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WOMEN'S HEALTH CARE PHYSICIANS

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This Committee Opinion was developed by the American College of Obstetricians and Gynecologists' Committee on Obstetric Practice in collaboration with Kurt R. Wharton, MD, and Meredith L. Birsner, MD.

Vaginal Seeding

ABSTRACT: Vaginal seeding refers to the practice of inoculating a cotton gauze or a cotton swab with vaginal fluids to transfer the vaginal flora to the mouth, nose, or skin of a newborn infant. The intended purpose of vaginal seeding is to transfer maternal vaginal bacteria to the newborn. As the increase in the frequency of asthma, atopic disease, and immune disorders mirrors the increase in the rate of cesarean delivery, the theory of vaginal seeding is to allow for proper colonization of the fetal gut and, therefore, reduce the subsequent risk of asthma, atopic disease, and immune disorders. At this time, vaginal seeding should not be performed outside the context of an institutional review board-approved research protocol until adequate data regarding the safety and benefit of the process become available.

Recommendations

The American College of Obstetricians and Gynecologists (ACOG) makes the following recommendations:

- The American College of Obstetricians and Gynecologists does not recommend or encourage vaginal seeding outside of the context of an institutional review board-approved research protocol, and it is recommended that vaginal seeding otherwise not be performed until adequate data regarding the safety and benefit of the process become available.
- The American College of Obstetricians and Gynecologists only supports the performance of vaginal seeding in the context of an institutional review board-approved research protocol.
- Should a patient insist on performing the procedure herself, a thorough discussion with the patient should be held acknowledging the potential risk of transferring pathogenic organisms from the woman to the neonate. Risk stratification is reasonable for such women in the form of testing for infectious diseases and potentially pathogenic bacteria. Serum testing for herpes simplex virus and cultures for group B streptococci, *Chlamydia trachomatis*, and *Neisseria gonorrhea* should be encouraged. It is further recommended that the obstetrician–gynecologist or other obstetric care provider document the discussion. Because of the theoretical risk of neonatal infection, the pediatrician or family physician caring for the infant should be made aware that the procedure was performed.
- Although findings are mixed regarding associations between breastfeeding and the development of asthma and atopic disease in childhood, exclusive breastfeeding for the first 6 months of life has multiple known benefits and remains the recommendation of ACOG for all women who do not have physical or medical conditions that prohibit breastfeeding.
- The paucity of data on this subject supports the need for additional research on the safety and benefit of vaginal seeding.

The Infant Microbiome

The human microbiome is the composite of genes of the microorganisms (microbiota) living in and on the human body that influence the health and development of the host (1). The gastrointestinal tract of the fetus is believed to be sterile. Bacterial transfer from the woman to infant occurs during birth, skin-to-skin contact after birth, and breastfeeding. Bacteria function to ferment unused energy substrates, stimulate the immune system, prevent growth of pathogenic bacteria, regulate development of the gut, and produce vitamins for the host (2). Cesarean delivery,

antenatal and intrapartum antibiotics, and formula feeding may interrupt the natural maternal-to-neonatal bacterial transfer during the critical early period of neonatal immune development. Commensal bacteria present in breast milk and maternal areolar skin bacteria contribute to the early seeding of the infant gut. A prospective longitudinal study of 107 healthy infant and woman pairs demonstrated that at 30 days, infants who were breastfed to obtain 75% or more of their daily milk intake received a mean (SD) of 27.7% (15.2%) of the bacteria from breast milk and 10.3% (6.0%) from areolar skin (3). Although findings are mixed regarding associations between breastfeeding and the development of asthma and atopic disease in childhood (4, 5), exclusive breastfeeding for the first 6 months of life has multiple known benefits and remains the recommendation of ACOG for all women who do not have physical or medical conditions that prohibit breastfeeding (6).

Vaginal Seeding

Vaginal seeding refers to the practice of inoculating a cotton gauze or cotton swab with vaginal fluids to transfer the vaginal flora to the mouth, nose, or skin of a newborn infant. The procedure is most often performed in conjunction with cesarean delivery. Cesarean delivery performed before the onset of labor or before the rupture of membranes prevents the fetus from coming into contact with vaginal fluid and bacteria. The intended purpose of vaginal seeding is to transfer maternal vaginal bacteria to the newborn. As the increase in the frequency of asthma, atopic disease, and immune disorders mirrors the increase in rate of cesarean delivery, the theory of vaginal seeding is to allow for proper colonization of the fetal gut and, therefore, reduce the subsequent risk of asthma, atopic disease, and immune disorders. The lay press in the United States and abroad has shown an interest in the concept of vaginal seeding. As a result, it has become increasingly common for patients to discuss the possible benefits of performing vaginal seeding with cesarean delivery with their obstetrician–gynecologists or other obstetric care providers. This Committee Opinion has been prepared in response to this public interest.

