Endovascular Treatment of Acute Ischemic Stroke:
Role of Remote Robotic Stroke Treatment

Satoshi Tateshima, MD, DMSc
Professor, Radiological Sciences & Neurological Surgery
Division of Interventional Neuroradiology
David Geffen School of Medicine at UCLA,

COI Disclosures 2020-2023

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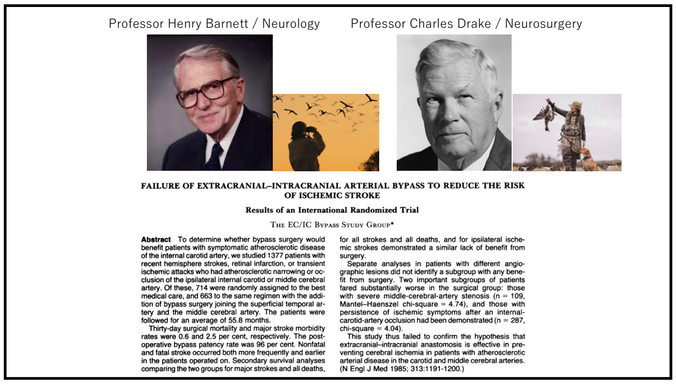


FAILURE OF EXTRACRANIAL–INTRACRANIAL ARTERIAL BYPASS TO REDUCE THE RISK OF ISCHEMIC STROKE

Results of an International Randomized Trial

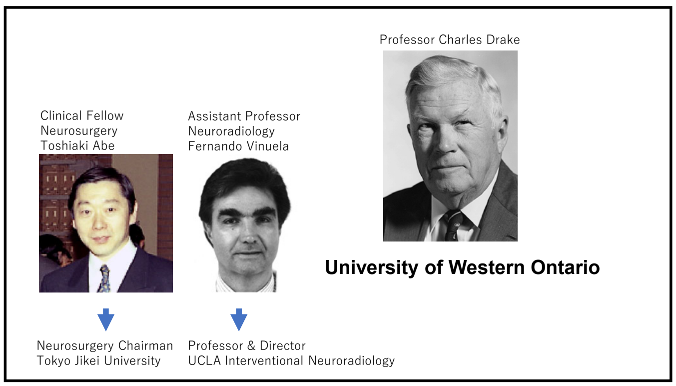
THE EC/IC BYPASS STUDY GROUP*

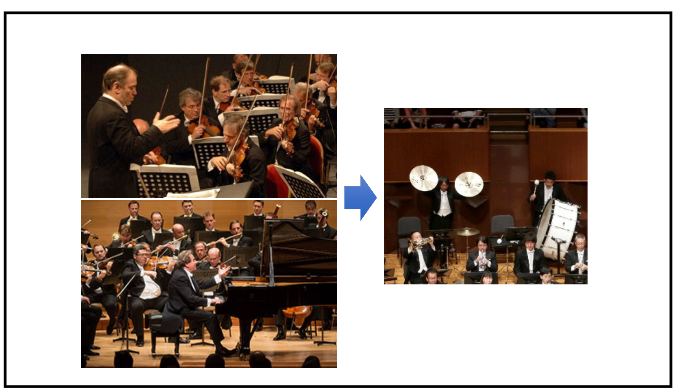
Abstract To determine whether bypass surgery would benefit patients with symptomatic atherosclerotic disease of the internal carotid artery, we studied 1377 patients with recent hemisphere strokes, retinal infarction, or transient ischemic attacks who had atherosclerotic narrowing or occlusion of the ipsilateral internal carotid or middle cerebral artery. Of these, 714 were randomly assigned to the best medical care, and 663 to the same regimen with the addition of bypass surgery joining the superficial temporal artery and the middle cerebral artery. The patients were followed for an average of 55.8 months.

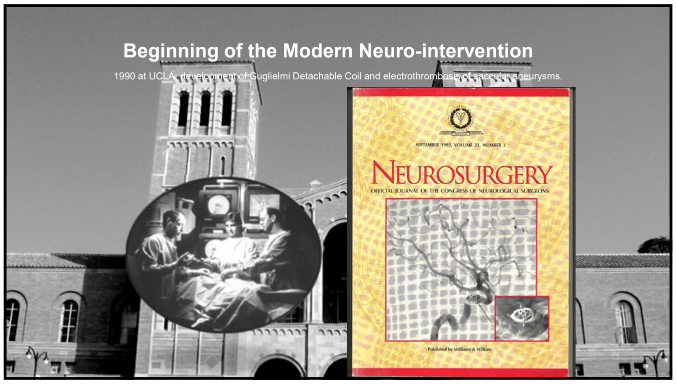
Thirty-day surgical mortality and major stroke morbidity rates were 0.6 and 2.5 per cent, respectively. The postoperative bypass patency rate was 96 per cent. Nonfatal and fatal stroke occurred both more frequently and earlier in the patients operated on. Secondary survival analyses comparing the two groups for major strokes and all deaths, for all strokes and all deaths, and for ipsilateral ischemic strokes demonstrated a similar lack of benefit from surgery.

