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Conservative Management of Placenta Accreta Spectrum: The Role of Cervical Length as a Predictive Tool

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ABSTRACT

Background: Placenta accreta spectrum (PAS) disorders represent a critical obstetric challenge characterized by abnormal placental invasion into the uterine wall, with rising incidence attributed to increasing cesarean delivery rates. While cesarean hysterectomy remains the conventional management approach, growing interest in fertility-preserving conservative surgical techniques has emerged. However, predicting surgical success and identifying high-risk candidates for conservative management remains challenging. Recent evidence suggests that cervical length (CL), measured by transvaginal ultrasound, may serve as a valuable anatomical predictor of surgical complexity and hemorrhagic complications in PAS cases. Shorter cervical length has been associated with more extensive lower uterine segment involvement, increased intraoperative bleeding, prolonged operative duration, and higher rates of conversion to hysterectomy. Understanding the relationship between CL and surgical outcomes could enhance preoperative risk stratification, facilitate multidisciplinary preparation, and support individualized patient counseling regarding uterine preservation options.

Keywords: Placenta accreta spectrum, cervical length, conservative management, transvaginal ultrasound, uterine preservation, surgical outcomes, intraoperative hemorrhage, predictive markers, fertility preservation, cesarean delivery complications

INTRODUCTION

Placenta accreta spectrum (PAS) disorders encompass a range of abnormal placentation conditions, including placenta accreta (abnormal adhesion), placenta increta (invasion into the myometrium), and placenta percreta (invasion through the uterine serosa and potentially into adjacent organs). The prevalence of PAS has increased dramatically over recent decades, primarily attributed to rising cesarean delivery rates worldwide. Current estimates suggest an incidence of approximately 1.7 per 10,000 pregnancies in the general population, with substantially higher rates among women with prior cesarean deliveries (1).

The risk of PAS escalates significantly with increasing number of previous cesarean deliveries. Women with one prior cesarean delivery and placenta previa face a 4.1% risk of PAS, which increases to 13.3% with two or more previous cesareans.1 This association has transformed PAS from a rare obstetric complication into a condition requiring systematic screening and specialized management protocols. The clinical implications are profound, with PAS being associated with massive hemorrhage, need for blood transfusion, intensive care admission, and substantial maternal morbidity and mortality (2).

Historically, planned cesarean hysterectomy with the placenta left in situ has been considered the standard of care for PAS management. However, this approach results in permanent loss of fertility and carries significant surgical risks, including urinary tract injury, bowel injury, and massive hemorrhage (3). Consequently, conservative surgical techniques aimed at uterine preservation have emerged as viable alternatives for appropriately selected patients who desire future fertility or wish to avoid hysterectomy.

Conservative management strategies vary widely and include expectant management with the placenta left in situ, manual removal of the placenta, excision of the involved uterine segment, and various hemostatic techniques (4). Success rates for conservative approaches range from 70% to 85%, though outcomes depend heavily on disease severity, surgical expertise, and patient selection. Not all PAS cases are amenable to conservative management, necessitating reliable preoperative predictors of surgical complexity and likelihood of success.

Recent evidence suggests that cervical length, routinely measured via transvaginal ultrasound, may serve as an independent predictor of operative difficulty and outcomes in PAS cases complicated by placenta previa. Shorter cervical length has been associated with increased blood loss, prolonged operative time, higher transfusion requirements, and greater risk of conversion to hysterectomy (5,6).

Pathophysiology of Placenta Accreta Spectrum

Decidual Deficiency Hypothesis

The prevailing hypothesis for PAS development centers on defective decidualization at the site of uterine scarring. During normal pregnancy, the endometrium undergoes decidualization—a complex transformation involving stromal cell proliferation and differentiation, immune cell infiltration, and vascular remodeling. This process precedes blastocyst implantation and is essential for proper placental development. In PAS, secondary defects in the endometrial-myometrial interface, typically from surgical trauma, disrupt normal decidualization and permit abnormally deep trophoblastic invasion (7).

Cesarean delivery represents the most common cause of endometrial-myometrial disruption, though cases have been reported following other uterine procedures including curettage, manual removal of placenta, and myomectomy. The extent of scar defects varies considerably, ranging from small superficial defects to deep myometrial disruptions extending from the endometrial cavity to the uterine serosa. Transvaginal ultrasound studies demonstrate that 20-65% of women with prior cesarean delivery have residual myometrial thinning, with women showing less than 50% residual myometrial thickness being at higher risk for chronic complications (8).

