Subclassification and Atlas of Complete Placenta Previa

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By

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Department of Obstetrics, Foshan Women and Children Hospital

The Department of Obstetrics at Foshan Women and Children Hospital holds a prominent position as a key clinical specialty of Guangdong Province and is recognized as a key high-level medical specialty in Foshan City. It serves as the medical quality control center for obstetrics in Foshan City, a treatment center for critically ill pregnant and postpartum women, and a guidance center of obstetrics in Foshan City. The department is entrusted with the crucial responsibility of providing obstetrics knowledge, skills training and assessment for primary hospitals across Foshan City, as well as playing a vital role in the rescue efforts for critically ill pregnant and postpartum women.

In August 2020, Foshan Obstetrics and Gynecology Hospital was officially inaugurated at Foshan Women and Children Hospital. On December 23, 2020, Xincheng Branch of the hospital has been fully put into operation. Chancheng Branch and Xincheng Branch collectively house five departments (prenatal area, delivery room, postpartum area, obstetric clinic and obstetric ultrasound group) and three diagnosis and treatment centers (fetal medical diagnosis and treatment center, gestational diabetes diagnosis and treatment center, and twin pregnancy diagnosis and treatment center).

The obstetric intensive care unit and obstetric integrated operation department have been established in Xincheng Branch, equipped with modern integrated digital operating room, which is specifically used for fetal surgery and major obstetric surgery. Pregnant women who need intrauterine treatment and severe pregnant women (including multiple pregnancy) are mostly transferred to Xincheng Branch. Over the years, Foshan Women and Children Hospital has been committed to providing high-

quality and safe whole-pregnancy management for pregnant and puerperal women in Foshan City and the whole western Guangdong Province at large. Every year, Foshan Women and Children Hospital handles a substantial number of pregnant women from both Foshan and its neighboring areas for prenatal examinations and deliveries, as well as the rescue and treatment of critically ill pregnant women and challenging medical cases. With an annual outpatient volume exceeding 200,000 visits and consistently delivering over 10,000 babies each year, Foshan Women and Children Hospital holds the leading position in Foshan City, making it the largest obstetrics department in the city. It is thus often referred to as the "cradle of Foshan people."

In the aspect of placenta previa research, under the leadership of Director Liu Zhengping, the Department of Obstetrics at Foshan Women and Children Hospital has been paying close attention to the clinical research of placenta previa, especially complete placenta previa since 2003. At present, a research group dedicated to the study of placenta previa has been established. The researchers include clinicians and nurses from obstetrics, ultrasound, MRI, anesthesia, surgery, pathology and other departments, as well as full-time researchers with preventive medicine and basic medicine education. Since 2015, through scientific and reasonable research design, the department has strived to collect completely and accurately real clinical cases and information about pregnant women with placenta previa, and constructed the real-world data on placenta previa. Currently, an electronic real-world database about pregnant women with placenta previa, known as the specialized disease database of placenta previa, has been established since January 1, 2010. By April 2023, the database contains 2,678 complete medical records related to placenta previa. Each record consists of 1,282 items of information, including basic information about pregnant and postpartum women, along with relevant details about pre-pregnancy, pregnancy, delivery and postpartum follow-up. In total, the database contains nearly 3.5 million data entries. The database is continuously updated as the clinical diagnosis of placenta previa increases.

In addition, the Chinese edition of *Subclassification and Atlas of Complete Placenta Previa*, independently compiled by Foshan Women and Children Hospital, has been selected as the publication planning project of the14th Five-Year Plan of National Key Publications by National Press and Publication Administration of China. The research result of "the Establishment of Clinical Comprehensive Management System of Severe Placenta Previa" project has won the second prize of the Scientific and Technological Achievement Award in the 4th National Maternal and Child Health Science and Technology Awards.

Liu Zhengping

Chief obstetrician, professor,
master's supervisor

Liu Zhengping is director of Department of Obstetrics and a chief medical expert of Foshan Women and Children Hospital, and executive deputy director of Foshan Institute of Fetal Medicine.

He is also a member of Pregnancy Hypertension Group of Perinatal Medicine Branch of Guangdong Medical Association, a member of Postpartum Hemorrhage Group of Perinatal Medicine Branch of Guangdong Medical Association, vice chairman of Foshan Perinatal Medicine Association, chairman of Obstetrics Special Committee of Foshan Association of Integrated Traditional Chinese and Western Medicine, a member of International Society of Placenta Accreta Spectrum (ISPAS), and an editorial board member of *Obstetrics-Gynecology and Genetics* and *Chinese Journal of Obstetric Emergency*.