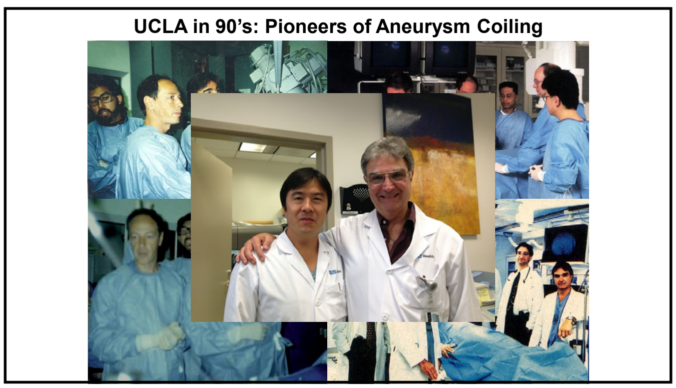
Separate analyses in patients with different angiographic lesions did not identify a subgroup with any benefit from surgery. Two important subgroups of patients fared substantially worse in the surgical group: those with severe middle-cerebral-artery stenosis (n = 109, Mantel–Haenszel chi-square = 4.74), and those with persistence of ischemic symptoms after an internal-carotid-artery occlusion had been demonstrated (n = 287, chi-square = 4.04).

This study thus failed to confirm the hypothesis that extracranial–intracranial anastomosis is effective in preventing cerebral ischemia in patients with atherosclerotic arterial disease in the carotid and middle cerebral arteries. (N Engl J Med 1985; 313:1191-1200.)






Beginning of the Modern Neuro-intervention
1990 at UCLA: development of Guglielmi Detachable Coil and electrothrombosis of saccular aneurysms.
SEPTEMBER 1992, VOLUME 31, NUMBER 3
NEUROSURGERY


UCLA in 90's: Pioneers of Aneurysm Coiling


Robocath
https://www.robocath.com/
microbot medical
https://microbotmedical.com/
Xcath
https://www.xcathinc.com
SIEMENS Healthineers
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Vascular Robotics
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Press Releases

BACK to PRESS RELEASES

Corindus Names Aquilla S. Turk, D.O. as Chief Medical Officer, Neuroendovascular

July 11, 2018

Steering Committee of 8 Neurovascular Physicians Developed to Advance Robotic Technology for Neurovascular Interventions and Acute Stroke Care

WALTHAM, Mass.--(BUSINESS WIRE)-- Corindus Vascular Robotics, Inc. (NYSE American:CVRS), a leading developer of precision vascular robotics, announced today that Aquilla "Quill" Turk, D.O. has joined the company as Chief Medical Officer, Neuroendovascular. Dr. Turk is a practicing physician at the Medical University of South Carolina where he serves as Director of the Stroke and Cerebrovascular Program, Director of the Neuroendovascular Program, and Professor with a joint appointment in the Departments of Radiology and Neurosurgery. Dr. Turk will serve alongside Dr. Aaron Grantham, Corindus' Cardiovascular CMO, to spearhead the company's clinical initiatives and expand robotic treatment into neurovascular procedures, specifically targeting acute ischemic stroke.

"I am pleased to welcome Dr. Turk to the Corindus team. His guidance and expertise will be critical as we expand our focus and technology to include treatment for neurovascular interventions." stated Mark Toland. President and Chief Executive Officer of Corindus. "We strongly believe that our technology pipeline can add value across the spectrum of vascular interventions, with remote access and advanced robotic capabilities at the forefront of our strategy."

In addition to Dr. Turk's appointment, Corindus has established a Physician Steering Committee dedicated to Neuroendovascular Procedures, which will be led by Dr. Turk. Members include:

- **Ricardo A. Hanel, M.D., Ph.D.,** Baptist Health System, Jacksonville, FL
- **Tudor G. Jovin, M.D.,** University of Pittsburgh Medical Center, Pittsburgh, PA
- **J. Mocco, M.D.,** The Mount Sinai Hospital, New York, NY
- **Raul G. Nogueira, M.D.,** Grady Memorial Hospital, Atlanta, GA
- **Vitor Mendes Pereira, M.D.**, MSc, Toronto Western Hospital-University Health Network, Toronto, ON
- **Adnan Siddiqui, M.D.,** Toshiba Stroke & Vascular Research Center, UB, Buffalo, NY
- **Satoshi Tateshima, M.D.,** Ronald Reagan UCLA Medical Center, Santa Monica, CA
- **Raymond D. Turner, M.D.,** Medical University of South Carolina, Charleston, SC

Corindus
Vascular Robotics

Corindus
Vascular Robotics

New Devices and Techniques

CASE REPORT

First-in-human, robotic-assisted neuroendovascular intervention

Vitor Mendes Pereira,[1] Nicole Mariantonia Cancelliere,[2] Patrick Nicholson,[1] Ivan Radovanovic,[3] Kaitlyn E Drake,[4] John-Michael Sungur,[4] Timo Krings,[1] Aquilla Turk[4,5]

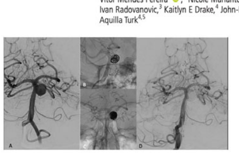


Figure 1 Digital subtraction angiography (DSA) images during the robotic-assisted neurointerventional procedure (anterior-posterior view). (A) Preoperative imaging of a right vertebral injection showing the sidewall basilar trunk aneurysm measuring 12 mm × 11 mm. (B) DSA per-procedure imaging showing the Atlas stent deployed at the basilar artery below the bifurcation and across the aneurysm neck, and the first coil deployed inside the aneurysm. (C) Final DSA demonstrating the final coil cast. (D) Final DSA showing the aneurysm occluded and a patent stent, with no perioperative complications.

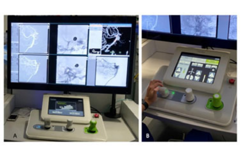


Figure 3 The operator's perspective. (A) The screen and the control console. The robotic arm is operated using three joysticks: one for microcatheter, one for microwire and one for the devices (stent and coils). (B) Closer view of the control console showing the screen during coil placement. The small screen shows three columns, each corresponding to a joystick, with additional commands such as millimetric moves for the microcatheter and devices or predefined rotations for the microwires.