Trophoblastic Invasion Patterns

Human placentation is characterized by physiologically invasive extravillous trophoblast (EVT) cells that normally penetrate the decidua and inner myometrium. During normal implantation, cytotrophoblast cells proliferate at the tips of anchoring villi, forming columns that undergo epithelial-mesenchymal transition and invade the decidual stroma. These cells differentiate into interstitial and endovascular subpopulations, with interstitial EVT typically migrating to the junctional zone where they fuse to form multinucleated trophoblast giant cells (9).

In PAS, EVT cells demonstrate increased depth of invasion, hypertrophic morphology, and altered differentiation patterns. The number of multinucleated giant cells is typically reduced, suggesting disrupted terminal differentiation. Matrix metalloproteinases secreted by EVT facilitate invasion through the extracellular matrix and can equally digest scar tissue when implantation occurs over a myometrial defect. This results in absence of the normal cleavage plane above the decidua basalis, preventing physiologic placental separation after delivery (10).

Vascular Remodeling Abnormalities

Normal placentation involves extensive remodeling of maternal spiral arteries, transforming them from narrow, muscular, vasoresponsive vessels into dilated, flaccid, low-resistance channels. This physiologic transformation is essential for establishing adequate uteroplacental blood flow. In PAS, spiral artery remodeling is often incomplete or aberrant, particularly in areas lacking decidua. Despite incomplete remodeling, PAS cases typically do not demonstrate uteroplacental insufficiency or fetal growth restriction, suggesting that vascular abnormalities are localized to the accreta area rather than affecting entire placental function. The extensive neovascularity often observed in PAS contributes to massive hemorrhage risk during attempted placental separation (11).

Prenatal Diagnosis of Placenta Accreta Spectrum

Ultrasound Imaging

Obstetric ultrasonography remains the primary diagnostic modality for antenatal detection of PAS. The sensitivity and specificity of second and third-trimester ultrasound for PAS diagnosis are reported to be 80-90% in tertiary referral centers, though diagnostic accuracy may be lower in community settings where operators have less experience with this condition (12). Key ultrasound findings suggestive of PAS include loss of the normal hypoechoic retroplacental zone, multiple vascular lacunae within the placenta creating a "Swiss cheese" appearance, thinning or disruption of the uterine serosa-bladder interface, extension of placental tissue beyond the uterine serosa, and turbulent lacunar blood flow on Doppler interrogation (13).

First-trimester ultrasound may identify early markers of PAS, including gestational sac implantation in the lower uterine segment, cesarean scar ectopic pregnancy, and irregular vascular spaces within the placental bed. These early findings allow for enhanced surveillance throughout pregnancy and facilitate timely referral to specialized centers. Three-dimensional power Doppler ultrasound has shown promise as an adjunctive tool, providing enhanced visualization of placental vascularity and improving diagnostic accuracy, though it remains investigational and requires specialized expertise (14).

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) serves as a complementary diagnostic tool, particularly in cases where ultrasound is limited by posterior placentation, maternal body habitus, or when assessing the extent of parametrial invasion in suspected placenta percreta. MRI findings suggestive of PAS include uterine bulging, heterogeneous placental signal intensity, dark intraplacental bands on T2-weighted images, and disruption of the myometrial border. However, MRI does not consistently demonstrate superior diagnostic accuracy compared to ultrasound and carries limitations including cost, availability, and requirement for radiologic expertise in placental imaging (15).

The FIGO consensus guidelines recommend ultrasound as the primary screening and diagnostic modality, with MRI reserved for cases where ultrasound findings are equivocal or when detailed mapping of percreta with adjacent organ involvement is necessary. Standardization of imaging protocols and terminology has been emphasized to improve diagnostic consistency and facilitate research in this field (16).

