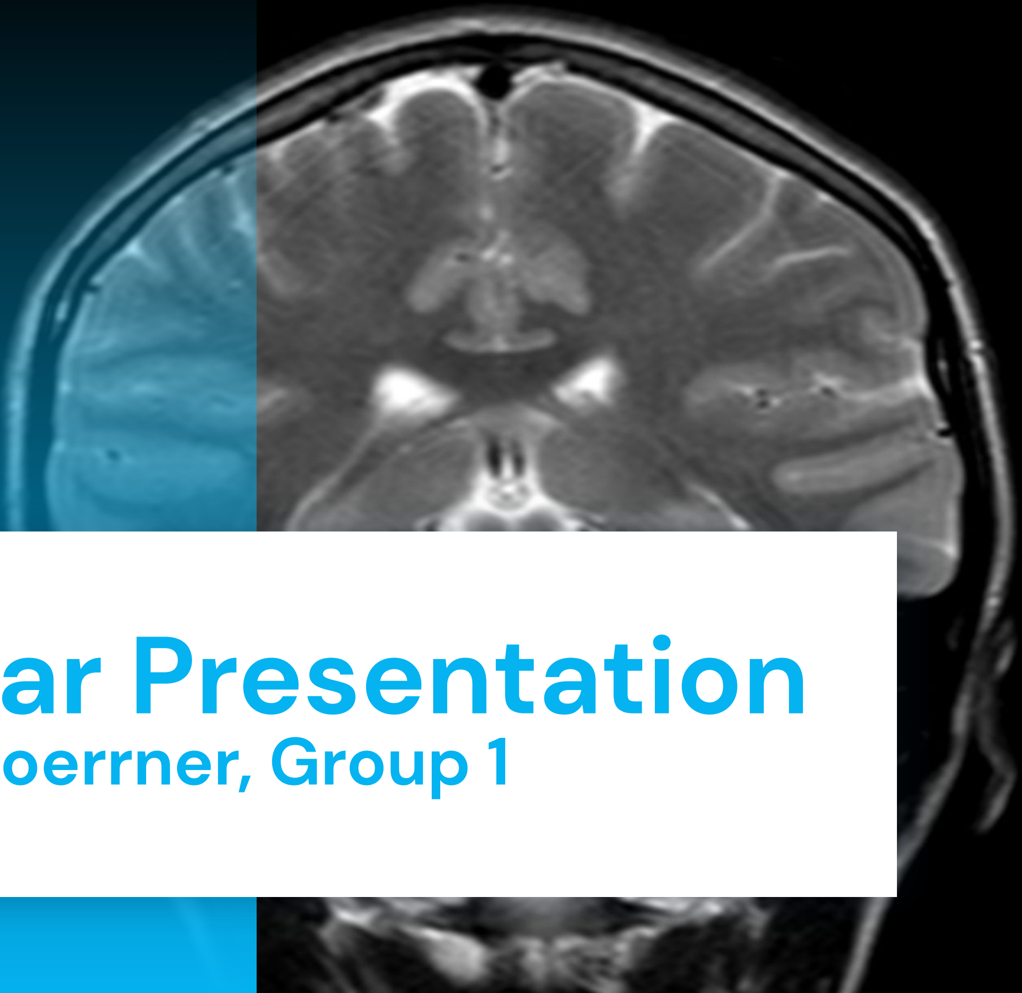


Seminar Presentation

Caroline Hoerrner, Group 1

Our Project: Key Points

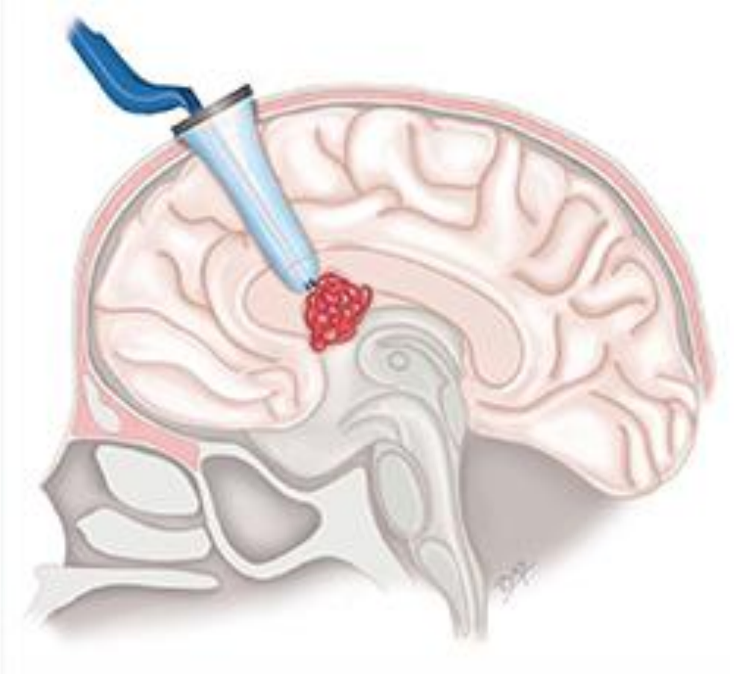
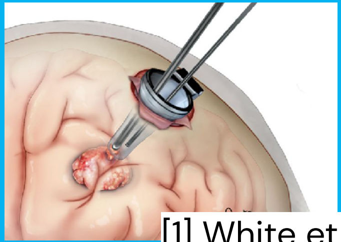


