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畸形精子症实验室检测临床实践指南 (2026 版)

中国医师协会生殖医学专业委员会生殖男科学组

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【摘要】 在中国, 约有 18% 的夫妇受不孕不育问题困扰, 其中男性因素不孕比例为 40%~50%。男性不育的致病因素复杂多样, 其中精子质量异常是主要原因之一。畸形精子症作为男性不育的重要病因, 其诊断依赖于实验室对精子形态的精准评估。目前, 畸形精子症的诊断面临诸多挑战, 包括临床认知有待提升、诊断标准与检测方法不统一、实验室技术人员专业水平存在差异且结果判读主观性较强、诊断流程尚未形成标准化体系、病因学检测不足、报告解读缺乏统一指引以及实验室与临床沟通协作不畅等问题。鉴于此, 中国医师协会生殖医学专业委员会生殖男科学组牵头, 组织多学科、多中心专家参与, 基于循证证据共同制定了本指南。本指南遵循国际、国内指南制定与报告规范, 旨在为畸形精子症实验室检测及临床实践提供推荐意见。

【关键词】 不育, 男性; 畸形精子症; 实验室诊断; 辅助生殖; 指南

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Clinical practice guideline for laboratory testing of teratozoospermia (2026)

Reproductive Andrology Group, Reproductive Medicine Professional Committee of Chinese Medical Doctor Association

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【 Abstract 】 Approximately 18% of couples in China are affected by infertility, of which the male factor accounts for approximately 40%–50%. Numerous factors contribute to male infertility, among which abnormal sperm quality is the primary one. Teratozoospermia is a predominant cause of male infertility, and its diagnosis relies on precise laboratory evaluation of sperm morphology. Currently, the diagnosis of teratozoospermia faces several challenges, including insufficient clinical awareness, inconsistent diagnostic criteria and methods, variability in technical proficiency among laboratory personnel coupled with subjective interpretation of results, lack of standardized diagnostic processes, inadequate etiological testing, absence of uniform guidelines for report interpretation, and poor coordination between laboratories and clinical departments. In light of this, the Reproductive Andrology Group of the Reproductive Medicine Professional Committee of Chinese Medical Doctor Association has initiated the development of this guideline, incorporating multidisciplinary and multicentre experts, following evidence-based methodology. This guideline adheres to the existing international and domestic guideline development and reporting standards, providing recommendations for laboratory testing and clinical practice regarding teratozoospermia.

【 Key words 】 Infertility, male; Teratozoospermia; Laboratory diagnosis; Assisted reproduction; Guideline

Fund program: National Key Research and Development Program of China (2023YFC2705504, 2024YFC2706900); Key Research & Development Program of Hubei Province (2025BCB016); Fujian Science and Technology Plan Project (2023D017)

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生殖免疫学的发展与思考

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【摘要】 生殖免疫学自 1953 年 Medawar 提出“妊娠免疫学悖论”以来, 经历了从经典免疫假说到循证医学转型的发展历程。早期的保护性抗体假说和辅助性 T 细胞 (helper T cell, Th) 1/Th2 范式推动了免疫治疗在生殖医学中的广泛应用, 但由于缺乏高质量随机对照试验 (randomized controlled trial, RCT) 证据, 经验性免疫治疗的有效性受到持续质疑。大规模 RCT 进一步表明, 泼尼松在反复种植失败患者中未能改善活产率, 凸显了“全身免疫抑制”策略应对“局部免疫调控”需求的根本性局限。与此同时, 技术进步为深入解析相关机制提供了新的研究手段与机遇。近三年来, 该领域在四个方向取得了重要进展: ①母胎界面的空间多组学解析, 包括早孕期时空图谱构建、CCR8 阳性蜕膜调节性 T 细胞 (regulatory T cell, Treg) 亚群的鉴定等; ②免疫代谢与母胎耐受, 揭示了 CD36 介导的脂质代谢通路在流产发病中的作用; ③训练免疫与表观遗传调控, “妊娠训练型蜕膜自然杀伤细胞”被证实具有增强的抗感染保护功能; ④微嵌合体与妊娠免疫记忆, 发现胎儿微嵌合细胞在多次妊娠间的替换规律及其与 Treg 维持的关联。在临床规范层面, 国内外指南与共识体系也在同步演进, 为基础发现向临床转化提供了循证依据。本文系统梳理了生殖免疫学的发展脉络、当前面临的转化困境以及前沿研究方向, 并就精准免疫干预策略的未来路径进行了讨论。

【关键词】 生殖免疫学; 母胎界面; 免疫耐受; 免疫代谢; 反复妊娠丢失; 反复种植失败

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Reproductive immunology: where we stand and where we are heading

