Comparison of outcomes between two surgical approaches used to remove uroliths in desert tortoises: A retrospective analysis of 108 cases

Brian Jochems, B.S.[1], Nadine Lamberski, DVM, DACZM[2], and Carmel Witte, M.S.[3]

[1] University of Missouri College of Veterinary Medicine, Columbia, MO
[2] Veterinary Services, San Diego Zoo Safari Park
[3] Wildlife Disease Laboratories, Institute for Conservation Research, San Diego Zoo Global

Introduction

- Bladder uroliths are a common pathologic finding in the Mojave desert tortoise (*Gopherus agassizii*).
- These calculi, usually urate in origin, can be due to dehydration, but also form due to nutritional imbalances or abnormal urine pH.
- Surgical removal of large uroliths is recommended using one of two techniques: a prefemoral approach or a plastronotomy.
- Factors to determine which surgical approach to use include sex, time of year, size of stone, size of tortoise, and surgeon's preference.
- The goal of this study is to compare the two surgical techniques to determine which is associated with the best patient outcomes.

Methods

- Abstracted data from 108 medical records from tortoises that had surgery to remove uroliths (66 prefemoral approach and 42 plastronotomy) at the San Diego Zoo Safari Park from June 2009 to July 2014
- Inclusion criteria were routine surgical procedures performed on healthy, asymptomatic adult tortoises
- Descriptive statistical analysis performed
- Two-by-two contingency tables created using intraoperative complications compared with variables such as surgical technique, gender, tortoise weight, and stone area to calculate odds ratios
- Intraoperative complications included bladder tears, moderate to severe coelomic contamination, excessive hemorrhage due to paramedian vein damage, and inability to locate bladder stone

Results

Population	Total Cases	Cases with Intraoperative complications	Males / Females	Avg. Surgery Duration (min)	Number of stones removed	Avg. Stone Area (cm^2)[a]	Avg. MCL[b] to stone ratio (% of MCL)	Urine pH
Overall	108	31	61/ 47	108 (98.8-117.2)	141	37.49 (33.4- 41.6)	21.58 (20.61-22.55)	7.7 (7.5-7.9)
Prefemoral	66	18	52/ 14	123.44 (110.2-136.7)	94	34.94 (29.6- 40.2)	20.67 (19.34-22.01)	
Plastronotomy	42	13	9/ 33	85.61 (78.0-93.2)	47	42.6 (36.3-48.9)	23.01 (21.75-24.27)	

Figure 1. Population characteristics of cases used in study are outlined. 95% Confidence Intervals are included in parenthesis when applicable.
[a] Average stone area is crude value based on longest length of stone parallel to midline multiplied by longest width of stone perpendicular to midline.
[b] MCL = Midline carapace length, stone length used for comparison is longest length of stone parallel to midline

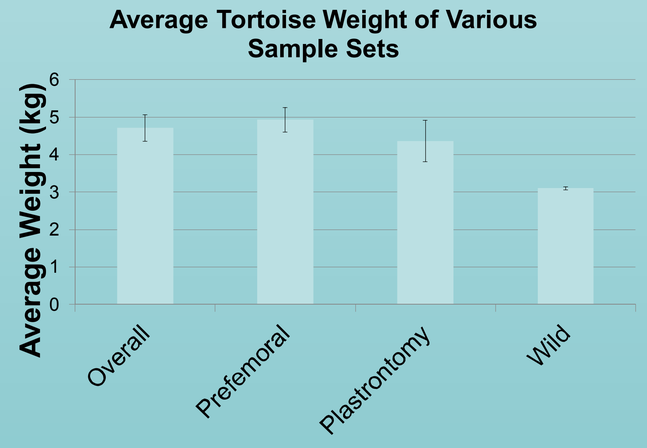


Figure 2. Graph depicting the average weight of tortoises in all 108 cases - 66 prefemoral cases, 42 plastronotomy cases, and 203 wild desert tortoises.[1] Error bars show 95% confidence.

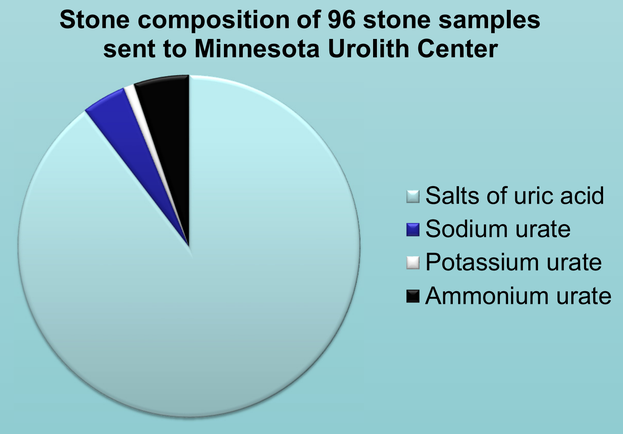


Figure 3. Reported compositions of stones removed from tortoises in these cases and sent to the Minnesota Urolith Center for analysis.