Association Between Mode of Delivery and Allergic Disorders

The incidence of cesarean delivery has increased dramatically in the United States and in the rest of the industrialized world. Concurrently, the incidence of allergic and autoimmune diseases has increased. It has long been hypothesized that neonatal exposure to the vaginal flora during vaginal birth reduces the risk of developing allergic disorders. This relationship has been suggested from retrospective studies yet it remains unproved. A retrospective cohort study from 2005 reported on 8,953 children in Oregon diagnosed with allergic rhinoconjunctivitis, asthma, atopic dermatitis, or food allergies. The risk of an allergic rhinoconjunctivitis diagnosis was significantly higher in the children born by cesarean delivery than in those delivered vaginally (adjusted odds ratio [OR], 1.37; 95% CI, 1.14–1.63). Cesarean delivery also was associated with subsequent diagnosis of asthma (OR, 1.24; 95% CI, 1.01–1.53); this association was gender specific, with a positive association restricted to girls (OR for asthma in girls, 1.53; 95% CI, 1.11–2.10; OR for asthma in boys, 1.08; 95% CI, 0.81–1.43). Children born to women who had repeat cesarean deliveries had an increased risk of developing allergic rhinoconjunctivitis (OR, 1.78; 95% CI, 1.34–2.37). A similar increase was noted for asthma in girls (OR, 1.83; 95% CI, 1.13–2.97) but not in boys (OR, 1.08%; 95% CI, 0.81–1.43) born to women with repeat cesarean deliveries (7).

A retrospective review from the Danish Medical Birth Registry and the Danish National Patient Registry analyzed health data of two million children born between 1977 and 2012. Children born by cesarean delivery had a significantly increased risk of asthma, systemic connective tissue disorders, juvenile arthritis, inflammatory bowel disease, immune deficiencies, and leukemia. Because this review did not identify differences in risk between children born by cesarean delivery with or without labor or by delivery with or without rupture of membranes, the specific effect of the lack of fetal exposure to the maternal vaginal microbiota is unknown. This association between cesarean delivery and increased risk of several chronic immune diseases suggests a shared environmental risk factor in early life. Further research is needed to clearly identify and address this risk factor (8).

Prospective studies have demonstrated that an infant delivered vaginally acquires microbiota resembling his or her mother's vaginal microbiota and that an infant born by cesarean delivery initially develops bacterial colonization resembling skin colonization from the mother or from the operating room microbiota (9, 10). A systematic review of associations between mode of delivery and the diversity and colonization pattern of gut microbiota during the first year of infant life found that the diversity and colonization pattern were significantly associated with the mode of delivery from birth to 3 months of life, but that the difference disappeared after 6 months (11).

A small study of 60 randomly selected 7-year-old children, 31 delivered by cesarean and 29 delivered vaginally, assessed microbiota composition by determining fecal microbiota profiles using culture-independent fluorescent in situ hybridization and compared the respective effects of delivery mode on gut microbiota (12). Significantly higher numbers of clostridia (generally considered a harmful species) were found in children delivered vaginally compared with children born by cesarean delivery. No differences were observed in other fecal bacteria, including *Bifidobacterium*, which generally is considered helpful for health promotion, or total numbers of bacteria. Children with asthma diagnosed by a physician had lower numbers of clostridia in their fecal specimens, whereas healthy children had higher

clostridial numbers. Although the authors conclude that abnormal development of intestinal microbiota after cesarean delivery may continue beyond infancy, the relationship between vaginal birth, clostridial colonization, and asthma remains unclear.

Childhood Asthma

Asthma is the most prevalent pediatric chronic disease and it affects more than 300 million people (13). One child in 10 in the Western world has asthma. A multitude of risk factors for the development of asthma have been identified. Childhood exposure to environmental allergens, air pollution, and particulate matter and viral respiratory tract infections are all associated with an increased risk of developing childhood asthma (14).

The risk of developing asthma has also been associated with the type of bacteria contributing to the gut microbiota during the first 100 days of life. Infants monitored in the Canadian Healthy Infant Longitudinal Development study who were found to be at risk of developing asthma had relative decreases in the abundances of the genus *Lachnospira* (associated with atopic wheezing in children) and increases in the species *Clostridium neonatale* (associated with neonatal necrotizing enterocolitis) compared with matched controls (15). The authors conclude that the opposing shifts in the abundance of these two species in the first 3 months of life suggest they play a role in protecting against (*Lachnospira*) or promoting (*C neonatale*) the development of asthmatic phenotypes seen in preschool-aged children. Infants born by cesarean delivery are known to have greater colonization with *Clostridium* within the first 3 weeks of life though not at 180 days (11).