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【Abstract】 Reproductive immunology has evolved considerably since Medawar posed the "immunological paradox of pregnancy" in 1953, transitioning from classical immune hypotheses to an evidence-based discipline. Early conceptual models, including the protective antibody hypothesis and the helper T cell (Th) 1/Th2 paradigm, facilitated the rapid clinical adoption of empirical immunotherapies. However, the lack of high-quality randomized controlled trial (RCT) evidence has led to sustained scrutiny of their efficacy. The largest RCT to date demonstrated no benefit of prednisone over placebo for live birth rates in patients with recurrent implantation failure, underscoring the fundamental mismatch between systemic immunosuppression and the compartmentalized

nature of immune regulation at the maternal-fetal interface. Meanwhile, technological advances have opened new avenues for mechanistic investigation. Over the past three years, notable progress has been made in four areas: 1) spatial multi-omics dissection of the maternal-fetal interface, including spatiotemporal atlas construction in early pregnancy and the identification of CCR8-positive decidual regulatory T cells (Treg); 2) immunometabolism and maternal-fetal tolerance, revealing the role of CD36-mediated lipid metabolic pathways in miscarriage pathogenesis; 3) trained immunity and epigenetic regulation, with pregnancy-trained decidual natural killer cells shown to confer enhanced antimicrobial protection; and 4) microchimerism and pregnancy immune memory, uncovering the displacement dynamics of fetal microchimeric cells across successive pregnancies and their association with Treg maintenance. On the clinical front, national and international guidelines and consensus statements have also been updated in parallel, progressively strengthening the evidence base for translating basic discoveries into practice. In this paper, we outline the developmental trajectory of the field, examine the translational challenges it currently faces, and discuss future directions toward precision immune intervention in reproductive medicine.

【Key words】 Reproductive immunology; Maternal-fetal interface; Immune tolerance; Immunometabolism; Recurrent pregnancy loss; Recurrent implantation failure

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生殖免疫专栏

生殖免疫专栏导读

1953年, Peter Medawar 提出“妊娠免疫学悖论”, 开启了一个至今仍未被完全回答的追问: 携带父源抗原的胎儿何以在母体内免遭排斥? 七十余年来, 从 Th1/Th2 范式到单细胞组学时代的精准分型, 生殖免疫学在争议与自我修正中不断生长。近年来, 免疫代谢、训练免疫、微嵌合体等新方向的涌现, 正在重塑我们对生殖免疫网络的理解。与此同时, 基础发现与临床转化之间的距离依然是学科面临的核心难题。

本期“生殖免疫专栏”汇集国内多个机构中青年学者的综述成果, 涵盖母胎界面免疫细胞功能解析、反复种植失败中的免疫异常机制与靶向治疗、系统性红斑狼疮和抗磷脂综合征对女性生殖功能的影响、子宫内膜菌群与子宫衰老的关系、宫腔粘连防治中隔离屏障的应用, 以及睾丸巨噬细胞在炎症转归与纤维化中的角色等主题, 系统呈现了母胎界面免疫调控的最新研究进展, 希望能够为反复种植失败等生殖免疫相关疾病的临床诊疗提供理论依据与策略参考, 促进基础研究成果向临床实践的转化应用。

我们所知道的, 远少于我们不知道的。希望本专栏能提供一些新的切入点, 也期待与更多同行一起继续探索。

专栏责任编委 刁梁辉 (深圳中山妇产医院)

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妊娠早期母胎界面的免疫代谢调控机制研究进展

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【摘要】 妊娠早期母胎界面的免疫代谢微环境对妊娠建立与维持至关重要。本文系统综述了母胎界面关键细胞（包括蜕膜免疫细胞与滋养层细胞）的免疫代谢调控网络及其在复发性流产（recurrent spontaneous abortion, RSA）中的病理机制。在生理状态下，蜕膜巨噬细胞、自然杀伤细胞及中性粒细胞通过精密的代谢重编程（如糖酵解、氧化磷酸化、嘌呤代谢）维持其功能极化与动态平衡，并与滋养层细胞通过人类白细胞抗原分子识别、细胞因子通信及代谢物交换（如乳酸、腺苷）建立免疫耐受。然而，在RSA病理过程中，该网络发生多重失调，如巨噬细胞向M1促炎表型极化以及滋养层细胞因代谢-表观遗传调控异常而侵袭受阻等。本文旨在综述母胎界面关键细胞生理机制与病理发现，阐明免疫代谢紊乱在RSA发病中的核心作用，为开发靶向免疫代谢的干预策略提供参考。