14th Congress of the European Society of Minimally Invasive Neurological Therapy
2022 Meeting Abstracts

PDF

P15 Evaluation of effectiveness and safety of the CorPath® GRX System in endovascular embolization procedures of cerebral aneurysms

FREE

M Piotin [1], R Blanc [1], R Turner [2], A Tomasello [3], M Ribo [3], M Galdámez [4], V Costalat [5], N Sourour [6], P Mordasini [7], M Killer-Oberpfalzer [8], H Rice [9], J Spears [10], VM Pereira [11]

Abstract

Introduction Robotic assisted endovascular intervention for percutaneous coronary and peripheral interventions has been available for several years. Robotic assisted neurointervention is a recently available technology with exciting future applications in the treatment of neurovascular diseases.

Aim of the Study The objective of this study was to evaluate the effectiveness and safety of robotic-assisted platform Corpath GRX (Corindus Vascular Robotics of Siemens Healthineers, Newton, Massachusetts) for treating cerebral aneurysms.

Methods This prospective, international, multi-center study enrolled cerebral aneurysm patients with clinical indication for endovascular coil and/or stent-assist coiling embolization. The primary effectiveness endpoint was defined as successful completion of the robotic-assisted endovascular procedure absent any unplanned conversion to manual for guidewire or microcatheternavigation, embolization coil(s) or intracranial stent(s) deployment, or an inability to navigate vessel anatomy.

Results The study enrolled 113 patients (age 56.1 years, 74.3% females) among 10 international sites. Femoral access was obtained in 60.2% while radial in 38.1% patients. The overall procedure time was 114.3 ± 43.5 min with 52.1 ± 27.3 min fluoroscopy time. Robot-assisted endovascular embolization was successfully completed in 107 patients with 94.7% primary effectiveness success. 5 patients underwent conversion to manual for procedure completion with 1 patient each for cassette and control console malfunction respectively.

Conclusions Our initial data demonstrates Corpath GRX System for robotic-assisted neurointerventions as effective and achieving high rates of technical success for cerebral aneurysms treatment.

Siemens Healthineers is cutting back on surgical robotics program

MAY 10, 2023 BY SEAN WHOOLEY

Siemens Healthineers said today that it plans to discontinue the use of its Corindus surgical robotics for cardiology procedures.

The CorPath system. [Image from Siemens Healthineers Endovascular Robotics/Corindus]

On the company's first-quarter earnings call, first reported by *Reuters*, CFO Jochen Schmitz confirmed the strategy shift. He said the "use of Corindus robots for cardiology operations did not fulfill our expectations." Schmitz reportedly added that the timeline for robots for neurological operations to reach the market constitutes "several years."

In 2019, Siemens Healthineers bought out Corindus for $1.1 billion. Corindus develops the CorPath robot-assisted device for coronary and peripheral vascular procedures.

Siemens Calls It Quits in Robotic Heart Surgery

Facing disappointing adoption in cardiology, Siemens Healthineers plans to develop a neurovascular robot instead.

Amanda Pedersen | May 11, 2023

REVIEW ARTICLE

A Review of Robotic Interventional Neuroradiology

C.B. Beaman, N. Kaneko, P.M. Meyers, and S. Tateshima

ABSTRACT

SUMMARY: Robotic interventional neuroradiology is an emerging field with the potential to enhance patient safety, reduce occupational hazards, and expand systems of care. Endovascular robots allow the operator to precisely control guidewires and catheters from a lead-shielded cockpit located several feet (or potentially hundreds of miles) from the patient. This has opened up the possibility of expanding telestroke networks to patients without access to life-saving procedures such as stroke thrombectomy and cerebral aneurysm occlusion by highly-experienced physicians. The prototype machines, first developed in the early 2000s, have evolved into machines capable of a broad range of techniques, while incorporating newly automated maneuvers and safety algorithms. In recent years, preliminary clinical research has been published demonstrating the safety and feasibility of the technology in cerebral angiography and intracranial intervention. The next step is to conduct larger, multisite, prospective studies to assess generalizability and, ultimately, improve patient outcomes in neurovascular disease.

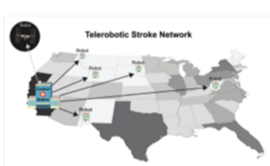
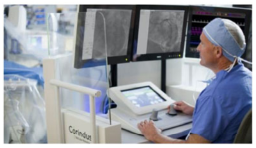


FIG 4. Telerobotic stroke network. A neurointerventionalist at the control station can operate multiple interventional robots to expand networks of care. "Robot" indicates potential sites of patient-side, interventional robots. Gray-scale indicates relative population size of each state.

AJNR 2021 May

'A landmark event': First human patients receive remote PCI

December 06, 2018 | Daniel Allar | Coronary Intervention & Surgery



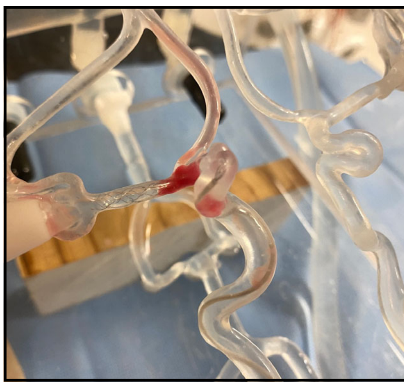
An interventional cardiologist performed percutaneous coronary interventions (PCIs) on five patients located 20 miles away this week—the first truly remote PCIs in human patients.