FIGO Classification System

The International Federation of Gynecology and Obstetrics (FIGO) has developed a standardized ultrasound-based classification system for PAS that grades disease severity based on imaging findings. Grade 1 (placenta accreta) demonstrates loss of the retroplacental clear zone and abnormal placental lacunae with minimal or absent bladder wall disruption. Grade 2 (placenta increta) shows myometrial invasion with myometrial thickness less than 1 mm but intact serosa. Grade 3 (placenta percreta) is characterized by invasion through the uterine serosa, subdivided into Grade 3a (invasion into surrounding tissues without bladder mucosal involvement), Grade 3b (bladder mucosal invasion), and Grade 3c (invasion beyond the uterus into other organs) (17).

This classification system facilitates standardized communication among clinicians, guides surgical planning, and enables comparison of outcomes across institutions. Accurate preoperative grading correlates with surgical complexity, blood loss, and likelihood of successful conservative management (18).

Conservative Management Strategies

Expectant Management

Expectant management involves delivery of the fetus via hysterotomy with the placenta left in situ, followed by observation for spontaneous placental resorption. This approach avoids immediate surgical intervention and hemorrhagic risk associated with attempted placental removal. Success is defined as uterine preservation without need for hysterectomy. Reported success rates range from 60-80%, with median time to complete placental resorption of approximately 13.5 weeks (range 4-60 weeks) (4).

Expectant management requires close postpartum surveillance for complications including infection, secondary hemorrhage, and disseminated intravascular coagulation. Approximately 50% of patients develop postpartum hemorrhage requiring intervention, and 65% require additional pelvic devascularization procedures such as uterine artery embolization or vessel ligation. The use of prophylactic methotrexate to accelerate placental involution remains controversial, with limited evidence of efficacy and potential for significant toxicity. Current guidelines do not recommend routine methotrexate use in expectant management of PAS (19).

One-Step Conservative Surgery

One-step conservative surgery involves excision of the involved lower uterine segment containing the abnormally adherent placenta, followed by uterine reconstruction. This technique is most applicable to focal PAS where the area of involvement is clearly demarcated and measures less than 16 cm^2. The procedure typically includes careful dissection and mobilization of the urinary bladder, delivery of the fetus through a fundal or high transverse hysterotomy avoiding the placenta, devascularization via bilateral uterine and ovarian artery ligation, wide excision of the invaded lower uterine segment, and reconstruction of the uterus or cervical tamponade if insufficient lower segment remains (20).

Success rates for one-step conservative surgery range from 70-85%, with lower success in cases of extensive invasion, posterior placentation, or placenta percreta. Intraoperative ultrasound can assist in precisely mapping the extent of placental invasion and guiding surgical excision. This technique requires substantial surgical expertise and is best performed at specialized centers with multidisciplinary teams including experienced obstetricians, urologists, and anesthesiologists trained in massive transfusion protocols (21).

Triple-P Procedure

The Triple-P procedure (Perioperative Placental Localization and Pelvic Devascularization) combines precise localization of placental borders, pelvic devascularization, and resection of the involved uterine segment. The technique emphasizes meticulous preoperative planning using ultrasound mapping, stepwise devascularization to minimize blood loss, and careful surgical technique to avoid disrupting the placenta prior to devascularization. Reported outcomes demonstrate success rates of approximately 80% with median blood loss of 1500-2000 mL (22).

Cervical Tamponade Technique

When insufficient lower uterine segment remains after excision of the accreta area, cervical tamponade using specialized balloons or packing can achieve hemostasis and avoid hysterectomy. This technique is particularly valuable in cases where the accreta extends close to the cervix, making traditional uterine reconstruction challenging. The tamponade device is typically left in place for 24-48 hours and removed under controlled conditions with immediate surgical backup available (23).

Cervical Length as a Predictive Marker

Measurement Technique

Cervical length is measured via transvaginal ultrasound with the patient in lithotomy position. A high-resolution transvaginal probe is inserted to visualize the cervix in a sagittal plane, and the shortest distance between the external os and the functional internal os is recorded. Measurements should be obtained when the bladder is empty and in the absence of uterine contractions to ensure accuracy. Multiple measurements are typically performed, with the shortest reliable measurement recorded (24).

In the context of PAS, cervical length measurement provides additional anatomical information beyond standard placental imaging. The measurement can be performed at the time of routine PAS assessment, typically in the third trimester, or immediately before scheduled delivery. Standardization of measurement technique is essential to minimize inter-observer variability and ensure reproducibility (25).

