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Neonatal Acute Omphalitis and Congenital Urachal Anomalies

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Abstract

Objectives – The objective of the study was to analyze clinical, laboratory and ultrasound imaging features of newborns with acute omphalitis (AO) and to define the most common congenital urachal anomalies that can present as neonatal AO and be diagnosed with umbilical ultrasound (US) imaging. **Patients and methods** – The study included newborns aged up to 44 post-conceptional weeks with AO and congenital urachal anomalies (persistent patent urachus, urachal cyst, diverticulum and sinus). **Results** – The study included 226 newborns, 132 (58.4%) male and 12 (5.3%) preterm. Their mean age was 9.7 days. The most frequent local signs of AO were umbilical discharge (151, 66.8%), periumbilical erythema (120, 53.1%) and periumbilical edema (64, 28.3%). The most frequently isolated bacteria, alone or in combination with other bacteria, was *Staphylococcus aureus* (120 newborns, 73.2%). Antibiotic treatment was needed in 148 (65.5%) newborns; most frequently intravenous flucloxacillin and gentamicin. US examination of the umbilical region was performed in 164 (72.6%) newborns with AO and congenital urachal anomalies were found in 96 (58.5%) newborns. The most frequent pathology was persistent patent urachus, found in 84 (87.5%) newborns. **Conclusions** – AO, one of the most common infections in the neonatal period, could be causally related to congenital urachal anomalies, especially persistent patent urachus, in more than half of cases. US imaging of the umbilical region represents the diagnostic modality of choice for detecting underlying urachal pathology.

Key Words: Newborn ▪ Umbilical Cord ▪ Inflammation ▪ Urachus ▪ Diagnostic Imaging.

Introduction

Acute omphalitis (AO) is one of the most common infections in the neonatal period. It is usually sporadic, though several risk factors are known, most commonly congenital urachal anomalies, which result from incomplete obliteration of the urachus. Congenital urachal anomalies can remain asymptomatic or present with nonspecific urinary and abdominal manifestations, commonly omphalitis or urinary tract infection (1, 2). Various types of congenital urachal anomalies have been described, including persistent patent urachus, urachal cyst, urachal diverticulum and urachal sinus (3). The most common is persistent patent urachus, a communication between the urinary bladder and the umbilicus, usually leading to prolonged umbilical discharge.

The objective of this study was to analyze clinical, laboratory and ultrasound (US) imaging features of newborns with AO, and to define the most common congenital urachal anomalies that can present as neonatal AO and be diagnosed with umbilical US imaging.

Patients and methods

A retrospective cohort study was conducted at the tertiary level neonatal department between January 2013 and March 2023. The study included

newborns aged up to 44 postconceptional weeks with AO and congenital urachal anomalies (persistent patent urachus, urachal cyst, urachal diverticulum and urachal sinus). The diagnosis of these pathologies was based on the presence of local clinical signs (umbilical erythema, edema, nonpurulent or purulent discharge), systemic clinical signs (fever, tachycardia, lymphadenopathy, irritability, lethargy, feeding difficulty), distinct laboratory findings (elevated C-reactive protein (CRP), elevated procalcitonin (PCT), leukocytosis), microbiology findings (growth of pathogenic bacteria from umbilical swab and/or hemoculture) and US imaging findings (US signs of infection and congenital urachal anomalies). The following data were collected from patients' medical records: gestational age, age at the onset of problems, gender, clinical signs of omphalitis and/or congenital urachal anomalies, laboratory results, microbiology and imaging workup and type of treatment (local disinfectant, oral or intravenous antibiotic).

Statistical Analysis

Numerical data were presented as mean, median and standard deviation. Categorical data were presented as frequencies and percentages. Descriptive statistical methods were used. The categorical variables were compared using the Chi-square test (statistically significant P value was considered <0.05). Analysis was performed using Microsoft Excel 2016 Ink.

Results

During the study period 226 newborns with AO were diagnosed. There was a slight male predominance (132, 58.4%). Twelve (5.3%) newborns were born prematurely. The mean age at admission was 9.7±6.5 days (median 8 days). Thirteen (5.7%) patients had an umbilical catheter prior to infection. Most newborns with AO had umbilical discharge (151, 66.8%), followed by periumbilical erythema (120, 53.1%), periumbilical edema and foul smell (64, 28.3%). Ninety-nine (43.8%) newborns had at least one systemic sign of infection, most commonly fever, tachycardia, lymphadenopathy, irritability, lethargy or feeding difficulty.