Researchers have been working toward this milestone for some time, first demonstrating the feasibility of Corindus Vascular Robotics' technology by operating from an adjacent room in a cath lab. They've also performed remote PCIs in pigs, navigating the robotic equipment from 100 miles away in one instance.

"The first in-human cases of remote robotic PCI represent a landmark event for interventional medicine," Tejas Patel, MD, chairman and chief interventional cardiologist at Apex Heart Institute in Ahmedabad, India, said in a press release.

Patel performed the procedures Dec. 4 and 5 from a temple located in Gandhinagar while another physician, Sanjay Shah, MBBS, was in the room with the patients at Apex Heart Institute.

According to Corindus, the success of the initial in-human cases should pave the way for more "tele-stenting" procedures to be performed around the globe.



Endovascular thrombectomy for large vessel occlusions.

NNT of 2 to achieve a 1-point reduction in the mRS score at 90 days based on a DAWN subgroup analysis.

ICS 2018, Dr. Saver, UCLA Professor Neurology

Neuro-endovascular Device Set-up

- Vascular access (groin, arm, wrist, neck, etc)
- Guide Catheter or Diagnostic Catheter
- Coaxial Catheter
- Microcatheter
- Treatment device (coils, stents, stent retrievers)

Corindus Robotic Procedures & Device Set-up

Coronary/IR Robotic System

Neuro-Intervention Robotic System

- Vascular access (groin, arm, wrist, neck, etc)
- Guide Catheter or Diagnostic Catheter
- Coaxial Catheter
- Microcatheter
- Treatment device (coils, stents, stent retrievers)

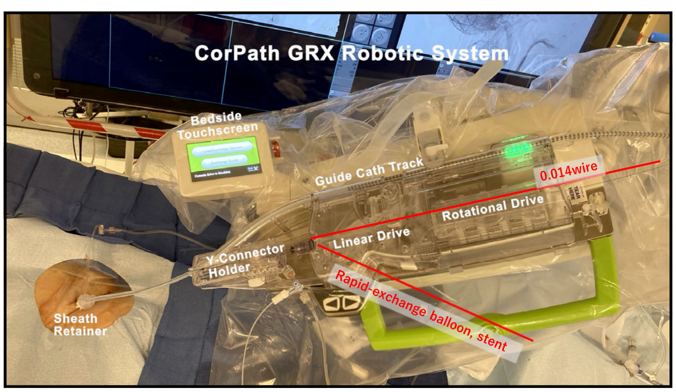
Corindus Robotic Procedures & Device Set-up

Coronary/IR Robotic System

Complete Robotic Neuro-Intervention

Neuro-Intervention Robotic System

- Vascular access (groin, arm, wrist, neck, etc)
- Guide Catheter or Diagnostic Catheter
- Coaxial Catheter
- Microcatheter
- Treatment device (coils, stents, stent retrievers)



Next-Gen Catheter Robotics

Beaman C, Saber H, Tateshima S. J Neurointerv Surg. 2022 Dec;14(12):1284

Robotic Intervention at RR UCLA

Phase 1

- Oct 2020 - Feb 2021, 44 interventional procedures (40 consecutive cases from Oct - Dec) were performed using Corindus CorPath GRX system.
- Nine physicians (6 attending staffs & 3 clinical fellows) operated the robot. All 9 physicians completed Corindus Phase 1 training prior to the clinical usage of the robot.

Phase 2

- Six attending staffs and 1 clinical fellow are fully trained; two clinical fellows under robotic training. Oct 2021 – present, 10 robotic interventional procedures including 6 complete robotic embolization procedures.
- The use of CorPath GRX was disclosed to the all patients at the time of consenting them.

Robotic Intervention at RR UCLA

- Robotic to manual conversion occurred in 11/54 (20.3%) cases.

  Phase 1 23% (10/44) Phase 2 10%* (1/10) * partial conversion

- Diagnostic cerebral angiogram without subsequent treatment was conducted in 27/48 cases. Full robotic success achieved in 20/27 cases (74%).
- For these 20 cases, the mean number of vessels successfully selected was 4.1 (range 1-7), the mean fluoroscopy time was 14.6 minutes (range 4.1 – 23.6 minutes), and the mean radiation exposure to the patients was 59.6 Gy/cm2 (range 26.2 – 102.0 Gy/cm2).

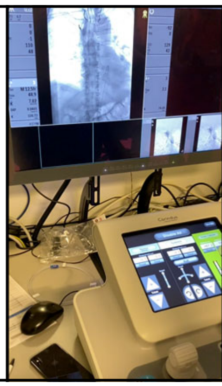
Case report

Robotic assistant spinal angiography: a case report and technical considerations

Satoshi Tateshima,[1] Hamidreza Saber,[1] Geoffrey P Colby,[2] Dieter Enzmann,[3] Gary Duckwiler[1]

Figure 3 Catheter manipulation using a push–pull and rotation joystick control solely based on the visual information.