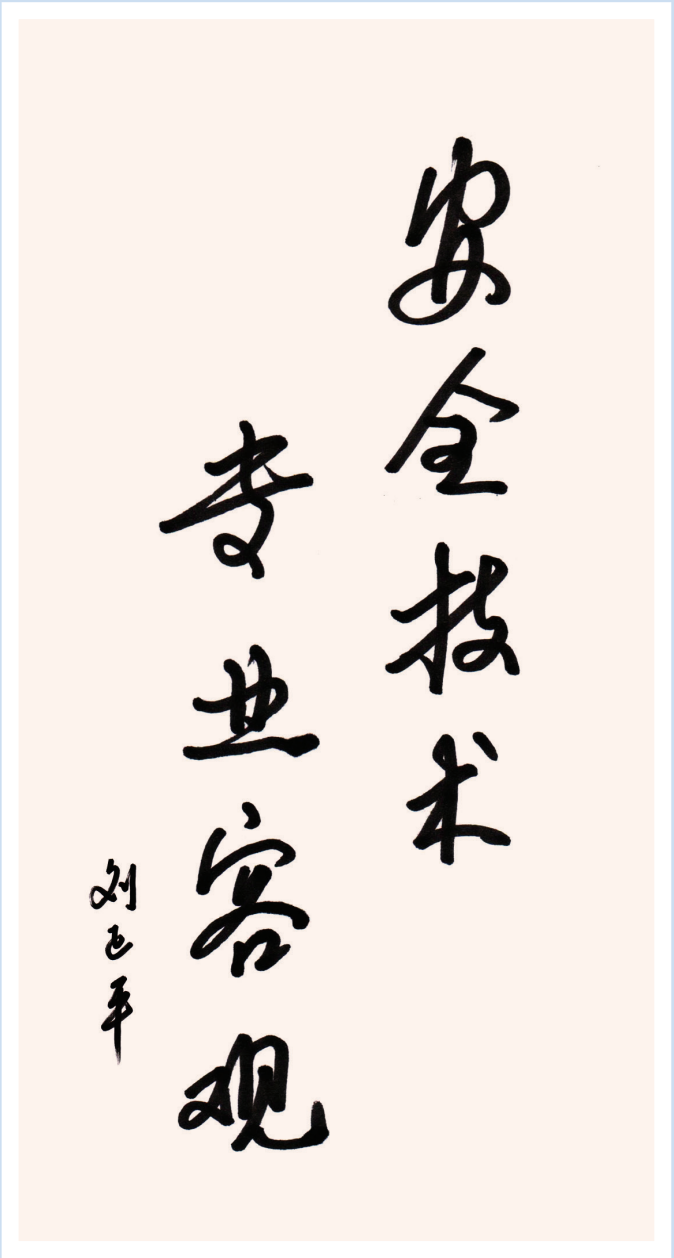
For nearly three decades, he has engaged in clinical practice of obstetrics and gynecology, accumulating extensive and distinctive expertise, particularly in obstetric critical care and fetal medical diagnosis and treatment. In 2014, he went to Philadelphia Children's Hospital for further study on fetal intrauterine surgery. He has presided over numerous scientific research projects of Foshan City and Guangdong Province and published more than 30 relevant academic SCI papers. "The Establishment of Clinical Comprehensive Management System of Severe Placenta Previa" project has won him the second prize of the Scientific and Technological Achievement Award in the 4th National Maternal and Child Health Science and Technology Awards. He has won Science and Technology Progress Award for many times. Moreover, he put forward, for the first time internationally, "The Types of Complete Placenta Previa and the Application of Liu's incision in Cesarean Section of Complete Placenta Previa," which has been certified as a technology project suitable for promotion in Guangdong Province. In 2011, he conducted the first intrauterine fetal surgery in Asia. The overall comprehensive level of the obstetric team led by him reaches the domestic advanced level.

