## Abstract

**Objective:** To present a unique case of tympanic membrane barotrauma sustained after riding a roller coaster at a local amusement park.

**Study Design:** Case report

### Literature Review

In 1944 Teed classified the otoscopic findings in 708 military personnel after exposure to different pressures at various water depths while using a submarine escape device. The resulting Teed’s classification of barotitis is a spectrum of disease with grade 0 being a normal TM and grade 4 with hemotympanum or perforation.

### Case Report

**History:** M.M. is a 24 year old male who presented with right ear pain and sensation of fullness, approximately 36 hours after riding a roller coaster at a local amusement park. The roller coaster reaches a maximum speed of 120 mph within 4 seconds. While waiting for the ride to begin, the patient turned his head to the left to speak with his girlfriend at the time of acceleration, causing his right ear to sustain full impact of forward throttle. Since getting off the ride, he has had otalgia and a subjective hearing loss, but denies vertigo and tinnitus.

**Physical Examination:** On physical examination the left external canal and tympanic membrane were found to be normal, and the right external auditory canal was edematous, erythematous and the right tympanic membrane was injected.

**Audiometry:** Audiogram performed 36 hours after the incident revealed normal hearing thresholds with 100% speech discrimination, normal tympanograms and reflexes were present.

**Course:** The patient was managed with observation and the symptoms resolved within 72 hours.

### Figures

Edematous external canal with early bleb formation (above) and erythema of the tympanic membrane (below), images taken 36 hours after the ride.

### Calculation of Total Pressure on Ear

Total Pressure = Dynamic Pressure + Static Pressure

\[ \text{Total Pressure} = 0.5(\text{density of air})(\text{velocity})^2 \times (\text{psi due to 420 ft. alt.}) + 0.5 \left( \frac{1.2 \text{ kg/m}^3}{53.6 \text{ mmHg}} \right)^2 + (14.7 \text{ psi} - 14.3 \text{ psi}) \]

\[ = 0.6 \text{ psi} \]

### Conversion of psi to dB

- \[ 10 \log [(\text{psi})/241(10^{13})] = \text{intensity in dB} \]
- \[ 10 \log [(0.6)/(241(10^{13})] = 181.6 \text{ dB} \]

## Literature Review

Roller coasters began as ice slides in Russia 400 hundred years ago. By the late 1800’s wheeled cars were added, and in 1873 the first American roller coaster was introduced in Pennsylvania. From the 1880s through the 1930s, roller coaster construction across the US exploded, with thousands of coasters erected nationwide. This number was cut to hundreds during the Great Depression, and policies of racial segregation lead to the demise of many amusement parks throughout the 1940s-1960s. The mid-1970s welcomed resurgence in coaster construction, introducing tubular steel structures, while suspended, stand-up, and hypercoasters debuted in the 1980s. From the late 1980’s until present, designers have continually pushed the limits of engineering to create the tallest, fastest rides possible, many of which now stand over 400 feet and achieve speeds of 120 miles per hour.

For 100 years, investigators have explored the otologic manifestations of pressure on human ears. In 1937 Armstrong and Heim coined the term aero-otitis media to describe a condition in pilots characterized by inflammation, discomfort, pain, tinnitus, and deafness. Since that time, the term otic barotrauma has evolved and is defined as traumatic injury of the tympanic membrane (TM) and middle ear caused by unequilibrium pressure differentials between the middle and external ears. Due to the symptoms listed above, this entity has been widely investigated in terms of its relationship with aviation as a means to identify the pathophysiology and potential treatment for both aircraft personnel and travelers alike.

**Diving-related barotrauma injuries have also been well described.**

### Conclusion

To our knowledge this is the first reported case of roller coaster induced barotrauma. As roller coaster engineers advance, otolaryngologists need to be aware of a new etiology of otic barotrauma.

## References