		Intraoperative Complications: Yes	No
Surgery Type Performed	Prefemoral	18	48
	Plastronotomy	13	29

Odds Ratio: 0.8365 (0.3578-1.956)

		Intraoperative Complications: Yes	No
Gender	Female	18	29
	Male	13	48

Odds Ratio: 2.292 (0.9802-5.358)

		Intraoperative Complications: Yes	No
Tortoise Weight	Above average	26	63
	Below average	5	14

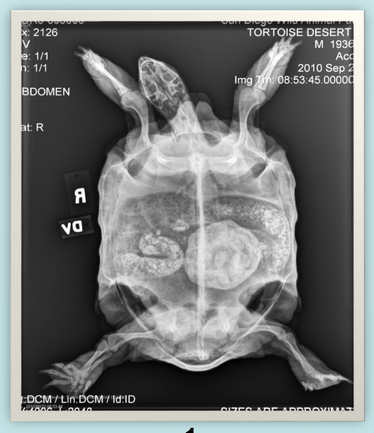
Odds Ratio: 1.156 (0.3776-3.537)

		Intraoperative Complications: Yes	No
Stone Area	Above average	23	36
	Below average	8	41

Odds Ratio: 3.274 (1.304-8.221)

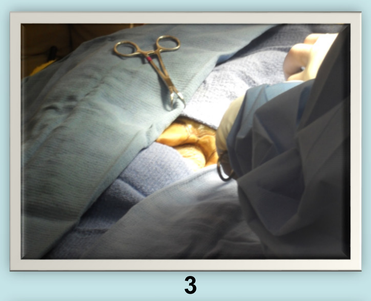
Figure 4. Set of four 2 x 2 contingency tables comparing intraoperative complications with a variety of risk factors (surgery type performed, gender, tortoise weight (kg), and stone area (cm^2)). Average weight based on wild desert tortoise data[1] (3.1 kg) and average stone area based on average of cases (37.5 cm^2).

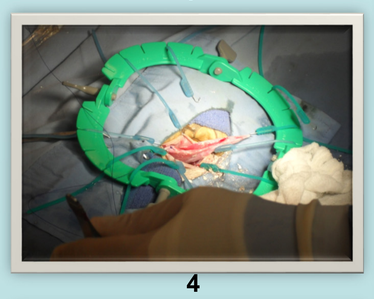
Surgical Techniques

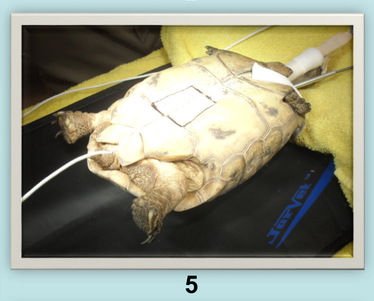


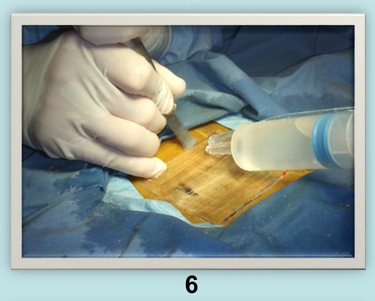
1

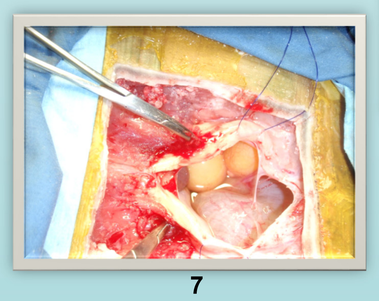

2

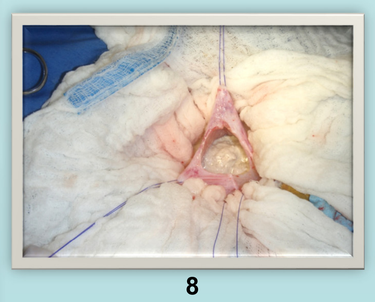

3

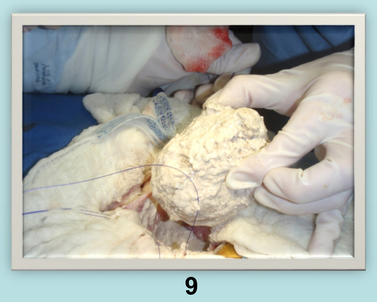

4


5


6


7


8


9

Images1-9. 1) Radiograph of a desert tortoise with bladder stone; the gold standard for diagnosing uroliths. 2) Tortoise receiving anesthetics intramuscularly. 3) Tortoise prepped for prefemoral approach. The left prefemoral fossa is visible; incision In the skin will be made just cranial to hindlimb to access coelomic cavity. 4) Bladder exteriorized through a prefemoral incision and then incised. Large stones were crushed or broken apart in the bladder and smaller stone fragments removed. 5) Tortoise prepped for plastron approach. 6) Surgical saw used to remove section of plastron. 7) Coelomic membrane incised exposing bladder. 8) Bladder incised exposing urolith. 9) Urolith being removed from the bladder; plastron fragment will be replaced and resin applied to seal the shell.

Conclusion & Future Studies

Based on the preliminary findings, the most significant risk factor associated with intraoperative complications of the four variables analyzed is the area of the stone being removed, with larger stones being three times more likely to result in intraoperative complications. Based on the odds ratio of 0.84 between the prefemoral and plastronotomy techniques, there is no difference between the two in terms of intraoperative complications .

Additional statistical calculations, such as regression modeling, can be used to strengthen associations between surgical type and intraoperative complications. Other measures of surgical outcome could also be analyzed, such as time to return to normal function (eating and defecating) or post-surgical survival. In addition, work is being done to medical management of uroliths such as dissolution of stone in the bladder.

Acknowledgements

We gratefully acknowledge the University of Missouri College of Veterinary Medicine, San Diego Zoo Global, and US Fish and Wildlife Service Desert Tortoise Grant for funding this project. We also acknowledge the San Diego Zoo Veterinary Services, including DVMs, RVTs, keepers and administrative staff who assisted in the surgical procedures and care of the tortoises, along with the staff of the Desert Tortoise Conservation Center.

References

Wild desert tortoise data taken from the following study:
1. Dickinson, V. M., J. L. Jarchow, and M. H. Trueblood. 2002. Hematology and plasma biochemistry reference range values for free-ranging desert tortoises in Arizona. Journal of Wildlife Diseases 38: 143-153.