JNIS / BMJ Case Rep. 2021 Mar 10;14(3):1-3

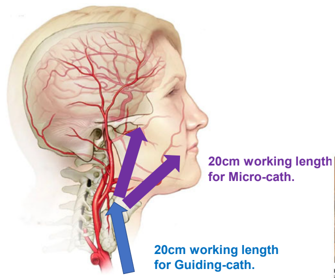


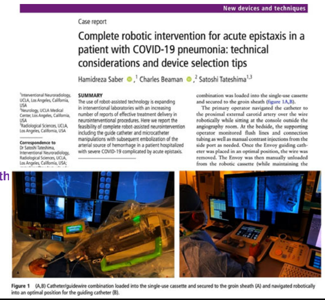
Reasons for Manual Conversion

- Tough anatomy (robotic failure & manual failure)
- Tough anatomy (robotic failure & manual success)
- Unable to form Sim2 cath.
- Cassette malfunction
- Patient body interference
- Switching catheter
- Robotic arm too short
- Robotic arm too limited ROM

Complete Robotic Intervention

Robotic system controlled guiding cath, microcath, microwire, coil





New devices and techniques

Case report

Complete robotic intervention for acute epistaxis in a patient with COVID-19 pneumonia: technical considerations and device selection tips

Hamidreza Saber [1], Charles Beaman [2], Satoshi Tateshima [1,3]

[1]Interventional Neuroradiology, UCLA, Los Angeles, California, USA
[2]Neurology, UCLA Medical Center, Los Angeles, California, USA
[3]Radiological Sciences, UCLA, Los Angeles, California, USA

Correspondence to
Dr Satoshi Tateshima, Interventional Neuroradiology, Radiological Sciences, UCLA, Los Angeles, California, USA;

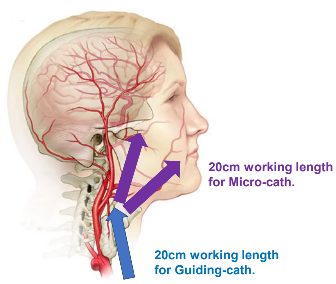
SUMMARY
The use of robot-assisted technology is expanding in interventional laboratories with an increasing number of reports of effective treatment delivery in neurointerventional procedures. Here we report the feasibility of complete robot-assisted neurointervention including the guide catheter and microcatheter manipulations with subsequent embolization of the arterial source of hemorrhage in a patient hospitalized with severe COVID-19 complicated by acute epistaxis.

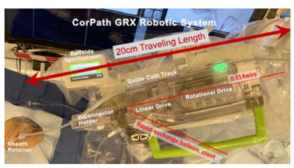
combination was loaded into the single-use cassette and secured to the groin sheath (figure 1A,B).
The primary operator navigated the catheter to the proximal external carotid artery over the wire robotically while sitting at the console outside the angiography room. At the bedside, the supporting operator monitored flush lines and connection tubing as well as manual contrast injections from the side port as needed. Once the Envoy guiding catheter was placed in an optimal position, the wire was removed. The Envoy was then manually unloaded from the robotic cassette (while maintaining the

Figure 1 (A,B) Catheter/guidewire combination loaded into the single-use cassette and secured to the groin sheath (A) and navigated robotically into an optimal position for the guiding catheter (B).

Complete Robotic Intervention

Robotic system controlled guiding cath, microcath, microwire, coil





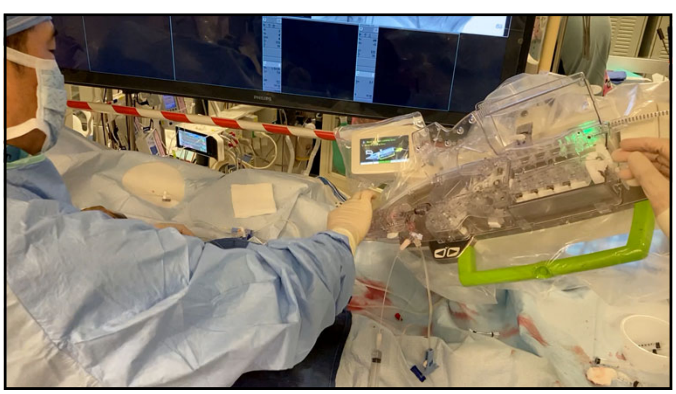
Complete Robotic Intervention

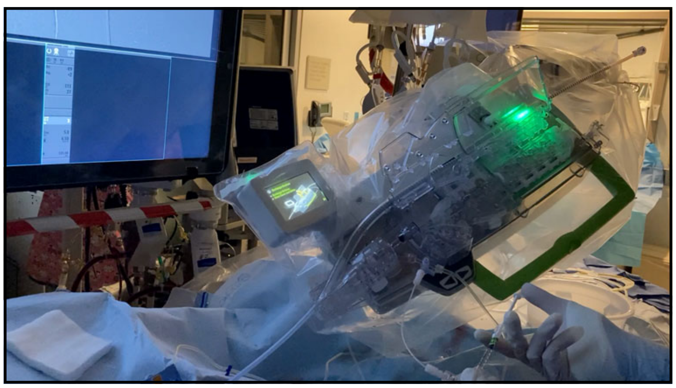
Robotic system controlled guiding cath, microcath, microwire, coil

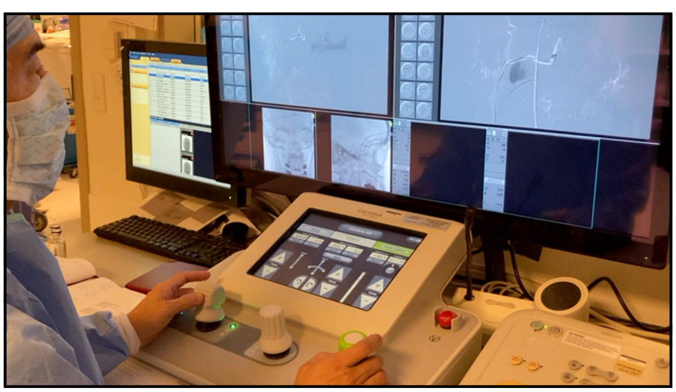
<u>Preferred device selections</u>

Envoy 5Fr or 6Fr MPC
V-18 wire

0.017-0.021 microcatheter
Synchro 14 Support







Complete Robotic Intervention

Robotic system controlled guiding cath, microcath, microwire, coil

Case 1) 38yo male, COVID-19 pneumonia, on ECMO, systemic anti-coagulation & uncontrollable epistaxis