【关键词】 巨噬细胞； 流产，习惯性； 母胎界面； 免疫代谢； 滋养层细胞

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Progress in immunometabolic regulation mechanisms at the maternal-fetal interface during early pregnancy

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【Abstract】 The immunometabolic microenvironment at the maternal-fetal interface during early pregnancy is essential for the establishment and maintenance of gestation. This review systematically summarizes the immunometabolic regulatory networks governing key cellular components of the interface, including decidual immune cells and trophoblasts, and delineates their pathological mechanisms in recurrent spontaneous abortion (RSA). Under physiological conditions, decidual macrophages, natural killer cells, and neutrophils undergo precise metabolic reprogramming (such as glycolysis, oxidative phosphorylation and purine metabolism) to sustain lineage-specific

functional polarization and dynamic homeostasis. Through human leukocyte antigen-mediated recognition, cytokine communication, and the exchange of metabolites such as lactate and adenosine, these cells cooperate with trophoblasts to establish immune tolerance. However, in RSA, this network becomes multi-level dysregulated, characterized by macrophage skewing toward a pro-inflammatory M1 phenotype and impaired trophoblast invasion driven by aberrant metabolism-epigenetic coupling. This review aims to summarize both physiological mechanisms and pathological findings, underscoring the central role of immunometabolic disruption in RSA and offering perspectives for developing therapeutic strategies targeting cellular metabolism at the maternal-fetal interface.

【Key words】 Macrophage; Abortion, habitual; Maternal-fetal interface; Immunometabolism; Trophoblast

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母胎界面免疫细胞异常在不明原因反复种植失败中的作用机制及靶向治疗研究进展

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【摘要】 反复种植失败 (recurrent implantation failure, RIF) 是辅助生殖技术临床应用中的核心难题, 其中 30%~50% 的患者发病原因尚不明确, 被定义为不明原因 RIF (unexplained RIF, uRIF), 其临床管理缺乏明确的干预靶点。胚胎成功着床依赖于母胎界面精细的免疫调控网络, 该网络失衡是 uRIF 的重要发病机制之一。自然杀伤细胞、巨噬细胞及 T 淋巴细胞是母胎界面核心免疫组分, 通过调控炎症反应、血管重塑及免疫耐受共同维持着床稳态。本文系统阐述上述免疫细胞在正常胚胎着床中的生理功能及其在 uRIF 状态下的异常改变, 探讨免疫细胞功能紊乱与雌孕激素信号异常、局部代谢微环境改变之间的交互作用, 并在此基础上归纳现有免疫干预策略及其疗效证据。通过系统梳理相关免疫机制与临床证据, 以期对 uRIF 的机制研究及个体化临床管理提供理论参考。

【关键词】 自然杀伤细胞； 巨噬细胞； T 淋巴细胞； 免疫治疗； 反复种植失败； 母胎界面； 免疫微环境

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Role of immune cell abnormalities at the maternal-fetal interface in unexplained recurrent implantation failure and progress in targeted therapy

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【Abstract】 Recurrent implantation failure (RIF) is a core challenge in the clinical application of assisted reproductive technology. Among these cases, 30%–50% have unknown etiologies and are defined as unexplained RIF (uRIF), for which clinical management lacks clear therapeutic targets. Successful embryo implantation depends on the finely-tuned immune network at the maternal-fetal interface, and dysregulation of this network is one of the important pathogenic mechanisms of uRIF. Natural killer cells, macrophages, and T lymphocytes serve as core immune components at the maternal-fetal interface, maintaining implantation homeostasis through the coordinated regulation of inflammatory responses, vascular remodeling, and immune tolerance. This review systematically describes the physiological functions of these immune cells during normal embryo implantation and their pathological alterations in the context of uRIF, explores the interplay between immune cell dysfunction and abnormalities in estrogen/progesterone signaling as well as changes in the local metabolic microenvironment, and summarizes existing immunomodulatory interventions and their therapeutic evidence. By systematically synthesizing the relevant immune mechanisms and clinical evidence, this review aims to provide a theoretical reference for mechanistic research and individualized clinical management of uRIF.