Thirty-five (15.5%) newborns had positive CRP values (more than 5 mg/L) and 11 (4.9%) had positive PCT values (more than 0,05 µg/L). Eight (3.5%) newborns had positive CRP and PCT values.

An umbilical swab was taken in 164 (72.6%) newborns with AO. The most frequently isolated bacteria, alone or in combination with other bacteria, was *Staphylococcus aureus* (120 newborns, 73.2%), while *Staphylococcus aureus* alone was isolated in 71 (43.3%) newborns. Other frequently isolated bacteria were *Escherichia coli* in 31 (18.9%) newborns, *Streptococcus agalactiae* in 30 (18.3%) and *Enterococcus faecalis* in 28 (17.1%) newborns. Other, mostly multiple bacteria, were isolated in 13 (7.9%) newborns, including *Proteus mirabillis, Morganella morganii, Klebsiella oxytoca, Streptococcus anginosus, Streptococcus pneumoniae, Staphylococcus haemolyticus, Staphylococcus epidermidis* and mixed bacterial flora. None of the hemocultures were positive.

Antibiotic treatment (intravenous or oral) was initiated in 148 (65.5%) newborns; most frequently the combination of intravenous flucloxacillin and gentamicin. In most cases the treatment was finished with oral flucloxacillin. None required surgical treatment.

US examination of the umbilical region was performed in 164 (72.6%) newborns with AO and congenital urachal anomalies were found in 96 (58.5%) newborns. The most frequent finding was persistent patent urachus, found in 84 (87.5%) newborns. Four (4.1%) newborns had urachal cyst, two (2.1%) urachal sinus and one (1.0%) urachal diverticulum.

Discussion

The study revealed clinical, laboratory and US features of newborns with AO. A typical clinical presentation of AO with umbilical discharge and periumbilical erythema was present in more than half of newborns. In 27.4% of newborns with AO umbilical swab for culture was not taken. In those

cases the diagnosis of AO was based on a combination of clinical signs and raised blood inflammatory markers.

The estimated incidence of AO in our study was 0.4%, which is close to the overall incidence of 0.7% in developed countries (4). However, in developing countries the incidence of AO is higher and can lead to fatal complications (5, 6). All newborns with AO in our study recovered completely and none had a fatal outcome.

The median age of newborns with AO in our study was eight days. This was expected as the umbilical cord stump dries and separates between the 5th and the 14th day of age and the umbilicus usually heals during the next 14 days (4). At that time the devitalized umbilical cord stump tissue promotes rapid bacterial colonization and growth. The thrombosed blood vessels allow entry into the bloodstream, potentially leading to systemic infection.

Male gender is a known risk factor for many neonatal infections and alike there was a slight male predominance in our study group, also reported in other similar studies (7, 8, 9). Other known risk factors for AO are prematurity, low birth weight, prolonged rupture of membranes, maternal infection, nonsterile delivery, home birth and umbilical catheterization (4). In our study 5.7% of newborns had umbilical catheters prior to AO. Although newborns with umbilical catheters are closely observed for local or systemic signs of infection, these can be discrete and difficult to notice. Only half of newborns with confirmed umbilical catheter related infection had local or systemic clinical signs of infection. Therefore, regular laboratory blood controls should be performed and the catheter should be replaced after 96 hours.

Antibiotic treatment of AO is usually initiated empirically and directed against gram-positive and gram-negative bacteria. Initial empiric treatment with anti-staphylococcal penicillin and aminoglycoside is recommended. In case of high prevalence of methicillin-resistant *Staphylococcus aureus* vancomycin should be administered while awaiting culture results. If there is suspicion for anaerobic infection, clindamycin or metronidazole is indicated (4). Most newborns in our study were initially treated with a combination of intravenous flucloxacillin and gentamicin and finished the therapy with a single antibiotic, accordingly to isolated bacteria and antibiogram. In case of AO in a well-appearing newborn without systemic signs of infection and negative inflammantory parameters, oral antibiotics may be reasonable if close follow-up is assured (10). Local antibiotic therapy is not reccomended.