Correlation with Surgical Outcomes

Recent evidence demonstrates significant associations between cervical length and multiple surgical outcome parameters in PAS cases. Shorter cervical length has been correlated with increased intraoperative blood loss, with studies showing mean blood loss of 2500-3500 mL in patients with cervical length less than 25-30 mm compared to 1200-1800 mL in patients with longer cervical measurements. This represents a clinically meaningful difference of approximately 50-100% increased hemorrhage risk (5).

Operative duration is similarly affected, with shorter cervical length associated with prolonged surgery. Patients with adequate cervical length (≥33 mm) demonstrate mean operative times of 60-75 minutes compared to 90-120 minutes in those with shortened cervix. This difference reflects increased surgical complexity, more extensive dissection requirements, and greater difficulty achieving hemostasis when the accreta involves or extends close to the cervical region (6).

Transfusion requirements show strong correlation with cervical length, with patients having shortened cervix requiring median 5-8 units of packed red blood cells compared to 1-2 units in those with preserved cervical length. Similarly, fresh frozen plasma requirements are substantially higher (median 3-4 units versus 1 unit). These differences have significant implications for blood bank preparation and resource allocation (26).

Predictive Thresholds

Receiver operating characteristic (ROC) curve analyses have identified cervical length thresholds with optimal sensitivity and specificity for predicting adverse outcomes. A cutoff of 30-33 mm demonstrates sensitivity of 75-80% and specificity of 80-85% for predicting massive hemorrhage (>2000 mL blood loss), with area under the curve values of 0.70-0.75. While not perfectly predictive, these metrics indicate clinically useful discriminatory ability (5,6).

Importantly, the predictive value of cervical length appears independent of other risk factors including number of prior cesareans, placental location, and FIGO grade. Multivariate analyses controlling for these variables demonstrate that cervical length remains a significant independent predictor of surgical complexity and outcomes. This suggests that cervical length provides unique anatomical information not captured by standard risk stratification schemes (27).

Proposed Mechanisms

Several mechanisms may explain the association between shortened cervical length and adverse surgical outcomes in PAS. First, shorter cervical length may indicate more extensive lower uterine segment involvement by the abnormally adherent placenta, making surgical dissection more challenging and increasing likelihood of uncontrollable hemorrhage. Second, cervical shortening may result from mechanical pressure exerted by the abnormally adherent placenta or from biochemical remodeling processes affecting cervical extracellular matrix. Third, shortened cervix may serve as a surrogate marker for overall lower uterine segment integrity and distensibility, with patients having adequate cervical length possessing better preserved lower segment anatomy facilitating safer surgical dissection (6).

Histopathological studies of hysterectomy specimens have revealed that patients with PAS and short cervical length demonstrate more extensive trophoblastic infiltration of the lower uterine segment and cervical stroma, supporting a direct anatomical relationship between cervical shortening and disease severity. Additionally, the interaction between cervical length and placental invasion depth appears synergistic rather than simply additive, suggesting complex biomechanical and biological relationships (28).

Multidisciplinary Management Approach

Preoperative Planning

Optimal management of PAS requires comprehensive preoperative planning involving multiple disciplines. Standardized checklists should ensure completion of all necessary preparations including informed consent for multiple procedures, recent laboratory studies including complete blood count and coagulation profile, blood

typing and crossmatching with adequate units reserved, notification of anesthesia, interventional radiology, surgical subspecialties, neonatal intensive care, and intensive care units. Massive transfusion protocols should be activated, and cell salvage equipment prepared when available (29).

Patient counseling is essential, addressing realistic expectations regarding surgical risks, likelihood of hysterectomy, transfusion requirements, intensive care admission, and long-term implications for fertility. Women choosing conservative management must understand that success cannot be guaranteed and that conversion to hysterectomy may be necessary if hemorrhage cannot be controlled. Shared decision-making principles should guide treatment selection based on individual patient values, priorities, and clinical circumstances (30)

Timing of Delivery

The optimal timing of delivery for PAS involves balancing risks of prematurity against risks of emergency delivery due to bleeding or labor. Decision analyses suggest 34-36 weeks gestation as the optimal window for planned delivery, though individualization based on specific clinical factors is appropriate. Factors favoring earlier delivery include history of preterm labor, vaginal bleeding, uterine contractions, short cervical length, and posterior placentation. Factors permitting later delivery include anterior placentation, stable clinical status, close proximity to specialized center, and patient reliability for monitoring (31).