Guo Xiaoling

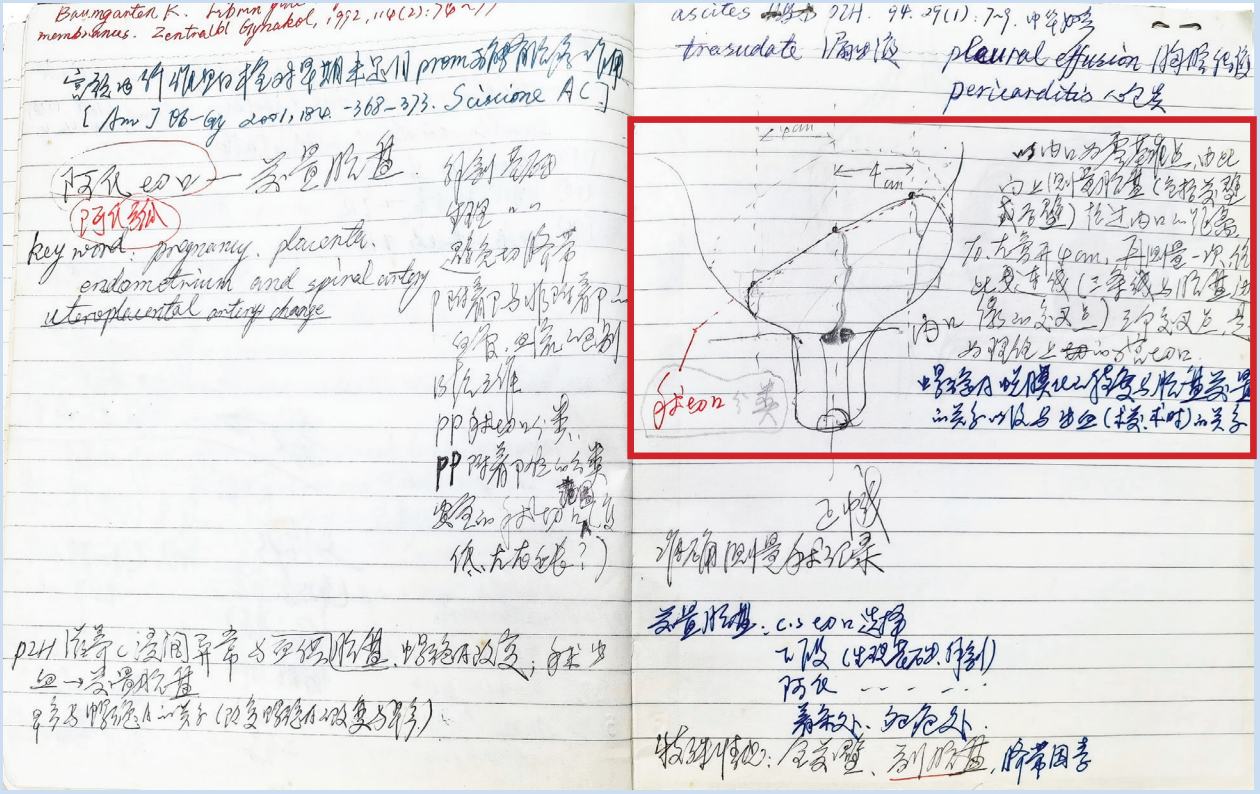
Chief obstetrician, professor,
doctoral supervisor

Guo Xiaoling is the party secretary of Foshan Women and Children Hospital, leading talent of science and technology of Foshan, vice chairman of Municipal Working Committee of China Maternal and Child Health Care Association, vice chairman of Maternal and Child Health Special Committee of Medical Genetics Branch of Chinese Medical Doctor Association, standing director of National Association of Maternal and Child Health, vice president of Guangdong Maternal and Child Health Care Association, vice president of Guangdong Medical Education Association, vice chairman of Prenatal Diagnosis Branch of Guangdong Medical Association, director of Special Committee of Obstetrics and Promotion of Natural Delivery of Guangdong Maternal and Child Health Care Association, vice president of Foshan Medical Association, vice president of Foshan Association of Traditional Chinese and Western Medicine, chairman of Perinatal Medicine Branch of Foshan Medical Association, director of Foshan Obstetrics Quality Control Center, and an editorial board member of *Obstetrics-Gynecology and Genetics* and *Chinese Journal of Obstetric Emergency*.

With over 30 years of experience in obstetrics and gynecology, she has presided over numerous scientific research projects of Foshan City and Guangdong Province. Her achievements include multiple awards in recognition of her contributions to Science and Technology Progress at both the provincial and municipal levels. She has published more than 20 SCI papers. Moreover, she has in-depth research and practice in perinatal medicine, especially in the management, diagnosis and treatment of high-risk pregnancy, rescue of critically ill pregnant women, prenatal diagnosis and eugenic genetic counseling.



The eight-character motto of Department of Obstetrics, Foshan Women and Children Hospital, which means "safety, technology, profession, objectivity"



Professor Liu Zhengping's hand-drawn sketch on the type of complete placenta previa and the primary concept of the Liu's incision, 2003

我院荣获“全国妇幼健康科学
技术奖”科技成果二等奖

Foshan Women and Children Hospital has won the second prize of the Scientific and Technological Achievement Award in the National Maternal and Child Health Science and Technology Awards

全国妇幼健康科学技术奖

证　书

为表彰全国“妇幼健康科学技术奖”获得者，特颁发此证书，以资鼓励。

获奖项目：危重型前置胎盘的临床综合管理体系建立

获奖类别：科技成果奖

获奖等级：二等奖

获 奖 者：刘正平

2021年9月

证书号：2021-K-B-4-01

The main contents of this book based on the research achievement of “The Establishment of Clinical Comprehensive Management System of Severe Placenta Previa” which won the second prize of the Scientific and Technological Achievement Award in the 2021 National Maternal and Child Health Science and Technology Awards.