AO is usually a polymicrobial infection and *Staphylococcus aureus* is the most frequently reported bacteria. Other common bacteria are group A and group B Streptococci, Gram-negative bacilli and rarely anaerobic bacteria (11). In our study 40.2% of newborns had polymicrobial AO and the most common pathogen was *Staphylococcus aureus*, isolated as one of the bacteria in 73.2% of newborns, or alone in 43.3% of newborns. Similar results were also found by other authors (6, 7). Congenital urachal anomalies were found in more than half of newborns with AO. During normal gestational development the urachus involutes and its lumen obliterates, becoming the median umbilical ligament. Incomplete involution of the urachus can cause diverse congenital urachal malformations. The most common congenital urachal anomaly in our study was persistent patent urachus, followed by much less frequent urachal diverticulum, sinus and cyst, as similarly reported by other studies (1, 12). There are several imaging options for congenital urachal abnormalities. The US of the umbilical region is the most frequently used technique in children and young adults (1). In our study the US of the umbilical region was performed in 72.6% of newborns with AO and revealed congenital urachal anomalies in 58.5% of cases. As US is fast, readily available and radiation-free diagnostic tool with diagnostic accuracy more than 90%, it should be included in the management of newborns with AO and possible urachal abnormalities (1). In doubtful cases contrast enhanced voiding urosonography (CEVUS), which shows reflux up the urachus, can be performed to confirm US diagnosis. Other imaging modalities, such as voiding cystourography, magnetic resonance imaging and computed tomography are not recommended in children since US is a safe, quick and radiation-free method (1).

The most frequently reported urachal abnormality is patent urachus, which was also the case in our study. Typical clinical presentation is prolonged umbilical discharge without omphalitis. However, the concurrence of omphalitis makes the clinical differentiation less obvious and challenging (Fig. 1a, Fig. 1b). In this case the US examination usually reveals the underlying pathology (13). Longitudinal US image of the midline ventral abdomen shows the tubular connection between the anterosuperior part of the urinary bladder and the umbilicus (Fig. 2).

Urachal cyst was, though rare, the second most frequent urachal pathology in our study. As reported, it is often clinically asymptomatic and incidentally found at US examination (1). Otherwise, it may become symptomatic due to umbilical infection or bleeding and consequently found with US. The urachal cyst forms when distal and proximal end of the urachal lumen close and the middle portion remains patent and filled with fluid (14). US therefore shows a midline homogeneous fluid-filled structure anywhere along the theoretical course of the urachus between the urinary bladder and the umbilicus.

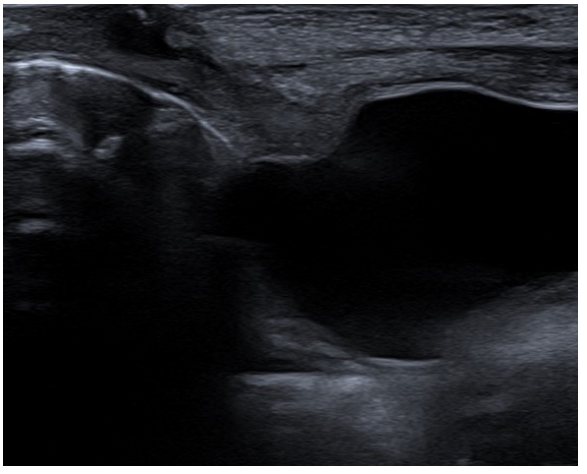

Fig. 1a. *Longitudinal ultrasound image showing a fluid filled urachus with thickened wall.*

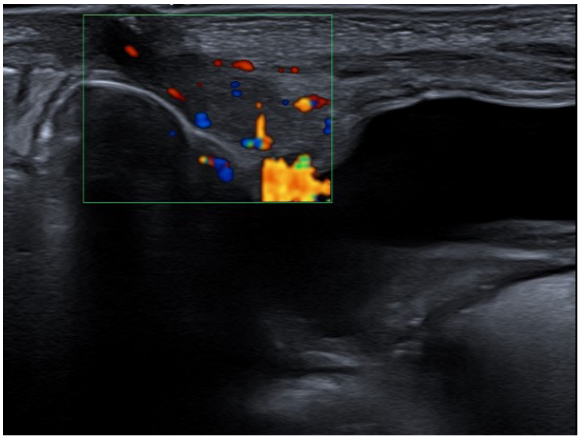

Fig. 1b. *Color doppler image showing hyperemia of the wall, suggesting inflammation.*