Recently, factors have been identified that may reduce the risk of developing asthma, including environmental exposures after birth and increased intake of n-3 fatty acids. A study of Amish and Hutterite children, which included a mouse model, examined exposure to Amish house dust (which has significantly higher endotoxin levels) and indicated that the Amish environment provides protection against asthma by engaging and shaping the innate immune response (16). In a separate randomized trial, 736 pregnant women were assigned to receive daily supplemental fish oil (n-3 long-chain polyunsaturated fatty acids) or placebo (olive oil) beginning at 24 weeks of gestation through the first postpartum week to assess the benefit of fish oil supplementation on wheezing disorders in offspring. The cohort of 695 children from these pregnancies was observed for 5 years. The risk of persistent wheeze or asthma was reduced by one third in the first 5 years of life among the children born to women who received fish oil supplementation (17).

In light of the broad evidence of environmental, dietary, and genetic factors that affect the risk of developing asthma, the contribution of variations in early microbiota of children associated with delivery route remains unknown.

Microbiota Restoration in the Newborn Infant Born by Cesarean Delivery

The microbiota of all infants born by cesarean delivery cannot be considered uniformly because some infants are born by cesarean delivery after onset of labor or the rupture of membrane whereas other infants are born before the onset of labor or before the rupture of membranes. Therefore, exposure to maternal vaginal bacteria will vary among all infants born by cesarean delivery. A pilot study of 18 newborns (7 born vaginally and 11 by cesarean delivery) and their mothers was conducted in an attempt to partially restore the microbiota of infants born by cesarean delivery using vaginal microbial transfer (vaginal seeding) (18). Four of the 11 infants born by cesarean delivery were exposed to vaginal fluids from gauze inoculated in the vaginas of their respective mothers who were negative for group B streptococci, had no signs of vaginosis, and had a vaginal pH less than 4.5, during the hour preceding cesarean delivery. Within 2 minutes of birth, the infants were wiped with the gauze along the mouth, face, and skin. Serial cultures from the anus, mouth, and skin of the infants and women were taken during the first month of life. Cultures were obtained from all 18 infants and women. Bacterial source tracking of the infant microbiome revealed that the microbiome of the four infants born by cesarean delivery and wiped with the inoculated gauze resembled that of infants delivered vaginally, particularly so during the first week of life. Effects upon the microbiome beyond the first 30 days of life and the effects upon long-term health of the four infants are not known. The results of this study have generated interest in the scientific community and even larger interest in the international lay population and social media. However, as only four infants underwent vaginal seeding, this study has neither the size nor the power to produce appropriate conclusions or recommendations or to confirm the safety of vaginal seeding. Additional larger scale studies are necessary to further explore potential benefits and risks of this practice.

Clinical Considerations

It is critical to note that the current state of cumulative investigative data into the potential benefit and harm of vaginal seeding at this time consists of a single pilot study in which only four infants underwent seeding, with no long-term follow up. It is also critical to note that the pilot study involved only women who were not carriers of group B streptococci, had no signs of vaginosis, and had a vaginal pH less than 4.5. Because 20% of pregnant women at term are carriers of group B streptococci, the risk of performing vaginal seeding in the general population is unknown. Of additional concern is the risk of undiagnosed *C trachomatis*, *N gonorrhea*, human papilloma virus, group A streptococci, and herpes simplex virus infections, among others, at the time of delivery

that could result in neonatal infection that may otherwise have been potentially avoided by cesarean delivery without seeding.

Should a patient insist on performing the procedure herself, a thorough discussion with the patient should be held acknowledging the potential risk of transferring pathogenic organisms from the woman to the neonate. Risk stratification is reasonable for such women in the form of testing for infectious diseases and potentially pathogenic bacteria. Serum testing for herpes simplex virus and cultures for group B streptococci, *C trachomatis*, and *N gonorrhea* should be encouraged. It is further recommended that the obstetrician–gynecologist or other obstetric care provider document the discussion. Because of the theoretical risk of neonatal infection, the pediatrician or family physician caring for the infant should be made aware that the procedure was performed. The American College of Obstetricians and Gynecologists only supports the performance of vaginal seeding in the context of an institutional review board-approved research protocol.

Conclusion

It has been hypothesized that the increasing prevalence of childhood asthma, atopic disease, and other immune disorders may be the result of the increasing incidence of cesarean delivery, which may prevent natural colonization of the neonatal gut with maternal vaginal flora. It is also possible that antenatal and intrapartum antibiotics as well as formula feeding may contribute to this dysbiosis. This hypothesis is supported solely by small retrospective studies. If the hypothesis is true, the best process to compensate for this dysbiosis of the neonatal gut is unknown. There is only one clinical trial (19) currently underway to investigate vaginal seeding, but the main outcome measure is neonatal microbiota, not clinical outcomes. At this time, the American College of Obstetricians and Gynecologists does not recommend or encourage vaginal seeding outside of the context of an institutional review board-approved research protocol, and it is recommended that vaginal seeding otherwise not be performed until adequate data regarding the safety and benefit of the process become available. The paucity of data on this subject supports the need for additional research on the safety and benefit of vaginal seeding.

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