【 Key words 】 Natural killer cells; Macrophages; T lymphocytes; Immunotherapy; Recurrent implantation failure; Maternal-fetal interface; Immune microenvironment

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蜕膜巨噬细胞在复发性自然流产中的代谢调控机制及临床干预策略

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【摘要】 作为蜕膜组织中第二大类免疫细胞, 蜕膜巨噬细胞参与胚胎植入、胎盘血管重铸、母胎耐受建立等多个妊娠相关过程。蜕膜巨噬细胞的极化及功能异常与复发性自然流产相关。近年来, 研究发现代谢重编程通过调控糖酵解、脂肪酸氧化及氨基酸代谢等关键通路, 影响巨噬细胞的极化倾向及功能, 已成为连接免疫与代谢的重要机制。阐明代谢重编程如何导致蜕膜巨噬细胞功能异常并据此开发靶向代谢的精准干预策略, 有望为复发性自然流产的诊治提供新视角和新策略。

【关键词】 巨噬细胞; 代谢重编程; 复发性自然流产

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Metabolic regulation mechanisms of decidual macrophages in recurrent spontaneous abortion and clinical intervention strategies

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【Abstract】 As the second most abundant immune cells in the decidua, decidual macrophages participate in embryo implantation, placental vascular remodeling, and the establishment of maternal-fetal tolerance. Dysregulation of decidual macrophage polarization and function contributes to recurrent spontaneous abortion (RSA) pathogenesis. Recent evidence shows that metabolic reprogramming, which modulates key pathways such as glycolysis, fatty acid oxidation, and amino acid metabolism, critically influences macrophage functions, thereby serving as a crucial link between immunity and metabolism. Elucidating how metabolic reprogramming induces dysfunction of decidual macrophages and developing metabolism-targeted precision intervention strategies hold promise for providing new perspectives and strategies for the diagnosis and treatment of RSA.

【 Key words 】 Macrophage; Metabolic reprogramming; Recurrent spontaneous abortion

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子宫蜕膜自然杀伤细胞调控免疫微环境参与妊娠相关疾病发生的研究进展

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【摘要】 母胎界面免疫微环境的动态平衡是调控妊娠进程的关键因素之一。子宫蜕膜自然杀伤 (decidual natural killer, dNK) 细胞作为母胎界面的核心免疫细胞, 在维持免疫微环境稳态中发挥着不可替代的作用。近年来, 研究表明 dNK 细胞与蜕膜巨噬细胞、T 淋巴细胞、滋养层细胞、血管细胞及基质细胞等构建出精密的细胞间互作网络, 调控子宫内膜容受性、胚胎着床及螺旋动脉重塑等核心生理过程。当免疫微环境失衡时, 易诱发复发性流产、子痫前期及反复种植失败等妊娠相关疾病。本文对 dNK 细胞与母胎界面关键细胞的互作机制及其在妊娠相关疾病发生中的作用进行综述, 以期为相关疾病的机制研究及临床诊疗提供参考。

【关键词】 母胎界面; 子宫自然杀伤细胞; 免疫微环境; 细胞互作; 妊娠相关疾病

Research progress on the regulation of immune microenvironment by uterine decidual natural killer cells and their involvement in the occurrence of pregnancy-related diseases

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【Abstract】 The dynamic balance of the maternal fetal interface immune microenvironment is one of the key factors regulating the pregnancy process. Uterine decidual natural killer (dNK) cells, as the core immune cells at the maternal-fetal interface, play an irreplaceable role in maintaining the homeostasis of the immune microenvironment. In recent years, studies have shown that dNK cells construct a precise intercellular interaction network with decidual macrophages, T lymphocytes, trophoblast cells, vascular cells, and stromal cells, regulating core physiological processes such as endometrial receptivity, embryo implantation, and spiral artery remodeling. When the immune microenvironment is imbalanced, it is easy to induce pregnancy-related diseases such as recurrent spontaneous abortion, preeclampsia, and recurrent implantation failure. This article reviews the interaction mechanisms between dNK cells and other primary cells at the maternal-fetal interface, as well as their role in the pathogenesis of pregnancy-related diseases, in order to provide reference for the mechanism research and clinical diagnosis and treatment of these diseases.

【Key words】 Maternal-fetal interface; Uterine natural killer cells; Immune microenvironment; Cell interaction; Pregnancy-related diseases

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系统性红斑狼疮对女性卵巢功能的影响

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【摘要】 系统性红斑狼疮 (systemic lupus erythematosus, SLE) 是一种好发于育龄期女性的慢性多系统自身免疫性疾病。尽管治疗手术的进步显著提升了患者长期生存率, 但其对女性生殖系统尤其是卵巢功能的损害尤为突出, 已成为临床诊疗中的一个难题。本文系统梳理了 SLE 相关卵巢功能障碍的现有研究证据, 并重点阐述了保护生育力的新兴策略。与健康人群相比, SLE 患者月经紊乱、卵巢储备功能减退及早发性卵巢功能不全的发病率均显著升高。然而, 该疾病与月经初潮年龄、绝经年龄及卵巢癌风险之间的关联仍存争议。从发病机制来看, SLE 诱发的卵巢功能损害是自身免疫损伤、内分泌紊乱和药物 (尤其是环磷酰胺) 诱导的性