Severe placenta previa (complete placenta previa, pernicious placenta previa, placenta previa with placenta accreta spectrum disorders) is one of the main causes of vaginal bleeding and maternal death, which is also the most critical type of placenta previa to mothers and fetuses. Severe placenta previa is prone to uterine incision which causes injury to placenta, scar rupture, difficulty in placental separation and other problems due to abnormal placental position, covered scar and placenta accreta spectrum disorders. It is often accompanied by iatrogenic placental abruption, which further leads to an increase in hysterectomy rate, maternal and neonatal mortality. After researching the preoperative diagnosis, surgical incision and operation mode of critical placenta previa, the obstetric team of Foshan Women and Children Hospital established the corresponding diagnosis system and the clinical comprehensive management system of severe placenta previa with Liu’s incision as the core. The establishment of this system can minimize intraoperative bleeding and other complications, which improves the predictability and capability to control critical placenta previa surgery. In critical placenta previa, the location of the placenta margin and the use of Liu’s incision can effectively prevent perforation on the placenta, which helps to avoid iatrogenic placental abruption and reduce bleeding during operation effectively. In the case of pernicious placenta previa and placenta increta, the Liu’s incision has achieved good surgical results, as well as economic and social benefits.

Preface

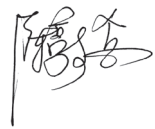
Complete placenta previa (CPP) represents a serious obstetrical complication posing a severe threat to the lives of both the mother and the fetus. The elevated risk of placenta accreta and massive perioperative bleeding associated with this condition. With the implementation of the two-child and three-child policies in recent years, there has been a rise in the incidence of CPP, leading to an increase in the absolute number of affected patients. A major concern in the obstetrics community around the world is how to help pregnant women with CPP safely weather gestation period and delivery term to ensure the safety of mothers and fetuses. The traditional solution in treating CPP is to perforate on the placenta directly and select an incision on the upper uterus or even on the back of the uterus. But all these approaches involve risks that expose pregnant women to harms, such as iatrogenic placental abruption and umbilical cord injuries. Some general hospitals with advanced hospital infrastructure introduce an endovascular interventional approach to prevent massive hemorrhage of pregnant women with CPP during delivery. While this technique is relatively good, requirements for advanced hospital infrastructure and technical skills from physicians make it difficult for most hospitals in acquiring the necessary equipment and personnel for interventional therapy. In the new era, obstetricians must consider strategies for both specialized maternal and child health care hospitals and primary hospitals to effectively manage cases of CPP without necessitating the referral of pregnant and postpartum women.

Professor Liu Zhengping of Foshan Women and Children Hospital has been diligently serving on the frontline of obstetrics and gynecology for 30 years. From military hospital to maternal and child hospital, from difficult gynecological surgeries to critical obstetrical complications, he has never hesitated in tackling even the most challenging clinical issues. It owes much to his unyielding spirit as a soldier. Facing CPP, he encountered perplexity and distress, yet he never avoided the challenge. Instead of referring CPP to higher-level hospitals like others, he chose to overcome it with his colleagues and patients. Just as he said, as a member of the Communist Party of China, he will never change his heart to serve the people wholeheartedly, regardless of the circumstances. When he first encountered CPP, solid gynecological surgical skills provided him with great help in the management of it. For many years thereafter, a set of clinical treatment theories for CPP—clinical application of Liu's incision in treating CPP was formed after years of constant accumulation and improvement. In clinical practice, approaches guided by this theory scored remarkable

therapeutic results, saving the lives of countless fetuses, preserving the uterus of countless patients and effectively lowering maternal mortality due to obstetric hemorrhage. This innovative approach has attracted many pregnant women with CPP to the Department of Obstetrics of Foshan Women and Children Hospital for treatment and has also been widely recognized and praised by domestic and foreign counterparts.

Subclassification and Atlas of Complete Placenta Previa systematically summarized Professor Liu's research on the type of complete placenta previa and the clinical application of Liu's incision over the years. Based on clinical practice, this book comprehensively discusses the theory of types of complete placenta previa, the application of Liu's incision in operations, and key points, challenges, and advanced approaches in surgery, diagnosis, anesthesia, nursing, etc. Additionally, this book combines two-dimensional surgical images, physical images, three-dimensional surgical teaching videos, and other digital resources. The combination of planar theoretical knowledge with clinical practice can help clinicians better understand and master approaches of clinical practice directly and stereoscopically. It is gratifying that, the research results, with this book as the main content, "The Establishment of Clinical Comprehensive Management System of Severe Placenta Previa" project, have won the second prize of the Scientific and Technological Achievement Award in the 2021 National Maternal and Child Health Science and Technology Awards. As an evaluation expert, I speak highly of Professor Liu's research project. Meanwhile, this book has also been selected as the publication planning project of the 14th Five-Year Plan of National Key Publications. Not only is it the recognition of his research, but also the recognition of the rationality of this book's idea, layout and content.

