



## A Case Report of an AppSurgeOn-Assisted Complex Cerebral Aneurysm Surgery: A New Frontier for Education and Operative Planning

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### ABSTRACT

With the increased interactivity and sophistication of apps, more specialty-specific apps are continuously invented with intentions to simulate the operative technique in a step-by-step approach. AppSurgeOn Neurosimulator, Vol. I is the first 3D neurosurgical simulator for use on smartphones and tablets. A 59-year male presented to the emergency department of another hospital with the sudden disturbed level of consciousness. Radiology showed a complex anterior communicating artery aneurysm that requires surgical clipping. The surgery was conducted fluently, then the patient improved gradually and discharged fully conscious with no neurological deficit. Our initial experience with this app shows that it is a helpful tool for not only the neurosurgeon but the entire team and the patient's family. The single platform is diverse and has numerous applications, including simulation, planning and education. It provides the surgeon with a degree of surgical rehearsal in preparation for a case, which in turn offers increased operative speed and precision. Such preoperative familiarity promotes mastery of the whole procedure, from patient positioning to dissection. AppSurgeOn facilitates the explanation of the procedure to the patients and their family through the use of its intuitive 3D model and visually approachable spatial representation. The AppSurgeOn – Neurosimulator Vol. I mobile app represents a realistic adjunct for complex neurosurgical procedures and can have an immense impact on the delivery of care and the potentials for patient satisfaction.



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## INTRODUCTION

### Background

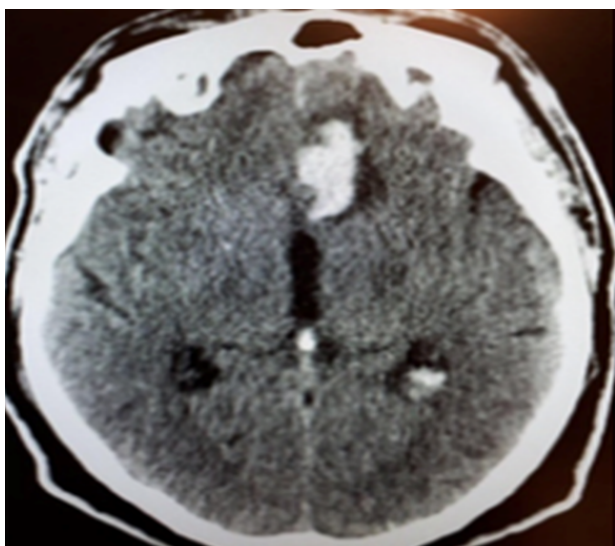
The development of reading material available on

smartphones has revolutionized the distribution of knowledge and research (Tripathi *et al.*, 2014). Smartphone applications symbolize a convenient, accessible and popular means of gaining information and improving education (Tobias and Tobias, 2015). The progressively more advanced technology available on smartphones permits them to offer a plethora of apps that have already proven beneficial in the medical setting (Drazin and Zaki, 2014). These Apps can also be used in the planning and preparation for complex and uncommon surgeries and can lead to the reduction of intra-operative errors and operation time (Müller *et al.*, 2003). Additionally, they have been shown to improve the patient's understanding and informed consent before procedures (Liew *et al.*, 2015).

AppSurgeOn Neurosimulator, Vol. I is the first 3D neurosurgical simulator for use on smartphones and tablets. It has been developed by UpSurgeOn – an international company ran by residents based in Italy. UpSurgeOn has produced a number of apps (the AppSurgeOn 3D series), providing a novel approach to the experience of neurosurgical training. These resources are characterized by full interactivity, high realism and inspiring precision (Team, 2018). Here we describe our initial experience in Iraq with the use of AppSurgeOn applications as an assisting tool throughout the clipping of a complex anterior communicating artery aneurysm.

