

# Filamentous Rods in the Cerebrospinal Fluid of a Child with Ventriculoperitoneal Shunt: “Separation Anxiety” at the Microscopic Level!

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## Abstract

Certain bacteria and antibiotic combinations can result in unusual morphologic transformations such as the creation of septate filamentous bacterial rods, where division is preserved, but separation is inhibited. This is often seen when subinhibitory concentrations of antibiotics are administered. Herein, we describe this phenomenon in the case of a teenage boy with an infected ventriculoperitoneal shunt, whose culture-proven *Pseudomonas aeruginosa* took on a filamentous appearance following antibiotic treatment. This transformation is important to recognize, so it is not misconstrued as fungal hyphae, committing the patient to unnecessary treatment.

**Keywords:** Antibiotic-mediated bacterial filamentation, filamentous rods, *Pseudomonas aeruginosa*

## INTRODUCTION

The morphologic recognition of organisms remains an important component of the diagnostic work up of a specimen in general pathology practice. An accurate interpretation requires familiarity with an organism’s typical morphology as well as morphologic variations, including artificial changes. This case report illustrates the morphologic transformation of antibiotic altered *Pseudomonas aeruginosa* in the cerebrospinal fluid of a young boy.

## CLINICAL HISTORY

Our patient is a 17-year-old boy with a history of hydrocephalus and placement of a ventriculoperitoneal shunt who presented with fever. Recent medical history included bacteremia, with blood cultures positive for *Propionibacterium acnes*. On hospital day 1, the patient was started on empiric broad-spectrum antibiotics: vancomycin (20 mg/kg every 6 h); cefepime (intravenous, 50 mg/kg every 8 h); Flagyl (intravenous, 10 mg/kg every 8 h); and amikacin (intravenous, 20 mg/kg daily). Cultures from cerebrospinal fluid (CSF) grew pansensitive *P. aeruginosa*. Subsequent peritoneal fluid and distal catheter cultures on

day 2 postadmission grew *P. aeruginosa*, and subsequently, the shunt was removed on day 3 postadmission (shunt hardware cultures also grew *P. aeruginosa*). Vancomycin and amikacin were subsequently discontinued (3 days of therapy each). On day 7 postadmission, a repeat CSF fluid analysis showed an elevated white blood cell (WBC) count of 674, and gentamicin (intravenous, 2.5 mg/kg every 8 h) was added for secondary Gram-negative coverage. Flagyl was discontinued on postadmission day 9 after anaerobic cultures remained negative (9 days of therapy), and gentamicin was discontinued on postadmission day 10 given recent negative routine CSF cultures (4 days of therapy). Unfortunately, a culture from the patient’s external ventricular drain on postadmission day 11 was again positive for *P. aeruginosa*, and ciprofloxacin (intravenous, 10 mg/kg) was added on postadmission day 12. Subsequent cultures were negative,

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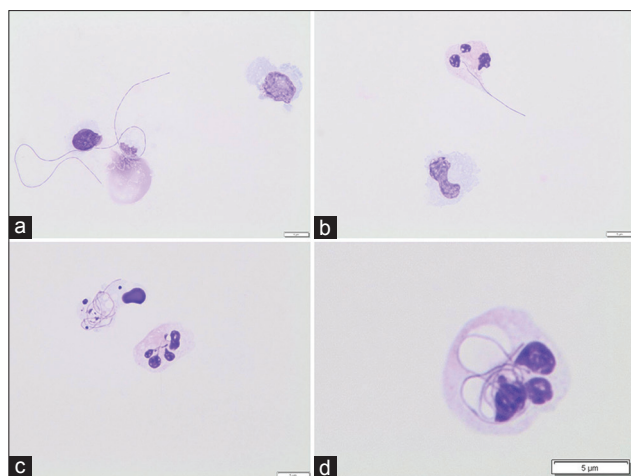
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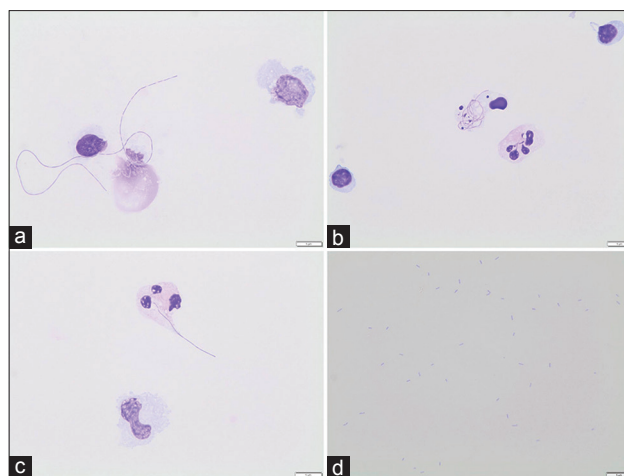
**Figure 1:** Giemsa-stained cytospin preparation from this child's cerebrospinal fluid showing long, intra- and extracellular, filamentous rods (a-d)

and ciprofloxacin was discontinued on postadmission day 17 (6 days of therapy). On postadmission day 31, cefepime was discontinued, a 21-day course after the last negative culture (32-day therapy in total). Morphologic examination of the CSF cytospin slide from day 1 of hospital admission showed mixed inflammatory cells along with several long septate filamentous rods [Figure 1]. What are these filamentous rods?

## COMMENTS

The filamentous rods seen are characteristic of antibiotic-altered *P. aeruginosa*. For certain bacteria and antibiotic combinations, there may be inhibition of separation but not division.<sup>[1]</sup> This results in an elongated septate appearance [which resembles and can be misconstrued as slender septate fungal hyphae,<sup>[1,2]</sup> Figures 1 and 2]. Note: the difference in size and morphology was compared to pretreatment *P. aeruginosa* [Figure 2d]. Our patient had another sampling of CSF 2 days after shunt externalization and subsequent removal, and no bacteria (filamentous, viable, or nonviable) were seen in the follow-up sample.

This antibiotic-induced filamentation phenomenon was first reported by Gardner in 1940 and involved *in vitro* studies of *Escherichia coli* given subinhibitory concentrations of penicillin.<sup>[3]</sup> It is now recognized that filamentation is a common and likely survival-related response that is seen most often in Gram-negative bacilli and subinhibitory concentrations of antibiotics, particularly those of the  $\beta$ -lactam family.<sup>[1,4]</sup> The literature on the subject, however, is relatively scant, and further, illustrations are few.<sup>[1,5,6]</sup> It should also be noted that bacteria of the order *Actinomycetales* (notable genera include *Nocardia*, *Corynebacterium*, *Actinomyces*, and *Rhodococcus*) commonly show filamentous branching formation in the absence of antibiotic administration.<sup>[7]</sup> It



**Figure 2:** Antibiotic-altered filamentous rods in the cerebrospinal fluid of a child with infected shunt (a-c) compared in size and appearance to pretreated *Pseudomonas aeruginosa* (d). All photos are taken at  $\times 100$  oil magnification of Giemsa-stained slides

is important to keep this phenomenon of antibiotic-induced bacterial filamentation in mind when analyzing the fluid of a patient that has been treated for bacterial infection and hence avoid diagnostic pitfalls and potential unnecessary treatment.

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## Authors' contribution

All authors are involved in the clinical aspects of the reported material and drafting and final revision of the manuscript.

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## Conflicts of interest

There are no conflicts of interest.

## Compliance with ethical principles

No prior ethical approval is required at our institution for isolated case reports. Case history and samples are reported anonymously.

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