In a nutshell, this book, rich in forms of expression, is highly original, practical, innovative and recommendable. It is an academic masterpiece with profound academic values, high-tech tastes, and good social benefits. The publication of this book will yield theoretical and technological breakthroughs in dealing with CPP and related complex obstetric operations. It helps to make the clinical operation of CPP more predictable and available and helps to address the dilemma of greater injury of traditional operation approaches and little penetration rate of new technologies in primary hospitals. It also helps to further improve the diagnosis and treatment ability of clinicians, especially clinicians in primary hospitals, thereby reducing maternal and neonatal mortality so as to escort the well-being of mothers and fetuses!



June 2023 in Guangzhou

Foreword

Placenta previa, CPP in particular, has always been a challenging clinical issue for obstetricians and gynecologists due to its serious complications such as high placenta increta rate and massive perioperative blood loss. Directly perforate on the placenta and incisions on the upper uterus, on the uterine fundus, and on the back of the uterus are common selected incisions for operations. These incisions, however, cannot effectively lower the risks of perioperative bleeding, hysterectomy and maternal and neonatal mortality as they often bring iatrogenic placental abruption, injury to the umbilical cord and other concurrent bleeding. As an emerging approach, endovascular interventional therapy is considered to be an effective way to solve such problems. But its application is limited due to its requirements for advanced hospital infrastructure and technical skills from physicians. Obstetricians in primary hospitals often face the dilemma of "making bricks without straw. "

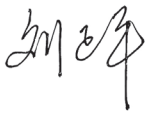
Since becoming a full-time obstetrician in 2003, I have been grappling with the challenge of discovering a straightforward, practical and effective approach distinct from traditional methods for managing the surgical incisions of CPP and its subclassifications. Combined with previous experiences in gynecological surgery, I conceived, drafted, and improved surgical incisions and classification again and again. It was not until 2004 when I visited the Queen Mary Hospital in Hong Kong that the classification of CPP and the measurement of corresponding quantitative indicators were preliminarily completed in the dormitory of the hospital, and a finalization diagram of a randomized placental edge surgical incision was designed. Upon my return, I immediately began implementing it clinically. I proposed the classification of complete placenta previa for the first time in China after many years of exploration and practice. Building on this, the principle of making incisions along the margin of the placenta on the uterine surface was established, and this incision was named Liu's incision. It is of specific significance for clinicians in selecting the type of incisions while avoiding the placenta and perforating on it when facing CPP. The classification and Liu's incision are suitable for hospitals at all levels, especially primary hospitals, due to their simplicity and convenience. Over the years, the impact of Liu's incision has been increasing through holding national continuing education training courses and popularization and application in hospitals at all levels. This technique plays an effective role in reducing postoperative bleeding of CPP, the incidence of hysterectomy, and maternal and neonatal mortality, and has been well-received by experts. This clinical research has

won the second prize of the Science and Technology Progress Award by Foshan Science and Technology Bureau and has been certified as a technology project suitable for promotion in Guangdong Province.

This book is a summary and development of the clinical application. It systematically introduces new ideas for the diagnosis and treatment of CPP and pernicious placenta previa in clinical practice in the obstetrics department of Foshan Women and Children Hospital. It details the classification of CPP and the application and clinical effect of Liu's incision in handling CPP and pernicious placenta previa. The contents are presented to readers in the form of informative texts and three-dimensional images. Videos are also provided to better explain important operations. Moreover, it also introduces issues, difficulties, latest theories and advanced technologies related to clinical epidemiology of placenta previa, placenta increta, and clinical diagnosis (including ultrasound diagnosis, MRI diagnosis, cystoscopy diagnosis, and pathological diagnosis). This book also encompasses innovative operational approaches and skills that have been put forward in our clinical practice and includes years of experience accumulated by the obstetrical team of Foshan Women and Children Hospital. We hope this book can offer great references in treating CPP, pernicious placenta previa, and related complex obstetric operations.

Looking back on the research history of the past two decades and observing the drafts and patients arriving at the hospital today, I am profoundly reminded that as an obstetrician, it is crucial to confront challenges with courage. Furthermore, it is essential to possess the determination and perseverance needed to address these challenges effectively. The persistent contemplation and exploration of the treatment for CPP have enabled the development of an innovative classification system and its corresponding diagnosis and treatment. This effort has yielded phased research results and led to the publication of this book.

I would like to extend my heartfelt gratitude to all the obstetricians and experts from relevant departments of Foshan Women and Children Hospital and the leaders and editors of South China University of Technology Press. Thank you for all the support in the preparation process of the publication. Mistakes and omissions are inevitable in this book. We welcome feedback, suggestions, and critiques from fellow professionals in obstetrics and gynecology who read the book to contribute to its refinement. If there are any issues, please contact Fan Dazhi (fandazhigw@163.com), the writing secretary of this book. It is genuinely hoped that this book proves to be immensely beneficial for healthcare professionals in the clinical field as well as pregnant and postpartum women.