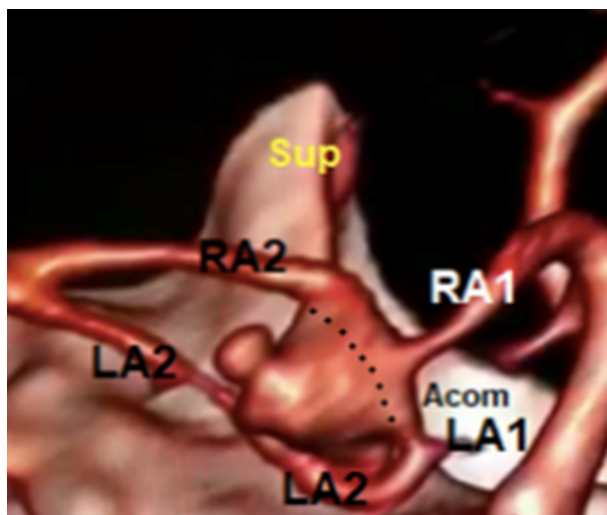
### CASE DESCRIPTION

A 59-year male presented to the emergency department of another hospital with the sudden disturbed level of consciousness (Glasgow Coma Scale score of 9). Initial resuscitation was performed and the patient was stabilized. Brain CT scan showed subarachnoid hemorrhage, predominantly in the area of the left gyrus rectus. Angiographic CT demonstrated a complex anterior communicating artery aneurysm, with a wide neck and two Murphy's teats. He was then referred to our unit to undergo surgical clipping, 6 days after his presentation.

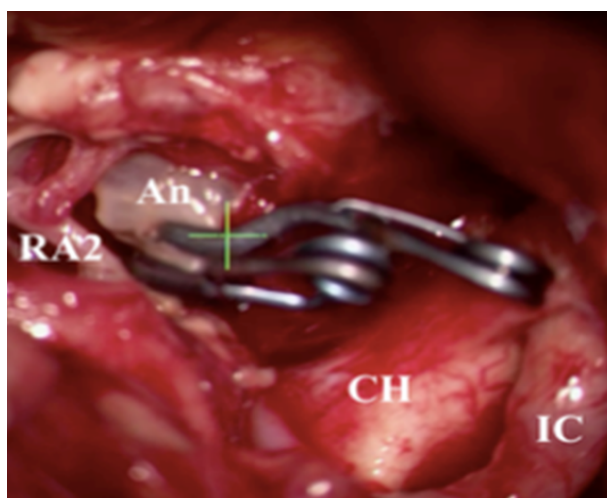


**Figure 1: Brain CT scan showed subarachnoid hemorrhage in the region of the left gyrus rectus**

Prior to surgery, the Neurosimulator Vol. I app was used to describe the procedure to the patient's family. This allowed them to gain a better appreciation of what the planned surgery involved, streamlining the consenting process. Subsequently, the family were able to engage more with the clinical team and were more involved in the patient's care. The surgical team also benefited greatly from the use of



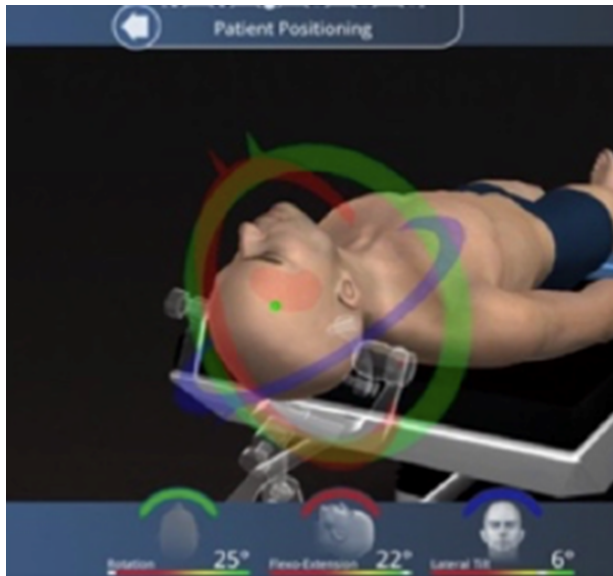
**Figure 2: 3D reconstruction of the aneurysm from the CT Angiography, the dotted line represents the aneurysmal neck**



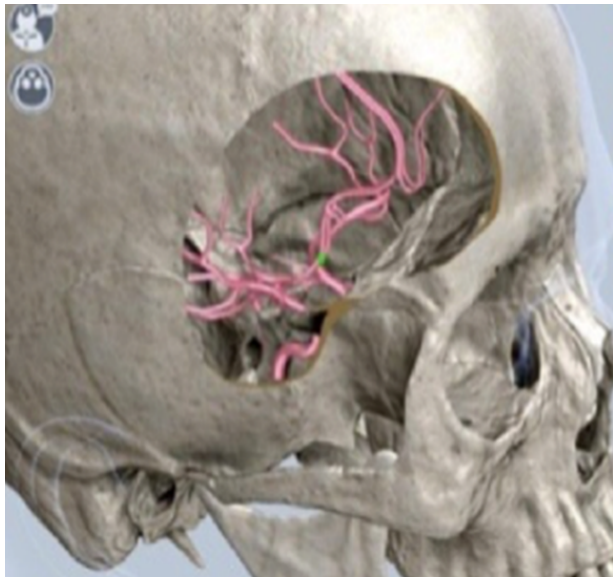
**Figure 3: Intraoperative microscopic view showing two-clip reconstruction for the neck of aneurysm through a right pterional craniotomy and trans-sylvian approach**

the app in the surgical briefing. The team felt better prepared in general for this complicated case, as the steps could be easily visualized and interacted within the app.

