# Kennedy Terminal Ulcers, Trombley-Brennan Terminal Tissue Injuries, Acute Skin Failure: Mystery Solved?

## Introduction

- Terminal skin lesions have remained an etiological mystery since they were first described in the 19th century by Dr. Charcot.
- These lesions are distinct from typical pressure injuries (PIs).
- Clinical manifestations include Kennedy terminal ulcerations (KTUs) and Trombley-Brennan terminal tissue injuries (TB-TTIs).
- TB-TTIs do not ulcerate, are found on the legs, and are associated with a more rapid death than KTUs.
- Most occur in the sacral, coccygeal, and gluteal areas, with fewer reports in lower extremities, spine, or ribs.
- Terminal ulcerations are thought to develop due to hypoperfusion of tissues in the final stages of life.
- Everyone develops hypoperfusion before death, but not everyone develops terminal skin changes. What is the difference between the two groups?

## Results

- We reviewed arterial aberrancies in the sacrococcygeal area, buttocks, and lower extremities. Anatomic aberrancies of the median sacral artery (MSA), lateral sacral artery (LSA), and persistent sciatic artery (PSA) are likely responsible for development of terminal skin lesions at the time of hypotension.
- We believe that KTUs, TB-TTIs, and "acute skin failure" have the same etiology-local arterial aberrancies. Our hypothesis is based on anatomy and physics.

Anatomy 2.1% of cases Lumbar arteries (paired) Ø=0.3 cr Internal iliac artery Ø=0.7 cm Common iliac artery (paired) Ø=1 cm Figure 1. Normal anatomy of Lateral Median sacral artery (MSA) Ø=0.2 cm sacral artery (LSA) Ø<0.2 cm pelvic arteries & MSA and LSA agenesis. Figure 2. 90% of cases 4% of cases MSA Aberrancies. Lumbar arteries (paired) Ø=0.3 cm Common iliac artery iliac artery (paired) Ø=1 cm (paired) Ø=1 cm MSA MSA 

The MSA and LSA provide blood to the coccyx and sacrum along with a network including the spinal artery, inferior gluteal artery, and superior gluteal artery. The MSA is agenetic in 2.1% of individuals while the LSA is absent in 0.3% of individuals. Both scenarios leave the sacral blood supply dependent on collateral circulation. When the MSA is present, it originates from the infrarenal aorta in 90% of cases; third, fourth, or fifth lumbar artery in 6% of cases; and common iliac artery in 4% of cases. The MSA is a small vessel with a diameter of only 2 mm compared to 2 cm for the infrarenal aorta, 3 mm for the lumbar arteries, and 1 cm for the common iliac artery. The LSA typically originates from the posterior division of the internal iliac artery; but has also been found to originate from the superior or inferior gluteal arteries. The internal iliac artery is much larger than the superior or inferior gluteal arteries, with a diameter of 7 mm versus about 1-1.5 mm. The PSA provides initial blood supply to the developing lower limb of the fetus. A lack of regression leads to a persistent sciatic artery and an underdeveloped femoral artery. The incidence of PSA is 0.025% to 0.6%, with bilateral persistence in 32% of cases. Six variants are described. Underdeveloped extremity arterial circulation can lead to Trombley Brennan Terminal Tissue Injuries.

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Figure 3. Six variants of a persistent sciatic artery.



—— Persistent sciatic artery (PSA) —— Femoral artery

## Discussion

# (MSA agenesis) 0.3% of cases MSA (LSA agenesis) LSA (agenesis) 6% of cases Lumbar arteries L4 (paired) Ø=0.3 cm MSA Type 5