Case 2) 74yo male, oral SCC, unresectable tumor, continuous oozing / bleeding, hemoptysis

Case 3) 35yo male, SNUC, continuous epistaxis requiring blood transfusion

Case 4) 63yo male, Laryngeal Ca, tumor bleeding, COVID-19 positive

Case 5) 75yo male, tongue SCC, lymph node met., hemoptysis

Case 6) 68yo male, epistaxis, status post right sinus surgery

Single operator experience

Saber H., Tateshima S. Interv Neurorad 2023 in press

Complete Robotic Intervention

Selected vessels

Case 1) Bilateral VAs, Bilateral CCAs, Bilateral IMAX As (PVA/Coil)

Case 2) Rt CCA, Rt ECA, Rt APA, Rt Asc Palatine, & 2 pedicles (PVA/Coils)

Case 3) Rt CCA, Rt ECA, Rt APA (Coils)

Case 4) Lt CCA, Lt ECA, Lt Facial A, & 3 pedicles (PVA, NBCA, Coils)

Case 5) Bilateral CCA, Bilateral ECA, Bilateral Facial A (PVA, Coils)

Case 6) Rt CCA, Rt ECA, Rt IMAX (PVA, Coils)

A total of 30 vessels selected (5 per case)

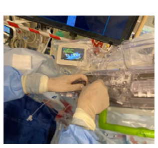
Saber H., Tateshima S. Interv Neurorad 2023 in press

Complete Robotic Intervention

Fluoroscopy Time & Procedure Time

Fluoroscopy 27.1 ± 7.6 minutes

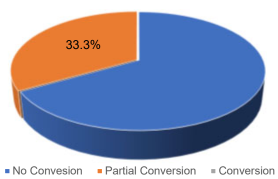
Procedure 75.9 ± 17.2 minutes



A total of 30 vessels selected (5 per case)

Saber H., Tateshima S. Interv Neurorad 2023 in press

Conversion to Manual Procedure

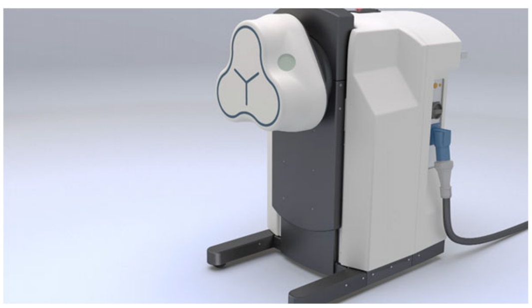


Reasons:

- Multiple intermittent angiography via microcatheter
- Coil jammed in microcatheter due to PVAs
- Simultaneous guide & micro cath manipulation

Saber H,, Tateshima S. Interv Neurorad 2023 in press

nanoflex



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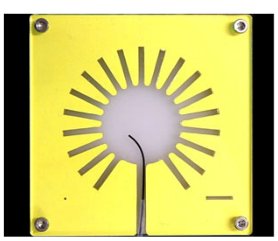
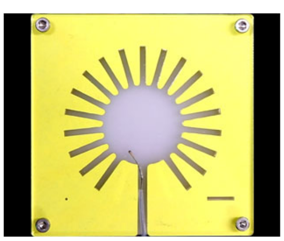


Conventional catheter



Magnetically-steered catheter

nanoflex

Tele-Stroke Treatment

- Tele-proctoring (onsite physician operates)
- Tele-proctoring and hybrid robotic thrombectomy (onsite physician & remote physician operate)
- Complete robotic thrombectomy with tele-monitoring (remote physician primarily operates)

FIG 4. Telerobotic stroke network. A neurointerventionalist at the control station can operate multiple interventional robots to expand networks of care. "Robot" indicates potential sites of patient-side, interventional robots. Gray-scale indicates relative population size of each state.

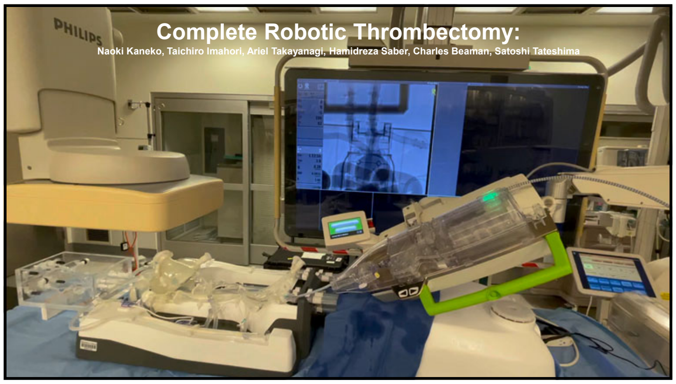
Extending Our Reach

Air EMS?

Trends of Non-Fatal HEMS Accident-Related Injuries

Richard J. Simonson, Joseph R. Keebler, Alex Chaparro
Embry-Riddle Aeronautical University

We conducted an investigation into non-fatal helicopter emergency medical service accidents from January 26, 1991 to April 26, 2018 via the National Transportation Safety Board aviation accident database. Over this 28-year timeframe 247 accidents results in 251 fatalities and 179 non-fatal injuries. Exploratory analysis of the data indicate that more non-fatal injuries occurred in September compared to any other month during the study timeframe. Exploratory correlational analysis via elastic net logistic regression concluded that no linear relationship of NTSB accident database data provide insights into what factors are correlated with an increased likelihood of non-fatal injuries. Further, no linear relationships of available variables provide insights into the increased number of non-fatal injuries in September during this investigation's timeframe. Future research should identify if these null results are due to a true lack or no relationship between available data and non-fatal injuries or if these results are due to inaccessibility to relevant data.