腺毒性三者共同作用的结果，其中环磷酰胺所致的性腺毒性尤为显著。本综述强调临床应将积极的卵巢功能监测与生育力保护策略（如促性腺激素释放激素激动剂应用、辅助生殖技术等）纳入育龄期 SLE 患者的常规诊疗方案。通过构建面向临床的诊疗框架，本文旨在为 SLE 女性的健康监测与生殖管理提供循证依据。

【关键词】 红斑狼疮，系统性； 早发性卵巢功能不全； 环磷酰胺； 卵巢储备功能减退

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Impact of systemic lupus erythematosus on ovarian function in females

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【Abstract】 Systemic lupus erythematosus (SLE) is a chronic multisystem autoimmune disease that occurs frequently in women of reproductive age. Although advances in treatment have significantly improved long-term survival, SLE continues to pose substantial risks to the female reproductive system, particularly ovarian function, representing a major clinical challenge. This review systematically synthesizes current evidence on SLE-associated ovarian dysfunction and highlights emerging strategies for fertility preservation. Key findings confirm that SLE patients exhibit a higher prevalence of menstrual disorders, diminished ovarian reserve, and premature ovarian insufficiency compared with the healthy population. In contrast, associations between SLE and menarcheal age, menopausal age, or ovarian cancer risk continue to be debated. Mechanistically, ovarian impairment involves a triad of autoimmune injury, endocrine dysregulation, and medication-induced gonadotoxicity, most notably from cyclophosphamide. Importantly, this review underscores the necessity of integrating proactive ovarian monitoring and fertility preservation approaches, such as gonadotropin-releasing hormone agonists and assisted reproductive technologies, into the routine care of reproductive-aged SLE patients. By providing a clinically oriented framework, this review aims to inform evidence-based management that safeguards both health and fertility in women with SLE.

【 Key words 】 Lupus erythematosus, systemic; Premature ovarian insufficiency; Cyclophosphamide; Diminished ovarian reserve

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内膜菌群在子宫衰老中的作用与研究进展

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【摘要】 近年来, 内膜菌群作为除免疫、血管和内分泌等传统因素外的“新型器官”, 其在维持子宫内膜组织稳态中的作用日益受到关注。多项研究表明, 内膜菌群失调可能通过诱发慢性炎症反应、扰乱局部免疫微环境以及干扰上皮细胞正常功能等多种途径, 进而加速子宫衰老的进程。因此, 针对内膜菌群进行靶向调控, 有望成为延缓子宫衰老、改善子宫内膜容受性的一种新兴治疗策略。本文对子宫内膜菌群的基本组成特征及其与子宫衰老之间的相互作用机制进行了系统综述, 并对以菌群为靶点的干预策略研究进展作出展望, 以期改善生殖结局提供新的思路。

【关键词】 子宫内膜; 菌群; 子宫衰老; 生殖医学

基金项目: 国家重点研发计划(2022YFC2702501); 国家自然科学基金(82225019)

Role of endometrial microbiota in uterine aging: current research and advances

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【 Abstract 】 In recent years, the endometrial microbiota has gained increasing recognition as a "new organ" crucial in maintaining endometrial homeostasis, alongside traditional factors such as immunity, vascular function, and endocrine regulation. Emerging evidence suggests that dysbiosis of the endometrial microbiota may accelerate uterine aging through multiple mechanisms, including the induction of chronic inflammation, disruption of the local immune microenvironment, and impairment of epithelial cell function. Consequently, targeted modulation of the microbiota holds promise as a novel therapeutic strategy to delay uterine aging and enhance endometrial receptivity. This article aims to systematically elucidate the fundamental characteristics of the endometrial microbiota and its mechanistic interactions with uterine aging, while also offering perspectives on recent advances in microbiota-targeted interventions. Ultimately, it seeks to provide new insights for improving reproductive outcomes.