June 2023

Introduction

Primary healthcare institutions mark a weak link in China's healthcare system, and the capacity building of these primary healthcare institutions has always been highly valued by the Communist Party of China (CPC) and the state. Since the 18th CPC National Congress, China has been actively implementing the Health Care Program for Poverty Alleviation, adhering to a people-centered approach in healthcare, promoting the expansion of high-quality medical resources and their balanced distribution in different regions. Efforts have been made to enhance the overall capabilities of county-level hospitals and establish long-term mechanisms for paired assistance and support. President Xi Jinping emphasized that we must first increase people's confidence and end their ignorance and illiteracy to end poverty. To end ignorance and illiteracy means to extend support in terms of knowledge, skills, and ways of thinking. Specifically for tertiary hospitals, it means assisting grassroots areas in "establishing a medical team that can stay and provide support."

Late-pregnancy vaginal bleeding induced by complete placenta previa (CPP) is one of the leading causes of maternal mortality worldwide. The traditional surgical solution is to perform a classical cesarean section incision in the lower uterine segment to avoid the placenta or perforate on the placenta directly to deliver the fetus. However, regardless of which option is chosen, it will inevitably cause some damage to the placenta and umbilical cord, leading to significant bleeding before delivery, often accompanied by iatrogenic placental abruption and other complications. This will further increase the risk of bleeding during childbirth and hypovolemic shock in newborns, resulting in an increased rate of uterine removal as well as maternal and neonatal mortality. Emerging medical technologies such as endovascular intervention treatment can effectively address this issue. However, they require advanced hospital infrastructure and technical skills from physicians, making it challenging for primary healthcare providers to learn and master these techniques.

In order to address this clinical challenge, our team has spent years exploring and practising, and for the first time, we proposed dividing CPP into four clinically significant types using ultrasound. We have developed corresponding quantitative indicators. Based on this classification, we have innovatively designed a randomized placental edge surgical incision named Liu's incision, which is performed inside the uterine cavity according to the specific direction of placenta's location. This incision provides further guidance for surgeries related to placenta previa.

This novel classification method and incision selection approach effectively address the challenge of how to avoid perforating in the placenta during CPP surgery. It minimizes the risks of intraoperative and postoperative bleeding, reduces the occurrence of uterine removal, and lowers maternal and neonatal mortality rates. This method effectively compensates for the shortcomings of traditional surgical approaches used in the past. Moreover, this classification method and the specific operation principle of Liu's incision are simple, convenient, and easy to master. During application, they do not require sophisticated hospital infrastructure or high technical skills from physicians, making it advantageous for primary healthcare providers to learn and apply. This achievement has won the Scientific and Technological Achievement Award in the 4th National Maternal and Child Health Science and Technology Awards, was certified as a technology project suitable for promotion in Guangdong Province, and received the second prize of Foshan Science and Technology Progress Award. It has also been widely applied in paired-up assistance regions such as Liangshan in Sichuan, Kashgar in Xinjiang, and Qiandongnan Prefecture in Guizhou.

This book is a summary of the aforementioned research content and original research achievements. It first proposed a refined classification method for CPP and the theoretical basis of the Liu's incision. This breakthrough overcomes the dilemma of traditional surgical incisions and approaches causing significant damage and the high learning threshold of emerging medical technologies. It provides a practical and feasible solution to effectively enhance the diagnostic and therapeutic capabilities of primary healthcare providers in complex obstetric surgeries. This approach holds significant medical significance as it reduces CPP surgery risks and improves the survival rates of pregnant women and neonates. This project possesses relatively mature experience in implementation, providing powerful medical support for grassroots communities through technological innovations. It demonstrates high practicality, innovation, and promotion value, with the aim of contributing to the "Healthy China Initiative" and improving the overall health of the population. It represents a significant contribution from Foshan Women and Children Hospital towards achieving these goals!

Editorial Committee
June, 2023

Chapter 1

Classification of Placenta Previa and Types of Complete Placenta Previa

1.1 Overview of Placenta

1.1.1 Relationship Among the Placenta, the Fetus and the Mother

The placenta is a fetal accessory organ, forming a disc-shaped structure composed of the amniotic membrane, chorion frorldosurm, and the corresponding maternal decidua basalis to the uterine fundus. The placenta serves as the central hub for substance exchanges between the fetus and the mother. The establishment of fetal-placental circulation forms the basis for material exchange between the mother and the fetus. The placenta plays an important role in endocrine activities as it can synthesize a variety of hormones, enzymes, and cytokines, among other factors, to uphold a healthy pregnancy. At the same time, the placenta acts as a selective barrier, safeguarding the fetus against the intrusion of harmful exogenous macromolecules (Figure 1.1).