Procedural Steps & Devices:

Procedure Time, Fluoroscopic Time, Radiation Dose Recorded in Each Step

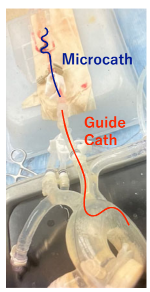
- **Navigation of guiding catheter from aorta to ICA**
- **Navigation of microsystem from ICA to M2 and thrombectomy**

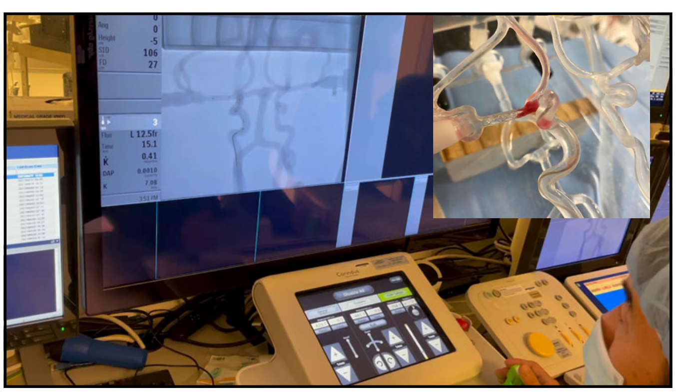
Robotic operator & on-site operator communicated with intercom to simulate remote robotic thrombectomy.

Guiding catheter: Benchmark 95 cm
Guidewire: Aristotle18

Microcatheter: Phenom21 150 cm
Microguidewire: Synchro SELECT Support

Stent retriever: Embotrap 5 x 37 mm





RESULTS - Interventional Outcome

	Manual (n = 7)	Robotic (n = 7)	P value
Technical success*	100%	100%	p = 1
First-pass revascularization success	42.9%	28.6%	p = 0.577

* (Stent retriever deployed and retrieved)

RESULTS - Procedural Time

	Manual (n = 7)	Robotic (n = 7)	P value
Total, sec [95% CI]	357 [314 - 401]	892 [673 - 1111]	p < 0.001
Guide-cath Portion, (Aorta - ICA), sec [95% CI]	74 [68 - 82]	177 [123 - 231]	p < 0.001 (technical difficulty)
Micro-cath Portion, (ICA - M2, thrombectomy), sec [95% CI]	283 [243 - 324]	715 [503 - 927]	p < 0.001 (device loading & unloading)

RESULTS - Radiation Exposure

	Manual (n = 7)	Robotic (n = 7)	P value
Fluoro time, min [95% CI]	3.48 [2.63 - 4.34]	7.04 [4.96 - 9.13]	p = 0.003
Radiation dose Air Karma, mGy [95% CI]	3.21 [2.52-3.91]	5.53 [4.09 - 6.99]	p = 0.004
Radiation to operator, μSv [95% CI]	0.215 [0.168 - 0.263]	0.02 [0.015 - 0.025]	p < 0.001

Our initial complete robotic thrombectomy using in vitro model suggests

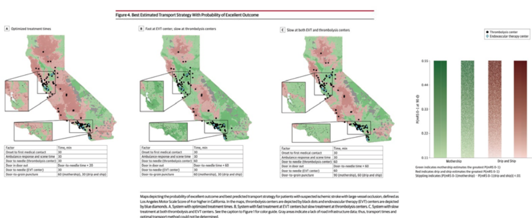
1) robotic thrombectomy may be equivalent to manual in terms of first pass effect,
2) might be inferior to manual in final recanalization rate,
3) longer procedure time than manual (roughly twice as much)
4) significantly less occupational radiation exposure

Research

JAMA Neurology | Original Investigation

Modeling Stroke Patient Transport for All Patients With Suspected Large-Vessel Occlusion

Jessalyn K. Holodinsky, MSc; Tyler S. Williamson, PhD; Andrew M. Demchuk, MD; Henry Zhao, MBBS; Luke Zhu; Michael J. Francis; Mayank Goyal, MD; Michael D. Hill, MD, MSc; Noreen Kamal, PhD



Original Research Article

INR INTERVENTIONAL NEURORADIOLOGY

Modeling optimal patient transport in a stroke network capable of remote telerobotic endovascular therapy

Interventional Neuroradiology
1–11
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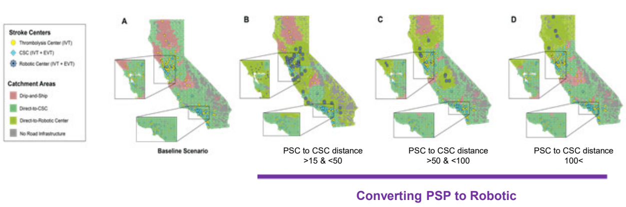
Charles Beaman[1,2,*], Jessalyn K Holodinsky[3,*], Mayank Goyal[3], Satoshi Tateshima[2], Michael D Hill[3], Jeffrey L Saver[1,**] and Noreen Kamal[4,**]



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Modeling optimal patient transport in a stroke network capable of remote telerobotic endovascular therapy

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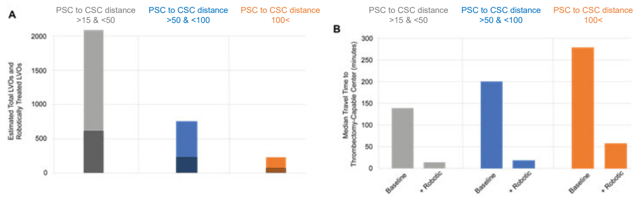