【 Key words 】 Endometrium; Microbiota; Uterine aging; Reproductive medicine

Fund program: National Key Research and Development Program of China (2022YFC2702501); National Natural Science Foundation of China (82225019)

生殖免疫专栏

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宫腔粘连防治中隔离屏障的应用研究进展及其免疫调控机制

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【摘要】 宫腔粘连多由宫腔手术或感染所诱发, 是一种可严重影响女性生育力的常见妇科疾病, 目前临床上首选宫腔镜下宫腔粘连分离术作为治疗, 但由于术后较高的粘连复发率, 术后应用隔离屏障类材料已成为预防粘连复发的关键。本文就宫腔粘连防治所应用的隔离屏障类型, 包括物理屏障(如宫内节育器、球囊、防粘连膜、机械支架)和生物屏障(如水凝胶、生物支架、羊膜)进行综述, 分析其特性及机制, 评估其在预防再粘连、促进内膜修复方面疗效, 以期防粘连屏障选择提供参考, 推动宫腔粘连防治向精准化、个性化发展。

【关键词】 宫腔粘连; 预防再粘连; 子宫内膜修复; 免疫调节

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Research progress on the application of isolation barriers in the prevention and treatment of intrauterine adhesions and their immunoregulatory mechanisms

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【Abstract】 Intrauterine adhesions, often induced by uterine surgery or infection, are a common gynecological condition that can severely impact female fertility. Currently, hysteroscopic transcervical resection of adhesion is the preferred clinical treatment. However, due to the high recurrence rate of adhesions postoperatively, the application of barrier materials has become crucial for preventing adhesion recurrence. This article reviews the types of barrier materials used in the prevention and treatment of intrauterine adhesions, including physical

barriers (such as intrauterine devices, balloons, anti-adhesion membranes, and mechanical scaffolds) and biological barriers (such as hydrogels, biological scaffolds, and amniotic membranes), analyzes their characteristics and mechanisms, evaluates their efficacy in preventing re-adhesion and promoting endometrial repair, aiming to provide references for the selection of anti-adhesion barriers and promote the development of precise and personalized approaches for the prevention and treatment of intrauterine adhesions.

【 Key words 】 Intrauterine adhesions; Re-adhesion prevention; Endometrial repair; Immunomodulation

Fund program: National Natural Science Foundation of China (82371636)

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睾丸巨噬细胞在睾丸炎症转归与纤维化进程中的作用机制及临床意义

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【摘要】 睾丸巨噬细胞 (testicular macrophage, TM) 作为睾丸免疫微环境中的核心免疫细胞, 对维持睾丸免疫稳态和调节炎症反应至关重要。随着生殖免疫学的不断发展, 越来越多的研究揭示了 TM 在睾丸炎症发生、发展及纤维化过程中的关键作用, 这些病理变化严重影响睾丸功能和男性生殖健康。然而, 目前对于其具体的免疫调节机制及介导纤维化的信号通路尚不完全清楚, 限制了临床干预手段的优化。本综述旨在系统阐述 TM 的生物学特性, 包括其起源、分布、表型特征和功能分化, 并深入分析 TM 在炎症环境中如何通过复杂的分子信号通路与其他细胞相互作用, 从而启动、介导炎症反应并驱动纤维化进程。此外, 本综述结合最新临床研究进展, 评估 TM 作为诊断生物标志物和潜在治疗靶点的价值, 以期为睾丸炎症及纤维化相关疾病的诊断、治疗和临床转化提供理论基础和新的研究方向。

【关键词】 不育; 男性; 睾丸巨噬细胞; 睾丸炎症; 纤维化; 免疫调节; 靶向治疗

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Role of testicular macrophages in the resolution of testicular inflammation and fibrosis: mechanisms and clinical implications

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【 Abstract 】 As pivotal components of the testicular immune microenvironment, testicular macrophages (TM) play an essential role in maintaining immune homeostasis and orchestrating inflammatory responses. Recent advances in reproductive immunology have highlighted the critical involvement of TM in driving the initiation, progression, and eventual fibrosis of testicular inflammation — pathological changes that significantly compromise testicular function and male reproductive health. Despite this, the precise immunoregulatory mechanisms and the signaling cascades driving fibrosis remain elusive, thereby hindering the development of optimized clinical interventions. This review systematically elucidates the biological characteristics of TM, covering their ontogeny, distribution, phenotypes, and functional plasticity. We further dissect the complex molecular signaling pathways through which TM interact with resident cells to initiate and mediate inflammation and propagate fibrotic remodeling. Finally, by synthesizing emerging clinical evidence, we evaluate the potential of TM as diagnostic biomarkers and therapeutic targets. This review aims to provide a theoretical foundation and identify novel directions for the diagnosis, management, and translational research of testicular inflammation and fibrosis-associated disorders.