Urachal sinus and urachal diverticulum, a non-communicating dilatation at the umbilical and respectively urinary bladder end of the urachus, were diagnosed in 3% of newborns. These two anomalies represent the rarest urachal anomalies, caused by incomplete closure of the urachus at the umbilical and urinary bladder end, respectively (1). The US imaging can demonstrate a midline focal protruding extension from the umbilicus (respectively urinary bladder) with no communication to the rest of the urachal tract (Fig. 3). The urachal diverticulum can be identified by CEVUS as a tubular contrast material–filled structure extending superiorly from the anterior urinary bladder dome.

Most of the patients with urachal anomalies are nowadays treated conservatively as spontaneous regression and closure are highly probable (1, 12). In case of complications, especially infection,

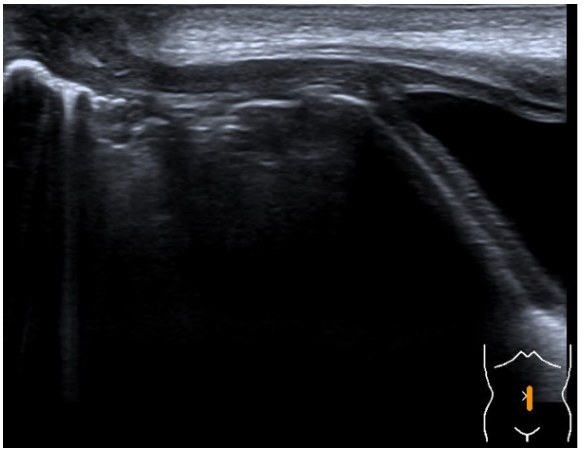

Fig. 2. *Longitudinal ultrasound image showing a tubular structure extending from the urinary bladder, representing patent urachus.*

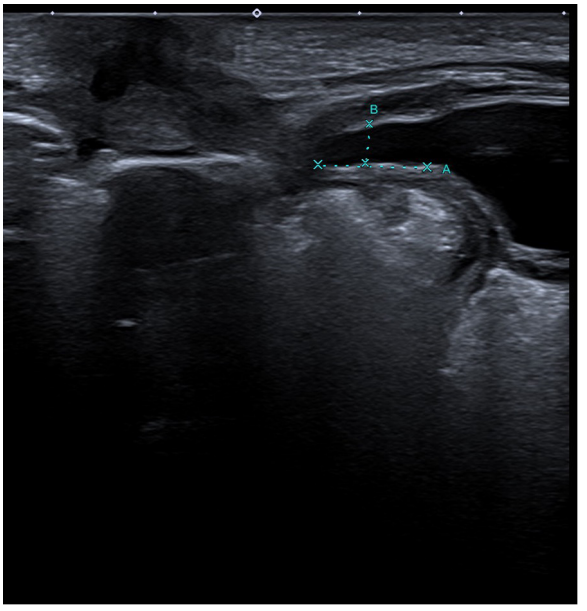

Fig. 3. *A hypoechoic fluid filled structure in the dome of the urinary bladder, representing urachal diverticulum.*

antibiotic treatment is indicated. Regular US follow-ups are recommended to confirm the regression of the urachal remnant, although their frequency is not well defined. As most urachal remnants resolve spontaneously till six months of age (12), which was also true for patients in our study, US follow-ups at age of sixth months might be reasonable to perform in case of persistent clinical presentation of urachal anomaly. Surgical intervention is rarely needed and indicated only in persistent cases with complications like recurrent infection, abdominal pain, bladder rupture and large cysts in infants after six months of age (12, 15, 16). The results of our study confirmed this as all the patients with urachal anomalies had US follow-ups and none needed surgical intervention.

Conclusion

Neonatal AO could be causally related to congenital urachal anomalies, especially persistent patent urachus, in more than half of cases. US imaging of the umbilical region represents the diagnostic modality of choice for detecting underlying urachal pathology. As clinical diagnosis of congenital urachal anomalies outside the neonatal period is often delayed due to nonspecific symptoms or the lack of symptoms, the value of umbilical ultrasound imaging is even greater.

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Conflict of Interest: The authors declare that they have no conflict of interest.

Data Statement: The data supporting the findings of this study are available from the corresponding author upon request.

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