Image sourced from University of Miami Health System

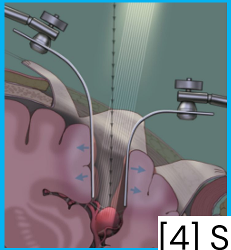
Our Project: Key Points

A



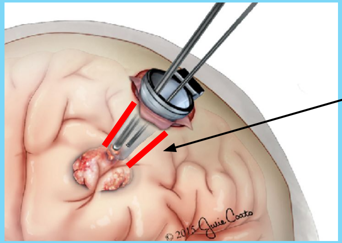
[1] White et al.

VS



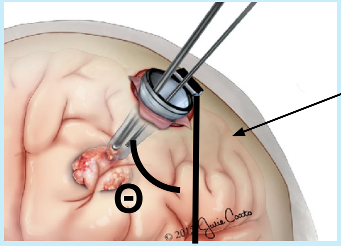
[4] Speltzer et al.

B



** Force exerted on surrounding tissue **

C



Orientation Angle

[1]
White, Tim et al. “**Frameless Stereotactic Insertion of Viewsite Brain Access System with Microscope-Mounted Tracking Device for Resection of Deep Brain Lesions: Technical Report**.” *Cureus* vol. 9,2 e1012. 4 Feb. 2017, doi:10.7759/cureus.1012

[2]
Marcus HJ, Zareinia K, Gan LS, Yang FW, Lama S, Yang GZ, Sutherland GR. **“Forces exerted during microneurosurgery: a cadaver study.”** Int J Med Robot. 2014 Jun;10(2):251-6. doi: 10.1002/rcs.1568. Epub 2014 Jan 16. PMID: 24431265; PMCID: PMC4377085.

[3]
Janota A, Šimák V, Nemec D, Hrbček J. **Improving the Precision and Speed of Euler Angles Computation from Low-Cost Rotation Sensor Data**. *Sensors*. 2015; 15(3):7016-7039. https://doi.org/10.3390/s150307016

1. Frameless Stereotactic Insertion of Viewsite Brain Access System with Microscope-Mounted Tracking Device for Resection of Deep Brain Lesions: Technical Report.

Selected

- Outlines use case for our project.
- Highlights current successes and pitfalls of the procedure.

Summary

- Defines efficient surgical workflow making use of neuronavigation, surgical microscope, and tubular retractor.
- Significant for defining future of this procedure.

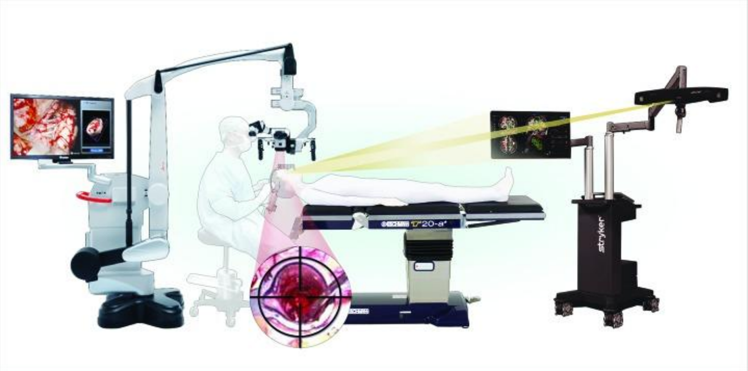
1. Insertion of Viewsite Brain Access System with Microscope-Mounted Tracking Device

Experiment

- Performed 3 cases of deep lesion resection
- Combined VBAS, neuronavigation, and microsurgery to allow for accurate approach with minimal tissue disturbance

Results

- Cases performed successfully with no complications and no post-procedure neurological symptoms



Surgical Setup. [1] White et al.