【 Key words 】 Infertility, male; Testicular macrophage; Testicular inflammation; Fibrosis; Immunomodulation; Targeted therapy

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·临床报道·

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PPOS 与 GnRH 拮抗剂方案在 PGT-A 周期助孕结局的比较

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【摘要】 目的 研究高孕激素状态下促排卵 (progesterone primed ovarian stimulation, PPOS) 方案与促性腺激素释放激素拮抗剂 (gonadotropin-releasing hormone antagonist, GnRH-A) 方案对胚胎植入前非整倍体遗传学检测 (preimplantation genetic testing for aneuploidy, PGT-A) 周期助孕结局的影响。**方法** 本研究为单中心回顾性队列研究, 根据纳入排除标准筛选后, 纳入 2018 年 1 月至 2025 年 1 月于郑州大学第三附属医院生殖健康医院接受 PGT-A 检测且采用 PPOS 或 GnRH-A 方案促排卵的 1 092 个助孕周期。对两组人群的基线数据进行 1:1 倾向性评分匹配 (propensity score matching, PSM)。最终, PPOS 组和 GnRH-A 组各纳入 307 个助孕周期。主要结局为累积活产率 (cumulative live birth rate, CLBR), 次要结局包括促排卵指标、胚胎实验室相关指标和首次冻融胚胎移植 (frozen-thawed embryo transfer, FET) 的助孕结局 (包括妊娠结局、产科结局和新生儿结局)。**结果** PSM 后, PPOS 组的保守估计 CLBR [48.00% (60/125)]、乐观估计 CLBR [78.40% (98/125)] 与 GnRH-A 组 [44.17% (72/163), $P=0.518$; 68.71% (112/163), $P=0.067$] 相比, 差异均无统计学意义。促排卵和胚胎实验室相关指标结局中, PPOS 组的双原核卵裂率 [98.68% (1 575/1 596)]、无整倍体囊胚周期率 [59.28% (182/307)], 与 GnRH-A 组 [97.78% (1 763/1 803), $P=0.048$; 46.91% (144/307), $P=0.002$] 相比, 第 3 天优质胚胎率 [54.48% (858/1 575)]、可利用囊胚形成率 [46.76% (657/1 405)] 与 GnRH-A 组 [61.03% (1 076/1 763), $P<0.001$; 50.84% (815/1 603), $P=0.026$] 相比, 但整倍体囊胚率和促排卵指标差异均无统计学意义 (均 $P>0.05$)。首次 FET 的妊娠结局、围产期结局和新生儿结局差异均无统计学意义 (均 $P>0.05$)。**结论** 在 PGT-A 周期中, PPOS 方案和 GnRH-A 方案在 CLBR、促排卵指标及首次 FET 助孕结局方面相当, 但 PPOS 方案中无整倍体囊胚周期率显著增加。

【关键词】 胚胎植入前非整倍体遗传学检测; 高孕激素状态下促排卵; 促性腺激素释放激素拮抗剂; 累积活产率

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Comparison of assisted reproductive outcomes between PPOS and GnRH antagonist protocols in PGT-A cycles

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【Abstract】 Objective To evaluate the impact of progesterone-primed ovarian stimulation (PPOS) versus gonadotropin-releasing hormone antagonist

(GnRH-A) protocols on assisted reproductive outcomes in preimplantation genetic testing for aneuploidy (PGT-A) cycles. **Methods** This single-center retrospective cohort study included 1 092 assisted reproductive cycles that underwent PGT-A and controlled ovarian stimulation with either the PPOS or GnRH-A protocol between January 2018 and January 2025 at the Reproductive Health Hospital, Third Affiliated Hospital of Zhengzhou University. Propensity score matching (PSM) at a 1 : 1 ratio was performed to balance baseline characteristics, resulting in 307 matched cycles per group. The primary outcome was cumulative live birth rate (CLBR). Secondary outcomes included ovarian stimulation outcomes, embryological outcomes, and assisted reproductive outcomes of the first frozen-thawed embryo transfer (FET), covering pregnancy, obstetric, and neonatal results. **Results** After PSM, no significant differences were observed between the PPOS and GnRH-A groups in conservative CLBR [48.00% (60/125) vs. 44.17% (72/163), $P=0.518$] or optimistic CLBR [78.40% (98/125) vs. 68.71% (112/163), $P=0.067$]. In ovarian stimulation and embryological outcomes, compared with the GnRH-A group, the PPOS group showed a slightly higher two pronuclei cleavage rate [98.68% (1 575/1 596) vs. 97.78% (1 763/1 803), $P=0.048$] and a higher rate of cycles without euploid blastocysts [59.28% (182/307) vs. 46.91% (144/307), $P=0.002$], but lower rates of day 3 high-quality embryos [54.48% (858/1 575) vs. 61.03% (1 076/1 763), $P<0.001$], and usable blastocyst formation [46.76% (657/1 405) vs. 50.84% (815/1 603), $P=0.026$], while the euploid blastocyst rate and ovarian stimulation indices were comparable (all $P>0.05$). Pregnancy, obstetric, and neonatal outcomes of the first FET cycle did not differ significantly between the two groups (all $P>0.05$). **Conclusion** In PGT-A cycles, there were no significant differences between the PPOS and GnRH-A stimulation protocols in terms of CLBR, ovarian stimulation outcomes, or the results of the first FET. However, the PPOS protocol showed a significantly higher rate of cycles without euploid blastocysts.