Antenatal corticosteroids should be administered to all women with PAS to enhance fetal lung maturity, typically given at 33-34 weeks in stable patients planning delivery at 34-36 weeks. In cases presenting with bleeding or contractions before 34 weeks, corticosteroids should be administered emergently prior to delivery if time permits (32).

Intraoperative Management

Surgical technique significantly influences outcomes. Key principles include vertical or Cherney incision to allow adequate exposure, hysterotomy placed at least 2 cm from placental margins guided by intraoperative ultrasound, delivery of the fetus without disturbing the placenta, high ligation of the umbilical cord, stepwise devascularization before attempted placental manipulation, and use of hemostatic techniques including compression sutures, topical hemostatic agents, and balloon tamponade as needed (33).

Anesthetic management typically involves general endotracheal anesthesia to facilitate potential hemodynamic instability, though neuraxial techniques may be appropriate in selected cases. Large-bore intravenous access, arterial line monitoring, and availability of rapid infusion devices are standard. Point-of-care testing for hemoglobin, lactate, and coagulation parameters guides real-time management decisions. Aggressive warming measures prevent hypothermia and coagulopathy (34).

The role of prophylactic interventional radiology procedures including balloon catheter placement in the internal iliac arteries remains controversial. Some centers employ this technique routinely, while others reserve it for selected high-risk cases. Randomized controlled trial data are lacking, and practice varies based on local expertise and resources. Balloon occlusion carries risks including arterial injury, thromboembolism, and ischemic complications (35).

Postoperative Care

Intensive care admission is appropriate for most PAS cases given the high risk of delayed hemorrhage, coagulopathy, and multiorgan complications. Close monitoring of vital signs, urine output, hemoglobin, and coagulation parameters continues for at least 24-48 hours. Thromboembolic prophylaxis with pneumatic compression devices and pharmacologic anticoagulation (once hemostasis is assured) reduces risk of venous thromboembolism (36).

In cases of expectant management with placenta left in situ, prolonged follow-up is necessary. Weekly outpatient visits during the first two months, followed by monthly assessments, monitor for infection, secondary hemorrhage, and placental resorption. Clinical examination, pelvic ultrasound evaluating retained tissue volume

and vascularity, and laboratory testing including hemoglobin, white blood cell count, and beta-hCG guide management. Most placental tissue resorbs within 3-6 months, though some cases require up to one year (37).

Antibiotic prophylaxis beyond routine surgical prophylaxis is controversial in expectant management. Some protocols employ 5-10 days of oral antibiotics (cephalosporin or amoxicillin-clavulanate), while others use single-dose gentamicin followed by 5 days of clindamycin. Evidence supporting extended antibiotic courses is limited, and practice varies widely. Fever, increased vaginal discharge, or elevated inflammatory markers warrant prompt evaluation and treatment for endometritis (38).

Integration of Cervical Length into Clinical Practice

Risk Stratification Algorithms

Incorporating cervical length measurement into PAS risk stratification algorithms enhances prediction of surgical complexity and outcomes. A proposed algorithm combines traditional risk factors (number of prior cesareans, placental location, ultrasound features) with cervical length to generate individualized risk scores. Patients with multiple high-risk features including shortened cervical length receive enhanced counseling regarding increased likelihood of massive hemorrhage, prolonged surgery, and potential hysterectomy (39).

Risk stratification guides preoperative preparation including blood product ordering (patients with short cervical length may require 8-12 units PRBC reserved versus 4-6 units for low-risk patients), surgical team composition (consideration of vascular surgery or urology backup for high-risk cases), and selection of operative suite (main operating room with advanced equipment rather than labor and delivery suite) (40).

Patient Counseling

Cervical length findings should be incorporated into preoperative counseling discussions. Patients with adequate cervical length (≥33 mm) can be counseled regarding favorable prognosis with conservative management, with success rates exceeding 90% and median blood loss under 1500 mL. Conversely, patients with shortened cervix (<25 mm) should understand substantially higher risks including 60-70% success rate for conservative management, median blood loss 2500-3500 mL, and likelihood of requiring 6-8 units of blood products (41).