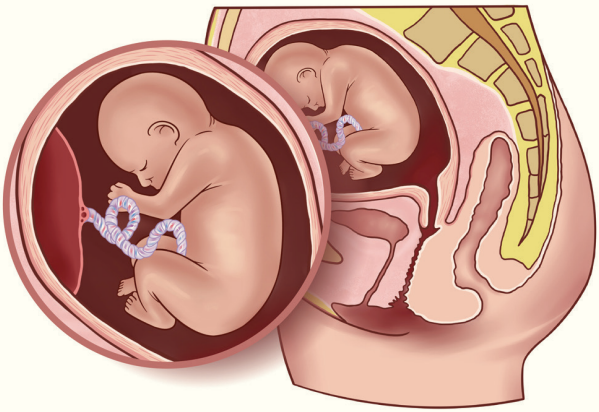


Figure 1.1 Relationship Among the Placenta, the Fetus and the Mother

1.1.2 Features of the Placenta

During normal pregnancy, the placenta begins to form at 6 to 7 weeks of gestation and is fully developed by the 12th week, occupying approximately one-third of the entire uterine

cavity. By the 16th week, it can cover half of the uterine cavity. A full-term pregnancy placenta is typically flat and round or elliptical, but can also have a heart-shaped, kidney-shaped, or irregular form; weighing between 500 g to 600 g, approximately one-sixth of the fetal weight; with a diameter of 16 cm to 20 cm and a thickness of 2.5 cm to 3.5 cm, exhibiting a central thickness and thin edges. The blood component in the placenta accounts for about one-fifth of the placenta's weight. The maternal surface appears dark red or crimson and is divided into 15 to 20 placental lobules with scattered calcification spots. The fetal surface is smooth and appears grey-white. The umbilical cord attaches to the center or slightly off-center of the placenta. Umbilical cord vessels disperse from the attachment point toward the periphery of the placenta (Figure 1.2).

In most pregnancies, the placenta is attached to the anterior wall, posterior wall, lateral wall or fundus of the uterus. External, maternal and fetal factors can lead to abnormal placental growth and development. Pathological changes raised by placental abnormalities can exert a certain impact on pregnancy outcomes. Common abnormalities of the placenta primarily involve abnormal placental attachment and abnormal placenta increta depth.

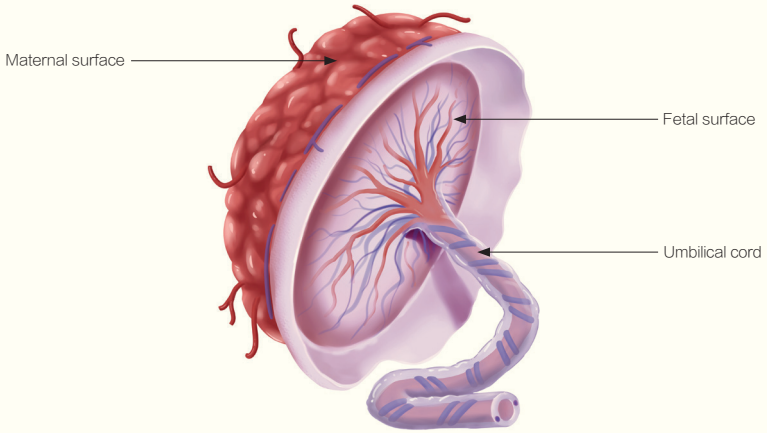


Figure 1.2 The Maternal Surface, Fetal Surface and Umbilical Cord

1.2 Introduction to Placenta Previa

1.2.1 Definition of Placenta Previa

Placenta previa refers to the condition where the placenta attaches to the lower segment of the uterus, reaches or covers the internal cervical os and is located below the presenting part of the fetus after 28 weeks of gestation (Figure 1.3). Placenta previa is one of the serious complications during pregnancy, representing a substantial cause of late pregnancy bleeding and preterm labor. It is also closely associated with maternal and fetal complications and mortality during the perinatal period.

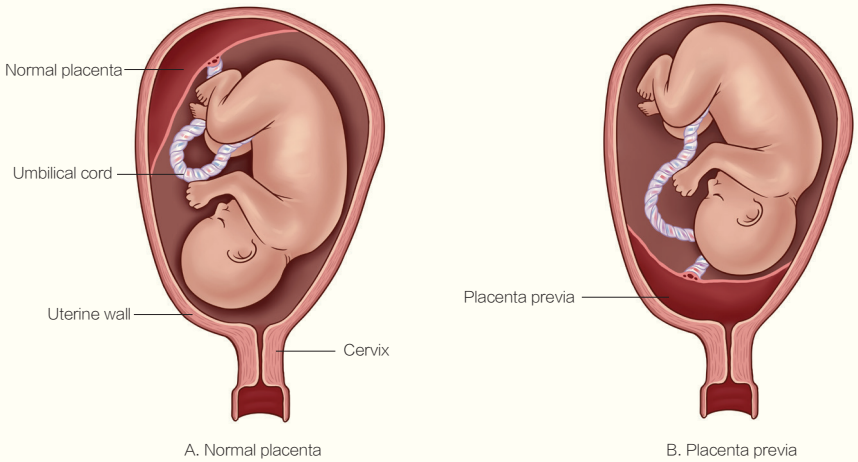


Figure 1.3 Normal Placenta and Placenta Previa

1.2.2 Pathogenesis and Incidence of Placenta Previa

The exact pathogenesis of placenta previa remains unclear, but currently, a more widely accepted view is that external, maternal and other factors lead to endometrial damage and aging. Subsequently, the embryo implants in the poorly vascularized lower segment of the uterus, wherein the placenta undergoes compensatory growth to ensure an adequate supply of

oxygen to the developing fetus. This compensatory growth results in continuous expansion of the placental area, culminating in placenta previa.