1. Insertion of Viewsite Brain Access System with Microscope-Mounted Tracking Device

Key Information Gathered

- Minimize time spent away from the surgical microscope
- Tubular retractor mobility aids resection
- Maneuverability of longer retractors is limited

1. Insertion of Viewsite Brain Access System with Microscope-Mounted Tracking Device

In my opinion – Good

- Provides detailed workflow
- Comprehensive overview of benefits of technology

In my opinion – Needs Improvement

- Quantifying the improvements to the procedure
- More data

2. Forces exerted during microneurosurgery: a cadaver study.

Selected

- Provides guidelines for minimizing parenchymal damage.

Summary

- Performed common microneurosurgical procedures and tested resulting force to brain
- Significant for identifying forces leading to injury.

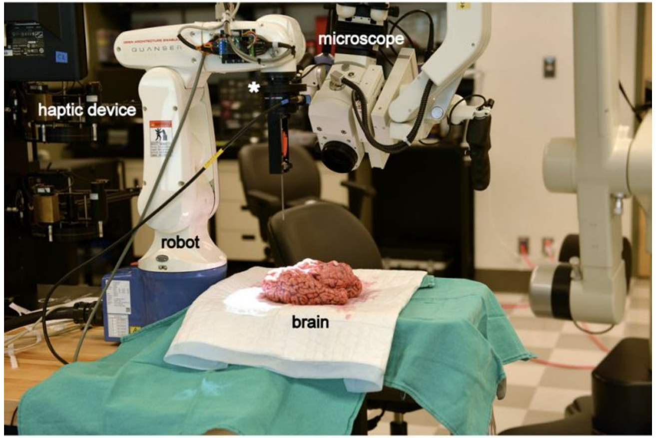
2. Forces exerted during microneurosurgery: a cadaver study

Experiment

- Performed incision and retraction maneuvers using force/torque sensor fitted onto 6 DOF robot arm.
- Determined average force of procedure, average force of injury

Results

- Average force to retract brain tissue 5mm(0.08N) was greater than the force of either stab incision(0.01N) or carrying incision(0.05N)
- Force exerted during sharp and blunt dissection were significantly different (0.03N compared to 0.22N)



Experimental Setup. [2] Marcus et al.

2. Forces exerted during microneurosurgery: a cadaver study

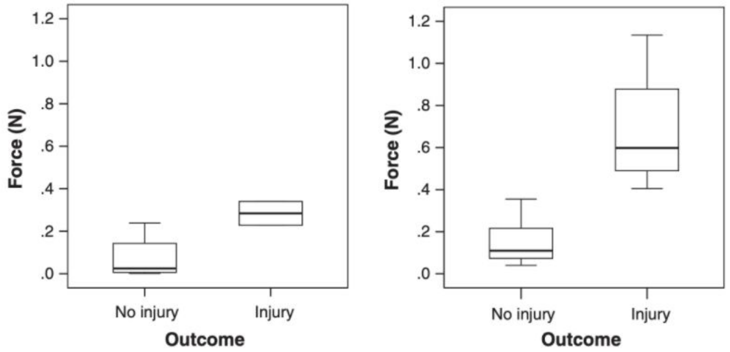
Key Information Gathered

- Retraction requires more force than other maneuvers
- Blunt dissection requires more force than other maneuvers

Table 1. The median (interquartile range) of forces exerted (Newton) when performing simple procedures in different brain regions

		Median (interquartile range)		
		Stab Incision	Carrying Incision	Retraction
Cerebrum (n = 24)	Gyrus rectus (n = 8)	<0.01 (0.00 – 0.03)	0.02 (0.01 – 0.03)	0.03 (0.03 – 0.05)
	Inferior temporal gyrus (n = 8)	<0.01 (0.00 – 0.01)	0.02 (0.00 – 0.03)	0.07 (0.06 – 0.09)
	Middle frontal gyrus (n = 8)	<0.01 (0.00 – 0.01)	0.15 (0.12 – 0.18)	0.08 (0.06 – 0.10)
Cerebellum (n = 12)	Cerebellar hemisphere (n = 8)	0.01 (0.00 – 0.01)	0.03 (0.02 – 0.04)	0.08 (0.02 – 0.13)
	Cerebellar vermis (n = 4)	0.02 (0.01 – 0.02)	0.12 (0.12 – 0.12)	N.A.
Brainstem (n = 22)	Midbrain (n = 6)	0.01 (0.00 – 0.01)	0.11 (0.04 – 0.26)	0.15 (0.13 – 0.20)
	Pons (n = 8)	<0.01 (0.00 – 0.01)	0.05 (0.04 – 0.06)	0.18 (0.12 – 0.21)
	Medulla (n = 8)	0.01 (0.01 – 0.03)	0.09 (0.06 – 0.16)	0.09 (0.06 – 0.11)
Other (n = 8)	Corpus callosum (n = 4)	0.01 (0.00 – 0.03)	0.23 (0.09 – 0.43)	N.A.
	Perforating floor of third ventricle (n = 4)	<0.01 (0.00 – 0.01)	N.A.	N.A.