【 Key words 】 Preimplantation genetic testing for aneuploidy; Progesterone-primed ovarian stimulation; Gonadotropin-releasing hormone antagonist; Cumulative live birth rate

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综述

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输卵管间质部妊娠的诊疗与生育力保护：焦点与进展

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【摘要】 输卵管间质部妊娠 (interstitial ectopic pregnancy, IEP) 是一种罕见但高风险的异位妊娠类型，其破裂后出血迅猛、死亡率高。目前其诊疗仍面临早期诊断困难、治疗方案个体化选择及生育力保护等多重挑战。本文聚焦现有诊疗方案的局限性、最新研究进展及对生育功能的影响三个关键维度，重点探讨影像学技术进步、新型生物标志物探索及微创手术发展对 IEP 诊疗的推动意义，旨在为临床提供更具指导性的诊疗思路。

【关键词】 输卵管间质部妊娠； 治疗； 生育力保护

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Diagnosis, treatment and fertility preservation in interstitial ectopic pregnancy: focus and progress

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【Abstract】 Interstitial ectopic pregnancy (IEP) is a rare but high-risk type of ectopic pregnancy, characterized by rapid and profuse hemorrhage upon rupture and high mortality rate. Currently, its diagnosis and management remain challenging due to challenges in early diagnosis, the need for individualized treatment approaches, and concerns regarding fertility preservation. This review focuses on three key dimensions: the limitations of current diagnostic and therapeutic strategies, the latest research progress, and the impact on reproductive outcomes. It particularly highlights the role of advances in imaging technology, the exploration of novel biomarkers, and the development of minimally invasive surgical techniques in advancing the diagnosis and management of IEP, aiming to provide evidence-based clinical guidance.

【Key words】 Interstitial ectopic pregnancy; Treatment; Fertility protection

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综述

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针刺治疗卵巢储备功能下降的多靶点机制概述

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【摘要】 卵巢储备功能下降 (diminished ovarian reserve, DOR) 是一种以卵泡数量减少和质量下降为特征的生殖功能障碍性疾病, 该疾病影响了女性的生殖健康和生活质量。传统激素替代疗法虽对临床症状有一定疗效, 但对生育力的改善效果并不明显, 长期使用存在不良反应的风险。早在中医古籍中就有针刺调节使胞宫定期藏泄, 恢复卵巢功能的记载。现代研究表明, 针刺可调节卵巢内分泌功能、抑制卵巢氧化应激和炎症反应、维持卵巢免疫平衡稳态、改善卵巢血流灌注情况、调节卵巢表观遗传修饰以及改善 DOR 患者的心理效应。其作用特点为多靶点、整体调节, 既符合中医理论, 又得到现代科学证据支持。本文旨在对近年来针刺治疗 DOR 的多靶点机制进行总结, 希冀对临床及科研提供一定的参考。

【关键词】 针刺; 卵巢储备功能下降; 信号通路; 表观遗传学; 多靶点机制

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An overview of the multi-target mechanisms of acupuncture in treating diminished ovarian reserve

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【 Abstract 】 Diminished ovarian reserve (DOR) is a reproductive dysfunction characterized by a reduction in both the quantity and quality of ovarian follicles, which adversely affects the reproductive health and quality of life of contemporary women. Although conventional hormone replacement therapy can alleviate certain clinical symptoms, its effectiveness in improving fertility is limited, and long-term use carries the risk of adverse effects. Ancient traditional Chinese medicine (TCM) texts contain records of acupuncture regulating the periodic storage and discharge function of the uterus (Baogong) to restore ovarian function. Modern research indicates that acupuncture can regulate the endocrine function of the ovaries, inhibit ovarian oxidative stress and inflammatory responses, maintain ovarian immune homeostasis, improve ovarian blood perfusion, modulate ovarian epigenetic modifications, and ameliorate psychological effects in patients with DOR. Its action is characterized by multi-target and holistic regulation, which aligns with

TCM theory and is supported by modern scientific evidence. This article aims to summarize the multi-target mechanisms of acupuncture in treating DOR in recent years, hoping to provide references for clinical practice and scientific research.

【Key words】 Acupuncture; Diminished ovarian reserve; Signaling pathway; Epigenetics; Multi-target mechanism

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