Globally, the incidence of placenta previa is 0.52% (0.45–0.59). The incidence, however, varies in different areas and regions. The highest incidence is observed among pregnant women in Asia, approximately at 1.22% (0.95–1.52). By contrast, the incidence is relatively lower in Europe, North America, and Africa, which is 0.36% (0.28–0.46), 0.29% (0.23–0.35), and 0.27% (0.03–1.1) respectively. The incidence of placenta previa in China is around 1.24% (1.12–1.36), with evident geographic disparities, especially in Hainan, Sichuan and Heilongjiang provinces (Fan et al. 2016).

1.2.3 Risk Factors of Placenta Previa

Risk factors of placenta previa include previous cesarean sections, previous miscarriages (induced abortion and spontaneous abortion), advanced maternal age, assisted reproductive technology, endometriosis, male fetus, smoking, and cocaine intake during pregnancy, etc. (Table 1.1) (Jenabi et al. 2022). Among them, previous cesarean sections increase the risk of placenta previa, and the risk is positively correlated with the number of cesarean sections.

Table 1.1 Partial Risk Factors and Size of Placenta Previa

Risk Factors	*OR* (95% *CI*)
Previous cesarean sections	1.60 (1.44–1.76)
Induced abortion	1.36 (1.02–1.69)
Spontaneous abortion	1.77 (1.60–1.94)
Advanced maternal age	3.16 (2.79–3.57)
Assisted reproductive technology	3.71 (2.67–5.16)
Endometriosis	3.03 (1.50–6.13)
Male fetus	1.20 (1.20–1.30)
Smoking	1.42 (1.30–1.54)
Cocaine intake during pregnancy	2.90 (1.90–4.30)

1.2.4 Clinical Manifestations of Placenta Previa

Placenta previa is mainly characterized by recurrent vaginal bleeding without inducement or pain in the third trimester of pregnancy or after labor. The incidence of this kind of

prenatal bleeding is about 51.6% (42.7–60.6). The physical signs of pregnant women are mainly related to the amount and speed of bleeding. Anemia may occur in gravidas with repeated bleeding. They may show a pale complexion, rapid and weak pulse, decreased blood pressure and other shock manifestations due to massive hemorrhage. Hemorrhagic shock can be observed in acute massive hemorrhage. Abdominal examinations reveal a soft uterus without tenderness, with a size consistent with the gestational weeks. Intermittent uterine contractions may occur, with complete hysteranesis during the intervals. Additionally, there might be presentations of breech or other abnormal fetal positions.

Placenta previa can also lead to intrapartum or postpartum hemorrhage and puerperal infection, which can result in adverse maternal and fetal outcomes, such as premature birth, fetal growth restriction, intrauterine hypoxia and even intrauterine fetal demise. Currently, it is believed that the occurrence time, amount and frequency of vaginal bleeding are closely associated with the types of placenta previa.

1.2.5 Authoritative Classification of Placenta Previa

In terms of the classification of placenta previa, most countries worldwide classify it according to the relationship between the lower edge of the placenta and the internal os.

1.2.5.1 Classification in the 9th Edition of *Obstetrics and Gynecology* (Xie, Kong, and Duan 2018)

Based on the last antepartum ultrasound findings, placenta previa is divided into the following four categories according to the relationship between the lower edge of the placenta and internal os. They are complete placenta previa, partial placenta previa, marginal placenta previa and low-lying placenta (Figure 1.4).

(1) Complete placenta previa (CPP): It also termed central placenta previa, refers to the condition where placental tissue completely covers the internal os.

(2) Partial placenta previa: It means that placental tissue partially covers the internal os.

(3) Marginal placenta previa: It means that the lower edge of the placenta attaches to the lower segment of the uterus, extending to the internal os without surpassing it.

(4) Low-lying placenta: It means that the placenta attaches to the lower segment of the uterus, with its edge positioned less than 2 cm away from the internal os.

1.2.5.2 Classification in the 25th Edition of *Williams Obstetrics* (Cunningham et al. 2020)

Based on the relationship between the placenta and the internal os, placenta previa is divided into the following five categories: complete placenta previa, partial placenta previa, marginal placenta previa, low-lying placenta and vasa previa (Figure 1.5).