, 16, 17]. In cases with unsuccessful attempts of intraoperative bleeding control, intraoperative or postoperative embolization may be the procedure of choice [18].

A comprehensive resuscitation at the ICU and a planned reoperation can be considered when the general condition of the patient is not stable. There are some cases need to be managed with staged operations to maintain metabolic balance and durability with full recusation which can be done at the ICU. Packing the pelvis with Mikulicz tampon or balloon tamponade can be lifesaving. Six of our patients with advanced colorectal cancers had to leave the operating room with pelvic packing. While there are multiple techniques for pelvic packing, application of multiple surgical pads on the source of hemorrhage is the fastest way to control and reduce blood loss due to MPH [15]. It has been argued that blood transfusion is an independent risk factor for postoperative patients since it is associated with increased number of leakages from anastomoses and postoperative infections. This is further explained by a transfusion induced impaired natural killer, macrophage, and helper T cell activity which altogether inhibit wound healing process [19].

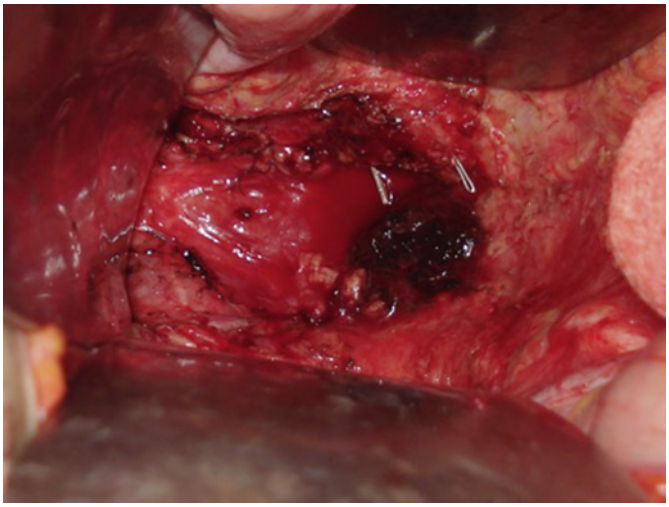

Fig. 3. Control of bleeding by cauterizing a piece of tissue (marked with arrows) from the rectus muscle over the presacral venous hemorrhage.

History of preoperative chemo-radiotherapy, increased level of inflammatory status, increased amount of blood transfusion, and prolonged bleeding time are the potential denominators of operative morbidity in patients undergoing CAPS. While it is one of the major tools to control locally advanced or recurrent pelvic cancers, there are certain reservations on the detrimental effects of preoperative chemo-radiotherapy. Preoperative chemo-radiotherapy complicates the healing process of surgical wounds, increases inflammation, and leads to unyielding fibrosclerosis [20]. Majority of patients undergoing CAPS have nutritional deficiency and systemic imbalances. Poor outcomes following CAPS such as longer hospital stay and increased number of readmissions can be related to the aforementioned factors being out of balance. It has been known that low preoperative albumin and Hg levels are associated with higher risk of postoperative bacterial and fungal infectious [21]. Another factor that impacts the outcome is the continuous inflammatory process

which may complicate course of surgery in many terms. Systemic inflammation negatively affects coagulation and healing processes [22]. From a technical perspective, inflamed tissues are prone to bleed due to their frail form. In patients with advanced pelvic cancer and inflammatory bowel disease, the risk of pelvic bleeding is high [2]. Considering patient's troublesome condition and urgency of surgery, preoperative strategies including systemic antibiotherapy and fecal diversion may reduce inflammation and pelvic sepsis related morbidity in CAPS [23].

It is crucial to assess the risks and hazards of CAPS in terms of improving the quality of life and survival of patients. The indications for CAPS should be evaluated and decided by concerted efforts of a multidisciplinary team to ensure the best interests of patients. Toward the goal of ensuring better quality of life and diminished morbidities the first critical step to take in terms of operative technique is to decide on performing a minimally invasive or an open surgery. Open surgery has been the main way of CAPS in general. Minimally invasive approaches could also be performed safely in selected cases [24–26]. Around one-fifth of our patients underwent laparoscopic surgery. While minimally invasive surgery potentially offers various advantages including shorter hospital stay and faster recovery compared to open surgery in patients with virgin abdomen, history of prior abdominal surgery may worsen outcomes of minimally invasive operations [27, 28]. Potential characteristics of complex disorders requiring CAPS may fade the expected benefits of minimally invasive surgery. Although it is doable, oncological safety and recovery benefits of laparoscopic resection for locally advanced tumors are still considered inconclusive [29].

Our study has some limitations due to its retrospective, non-randomized, and multi-centric nature; however, it is one of the largest series evaluating major pelvis hemorrhage during CAPS. While having preoperative chemo-radiotherapy and increased inflammatory status may potentially be the risk factors, we found no independently associated factors associated with MPH-related morbidity in patients undergoing CAPS. Future studies including larger numbers of patients with more homogenous characteristics would provide further insights on the impact of MPH on the outcomes CAPS.

Statement of Ethics

This study protocol was reviewed and approved by Acibadem University Institutional Review Board, approval number (2018-6/17). Written informed consent was not required for the retrospective study which includes standard clinical data with no patient identifier. A waiver of informed consent was approved by the Institutional Review Board to allow access to protected health information by the research team only without sharing or releasing identifiable data to anyone.

Conflict of Interest Statement

The authors have no conflict of interest.

Funding Sources

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Author Contributions

Erman Aytaç, Selman Sökmen, Ersin Öztürk, Ahmet Rencüzoğulları, Uğur Sungurtekin, Cihangir Akyol, Sezai Demirbaş, Sezai Leventoğlu, Feza Karakayalı, Mustafa Ali Korkut, Mustafa Öncel, Barış Gülcü, Aras Emre Canda, İsmail Cem Eray, Utku Özgen, Şiyar Ersöz, Tahir Özer, İsmail Hakkı Özerhan, Osman Bozbıyık, Mustafa Haksal, and Berke Mustafa Oral contributed to the conception and design, acquisition of data, analysis and interpretation of data; drafting the article, critical revision, and final approval.

Data Availability Statement

All data generated or analyzed during this study were included in this article. Further inquiries can be directed to the corresponding author.

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