Physics

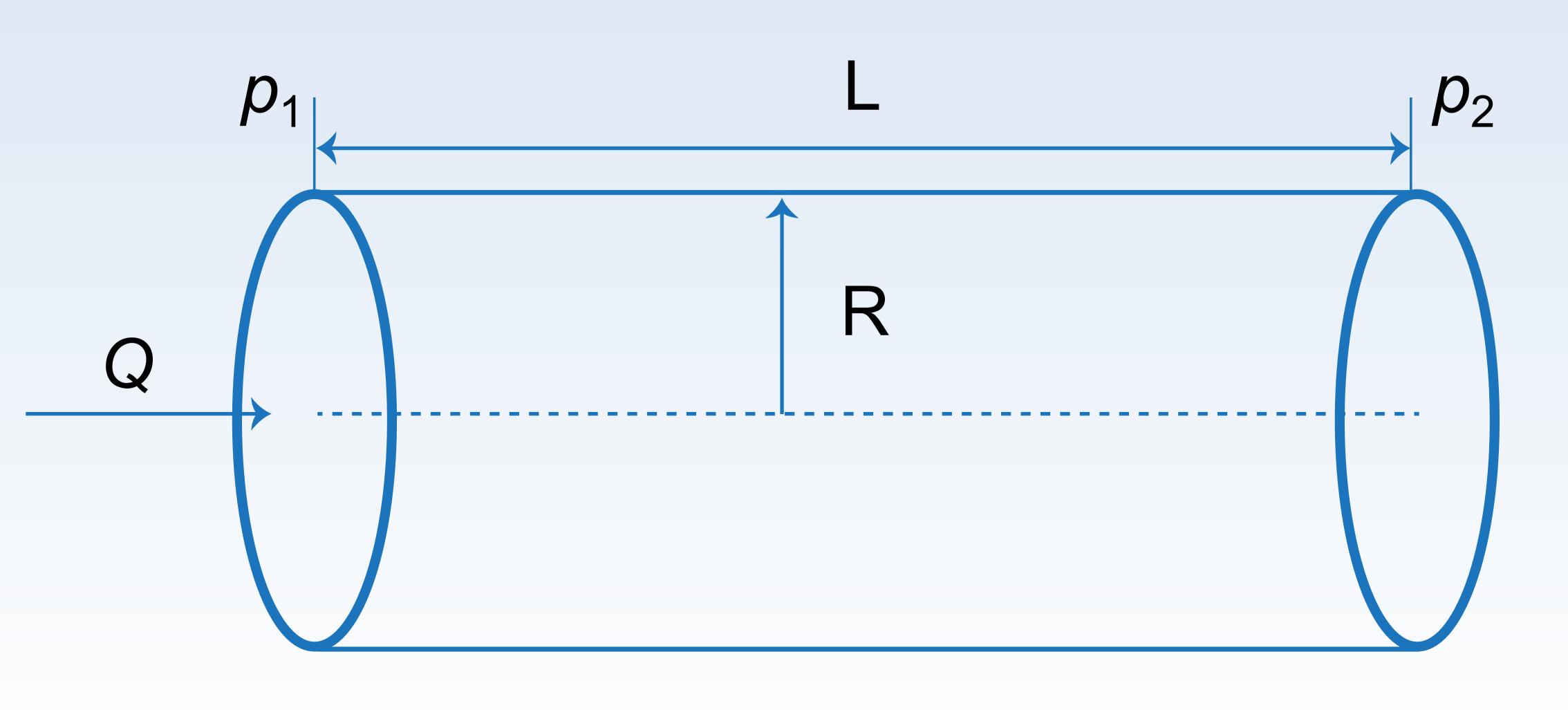
According to the Hagan-Poiseuille equation, the pressure of liquid flowing through a pipe is inversely proportional to the radius to the fourth power. So, even a slight decrease in the pipe's radius results in a significant pressure change. Fluid flow relies directly on this pressure difference; if it's minimal or absent, fluid flow decreases. In arterial anomalies, where there's a small change in diameter, the pressure gradient is lower, resulting in reduced flow. This reduction in flow causes inadequate perfusion, leading to hypoperfusion and ischemia. We'll illustrate this using the example of the median sacral artery.

## Pressure gradients dependent on MSA origination

- 1) 2 cm (diameter of the infrarenal aorta) to 0.2 cm (diameter of the MSA): Pressure gradient increases 10,000 times.
- 2) 1 cm (diameter of the common iliac artery) to 0.2 cm (diameter of the MSA): Pressure gradient increases 625 times.
- 3) 0.3 cm (diameter of the lumbar artery) to 0.2 cm (diameter of the MSA): Pressure gradient increases approximately 5 times.

Based on our calculations, the pressure gradient is roughly 2,000 times lower when the MSA originates from an aberrant lumbar artery compared to when it originates from the infrarenal aorta.

Figure 4. Blood flow (Q) in the pipe is dependent on the pressure difference (p1-p2).





## Conclusion

- Terminal lesions arise because decreased blood flow exposes previously compensated arterial aberrancies, leading to tissue ischemia and necrosis.
- External pressure may contribute to formation of terminal skin lesions located in pressure areas. However, terminal skin lesions may not form without underlying anatomic arterial aberrancy.
- The authors suggest (antemortem) abdominal computed tomography angiography with lower extremity runoff, or postmortem evaluation of aberrant blood vessels) to confirm or deny the hypothesis.

## References