N.A. = Not applicable.



Results. [2] Marcus et al.

2. Forces exerted during microneurosurgery: a cadaver study

In my opinion – Good

- Identifying different types of forces
- Testing different regions of the brain

In my Opinion – Needs Improvement

- Integrity of specimen
- Identifying specific thresholds of injury

3. Improving the Precision and Speed of Euler Angles Computation from Low-Cost Rotation Sensor Data

Selected

- Provides optimal way to deal with IMU data.

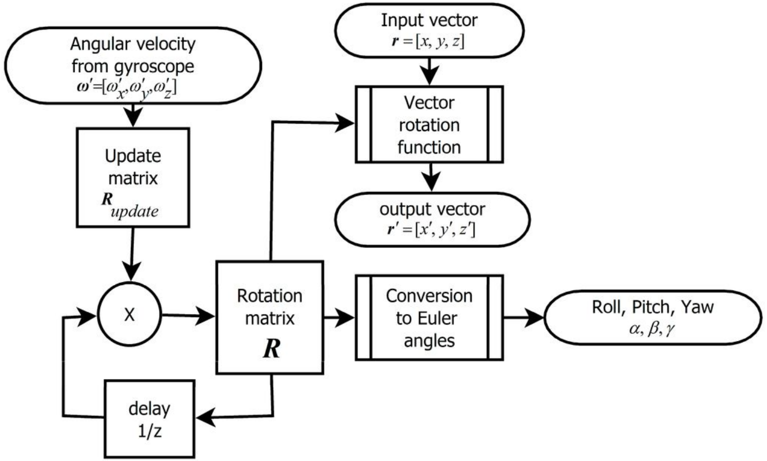
Summary

- Authors tested sample motion data by interpreting gyroscope angular velocity values into rotation matrices, quaternions, and euler angles.
- Significant in providing best case representation given computing power and sampling frequency.

2. Improving the Precision and Speed of Euler Angles Computation

Experiment

- Created 120 s of simulated motion data
- Interpreted angular velocity into euler angles, rotation matrices, and quaternions
    - Calculated both quaternions and rotation matrices using precise and fast methodology
- Interpreted error



Algorithm. [3] Janota et al.

3. Improving the Precision and Speed of Euler Angles Computation

Results & Key Information

Table 1. Comparison of methods in terms of 8-bit AVR processor clock cycles.

Algorithm	Updating of the Rotational Matrix	Integration of the Euler Angle Rates	Updating of the Quaternion
Redundancy (count of variables)	**9	****3	***4
Gyroscope data processing (rotation update)	*** + 17,230 (6034 +)	***14,750	****11,462 (5120 +)
Normalization	**12,265	*****0	****1972
Vector transformation	****2301	*15,231 3)	***4321
Transformation to the rotational matrix	*****0	**12,930	****3536
Transformation to Euler angles	****7820	*****0	***10,673
Transformation to quaternion	***3370	**13,020	*****0
Clock cycles for the gyroscope-only system 1)	37,315 (26,119 +)	14,750	24,107 (17,765 +)
Clock cycles for the compensated system 2)	40,281 (29,085 +)	29,981 3)	39,476 (33,134 +)

Table 3. Accuracy of the algorithms.

Sampling Frequency	Maximal Error of the Algorithm during 120 s of Simulated Movement				
	Matrix-Based Algorithm		Integration of Euler Angle Rates	Quaternion-Based Algorithm	
	Fast	Precise	Step Integration	Fast	Precise
10 Hz	>180°	8°	>180°	30°	8°
50 Hz	4°	1°	>180°	1°	1°
100 Hz	1°	0.6°	>180°	0.6°	0.6°
500 Hz	0.1°	0.1°	8°	0.1°	0.1°
1000 Hz	0.06°	0.06°	4°	0.06°	0.06°

Results. [3] Janota et al.

3. Improving the Precision and Speed of Euler Angles Computation

In my opinion – Good

- Concise
- Clear illustration of pros and cons of each method
- Robust sampling frequency

In my opinion – Needs Improvement

- Model specifications

References

White, Tim et al. “Frameless Stereotactic Insertion of Viewsite Brain Access System with Microscope-Mounted Tracking Device for Resection of Deep Brain Lesions: Technical Report.” *Cureus* vol. 9,2 e1012. 4 Feb. 2017, doi:10.7759/cureus.1012

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Supplemental References

Spetzler et al. The quiet revolution: retractorless surgery for complex vascular and skull base lesions. Journal of Neurosurgery. 116:291-300, 2012

Questions & Feedback