This information facilitates shared decision-making, allowing patients to make informed choices aligned with their values and priorities. Some patients with shortened cervix and high-risk features may opt for planned hysterectomy to avoid risks of massive hemorrhage and emergency surgery. Others may choose to attempt conservative management despite increased risks, accepting potential need for conversion to hysterectomy. Respect for patient autonomy and individualized counseling are paramount (42).

Quality Improvement Initiatives

Healthcare systems can implement quality improvement initiatives incorporating cervical length measurement into standardized PAS care pathways. Electronic medical record alerts can prompt cervical length measurement when PAS is suspected based on prior cesarean delivery and placenta previa. Standardized reporting templates ensure consistent documentation of cervical length along with other key imaging parameters (43).

Institutional review of PAS cases can examine relationships between cervical length and outcomes, identifying opportunities to refine surgical techniques and improve results. Benchmarking against published data allows centers to assess their performance and implement evidence-based practices. Multidisciplinary debriefing after each PAS case promotes continuous learning and system improvement (44).

Future Directions and Research Needs

Prospective Validation Studies

While retrospective cohort studies have demonstrated associations between cervical length and PAS outcomes, prospective validation in diverse populations is needed. Multicenter prospective studies with standardized cervical length measurement protocols, blinded outcome assessment, and adequate sample sizes would provide

higher-quality evidence regarding predictive accuracy. Such studies should include diverse patient populations across different geographic regions and healthcare settings to assess generalizability (45).

Combined Predictive Models

Development of multivariable prediction models incorporating cervical length along with other clinical, laboratory, and imaging parameters may enhance prognostic accuracy beyond cervical length alone. Candidate variables include maternal age, body mass index, number and type of prior uterine surgeries, placental location and grade, presence of placental lacunae, bladder wall involvement, myometrial thickness, and potentially novel biomarkers. Machine learning approaches may identify complex interactions and non-linear relationships not evident with traditional statistical methods (46).

Biological Mechanisms

Further investigation into biological mechanisms linking cervical length to PAS outcomes is warranted. Histopathological examination of hysterectomy specimens with detailed mapping of trophoblastic invasion patterns relative to cervical anatomy could elucidate anatomical relationships. Molecular analyses examining extracellular matrix composition, inflammatory markers, and vascular mediators in cervical tissue from PAS patients with varying cervical lengths may reveal biochemical pathways underlying cervical shortening and disease severity (47).

Intervention Studies

If cervical length proves to be a robust predictor of outcomes, intervention studies examining whether outcomes can be improved through cervical length-guided management strategies would be valuable. For example, randomized trials could compare standard management versus enhanced interventions (prophylactic balloon catheters, adjunctive hemostatic techniques, modified surgical approaches) in patients with shortened cervical length. Demonstrating that cervical length-guided strategies improve outcomes would strengthen the case for routine measurement (47).

Long-Term Outcomes

Limited data exist regarding long-term outcomes following conservative management of PAS, particularly in relation to cervical length. Prospective cohort studies with extended follow-up could examine subsequent pregnancy outcomes, uterine scar characteristics on imaging, menstrual patterns, chronic pelvic pain, and quality of life measures. Understanding whether cervical length at index PAS delivery predicts complications in subsequent pregnancies would inform counseling regarding future reproductive planning (48).

Conclusion

Placenta accreta spectrum disorders represent a major obstetric challenge with increasing incidence paralleling rising cesarean delivery rates worldwide. While cesarean hysterectomy has been the traditional management approach, conservative surgical techniques offer the possibility of fertility preservation for appropriately selected patients. Success of conservative management varies substantially based on disease severity, anatomical factors, and surgical expertise, necessitating reliable preoperative predictors of outcomes (48).

Emerging evidence demonstrates that cervical length, measured via transvaginal ultrasound, serves as an independent predictor of surgical complexity and outcomes in PAS cases complicated by placenta previa. Shorter cervical length correlates significantly with increased blood loss, prolonged operative time, higher transfusion requirements, and reduced likelihood of successful conservative management. A threshold of approximately 30-33 mm appears to have optimal discriminatory ability, with sensitivity and specificity around 75-85% for predicting massive hemorrhage and failed conservative management (49).

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