Stroke

Predictors and Functional Outcomes of Fast, Intermediate, and Slow Progression Among Patients With Acute Ischemic Stroke

Woo-Keun Seo, MD, PhD; David S. Liebeskind, MD; Bryan Yoo, MD; Latisha Sharma, MD; Reza Jahan, MD; Gary Duckwiler, MD; Satoshi Tateshima, MD; May Nour, MD; Viktor Szeder, MD, PhD; Geoffrey Colby, MD, PhD; Sidney Starkman, MD; Neal Rao, MD; Mersedeh Bahr Hosseini, MD; Jeffrey L. Saver, MD; for the UCLA Penumbra Imaging Investigators

eTable IV. Imaging parameters among slow, intermediate, and fast progressors

	Total (n=77)	Slow progressor tertile (n=20)	Intermediate Progressor tertile (n=28)	Fast progressor tertile (n=29)	p[a]	p[b]
Speed of infarction progression, mean (SD), cc/hr	8.4 (20.9)	0.0 (0.0)	2.6 (1.8)	22.9 (32.0)	<0.01	<0.01
HIR, mean (SD)	0.5 (0.2)	0.3 (0.3)	0.5 (0.2)	0.6 (0.2)	<0.01	<0.01
Core volume, mean (SD)	25.9 (39.2)	0.0 (0.0)	15.2 (11.9)	55.4 (51.6)	<0.01	<0.01
Tmax6, mean (SD)	98.0 (65.0)	79.8 (49.4)	83.0 (53.7)	126.6 (76.5)	0.01	<0.01
Tmax10, mean (SD)	54.1 (54.0)	32.0 (36.7)	41.1 (31.6)	83.2 (69.4)	<0.01	<0.01
mismatch volume, mean (SD)	72.2 (50.8)	79.8 (49.4)	68.0 (54.0)	71.2 (49.6)	0.73	0.67
mismatch ratio, mean (SD)	28.4 (42.0)	79.8 (49.4)	16.5 (22.1)	4.1 (3.7)	<0.01	<0.01
extreme mismatch ratio, mean (SD)	12.7 (23.2)	32.0 (36.7)	9.0 (12.4)	2.6 (2.6)	<0.01	<0.01
Collateral score, mean (SD)	1.9 (0.9)	2.3 (0.7)	2.2 (0.8)	1.4 (1.0)	<0.01	<0.01
ASPECTS score, mean (SD), (n = 62)	8 (6 – 10)	10 (7 – 10)	8 (6 – 10)	8 (5 – 9)	0.16	0.06

HIR hypoperfusion intensity ratio; ASPECTS the Alberta Stroke Programme Early CT Score

[a] p-values presents equality among groups which were tested by Kruskall-Wallis test / ANOVA test.

[b] p-values presents the trends according to the increase of tertiles which were tested by Spearman's correlation

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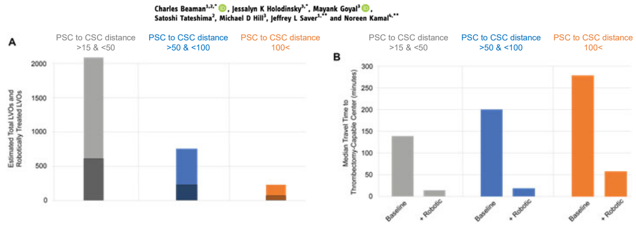
Modeling optimal patient transport in a stroke network capable of remote telerobotic endovascular therapy

Charles Beaman[1,2,*], Jessalyn K Holodinsky[3,*], Mayank Goyal[3], Satoshi Tateshima[2], Michael D Hill[3], Jeffrey L Saver[1,**] and Noreen Kamal[4,**]

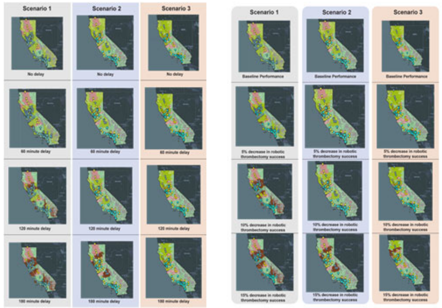


Impact of Procedural Time Delay **Impact of Robotic Success Rate**

Scenario1
PSC to CSC distance
>15 & <50

Scenario2
PSC to CSC distance
>50 & <100

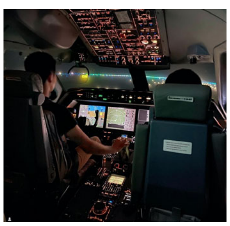
Scenario3
PSC to CSC distance
100<



Dark green indicates optimal transport directly to CSC. Olive green indicates optimal transport to a robotic EVT center.
Red indicates optimal transport to PSC using drip-and-ship transport method. Gray areas indicate a lack of road infrastructure data.

Modeling Optimal Patient Transport in a Stroke Network Capable of Telerobotic Endovascular Therapy Beaman C, Holodinsky JK, Goyal M, Tateshima S, Hill MD, Saver J, Kamal N

Realistic Emergency Simulation



Summary

- The key for the successful complete robotic intervention includes; catheter slack control, carefully choosing adequate catheter length, & device selection.
- Our initial complete robotic thrombectomy using in vitro model suggests 1) robotic thrombectomy may be equivalent to manual in terms of first pass effect, 2) might be inferior to manual in final recanalization, 3) longer procedure time than manual, 4) significantly less occupational radiation exposure.
- Some PSC in California >100miles away of CSC may benefit from remote-robotic thrombectomy.

Thank you for your attention

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