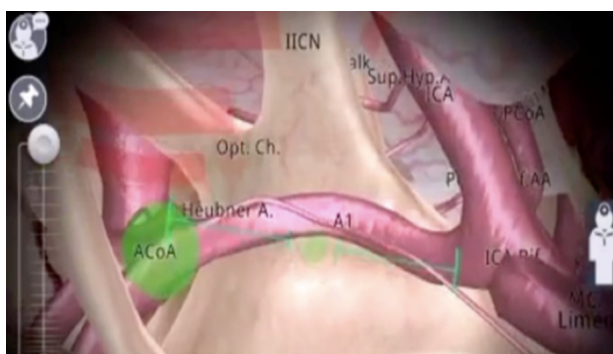
Surgical clipping through standard right pterional craniotomy was performed the day after transfer. The surgery was conducted fluently, without any intraoperative complication. The patient spent 2 days on intensive care, and the subsequent postoperative course was uneventful. The patient improved gradually and was discharged 7 days after admission to our unit, fully conscious with no neurological deficit (Figures 1, 2 and 3).



**Figure 4: Neurosimulator, Vol.I can be used to plan multiple surgical steps: patient positioning**



**Figure 5: Craniotomy and selection of ROI (highlighted in green in the center of the image)**



**Figure 6: Simulated trans-sylvian approach to the anterior communicating artery aneurysm with all the critical surrounding structures marked**

## RESULTS AND DISCUSSION

As Iraq remains a developing country, not all the neurosurgical centers offer surgical clipping for cerebral aneurysms as a routine practice. These are complicated procedures with a necessity for being versed in the various operative steps. All members of the team (including the surgeons, anesthetists and nursing staff) benefit from increased familiarity with a complex case prior to the surgery. The lack of this awareness can lead to intraoperative complications and poor surgical results. Surgical simulation offers the opportunity to minimize the learning curve for a variety of procedures and will affect the standard of care delivered to the patient.

With the increased interactivity and sophistication of apps, more specialty-specific apps are continuously invented with intentions to simulate the operative technique in a step-by-step approach. Such innovative mobile software provides learning resources in times of limited training opportunities and supports the provision of medical care in remote settings (Benes, 2006). Such apps promise to provide future generations of residents with quick, easy access to information needed in order to prosper in their education and careers (Murfin, 2013). Thus, rigorous evaluation, validation, and the development of best-practice standards for medical apps are required to ensure a fundamental level of quality and safety when these tools are used (Misra et al., 2013).

In the neurosurgical field, there are more than forty applications available. Generally, these can be categorized into six broad categories: patient information, education & training, clinical tools, reference, conference adjunct and marketing (Mosa et al., 2012; Kulendran et al., 2014). Serving multiple functions will be the challenge to the newly added apps and, most importantly, how to improve the fluency and outcome of the management.

AppSurgeOn is an innovative series of apps produced by UpSurgeOn, with the sole intention of making high-quality neurosurgical education material widely available and accessible. These apps are made with the aim to revolutionize the training of neurosurgical residents, by providing a platform through which preoperative decision-making can be trialed and tested. It achieves this through interactive 3D models, allowing the user to freely explore and interact with the intracranial anatomy in a realistic manner on a simulated patient. Our initial experience with this app shows that it is a helpful tool for not only the neurosurgeon but the entire team and the patient's family. The single platform is diverse and has numerous applications, includ-

ing simulation, planning and education. It provides the surgeon with a degree of surgical rehearsal in preparation for a case, which in turn offers increased operative speed and precision. Such preoperative familiarity promotes mastery of the whole procedure, from patient positioning to dissection. App-SurgeOn facilitates the explanation of the procedure to the patients and their family through the use of its intuitive 3D model and visually approachable spatial representation.

Other added features of the AppSurgeOn Neurosimulator include a full overview of 15 regions of interest (ROIs). These are visualized through a complete brain MRI and an interactive 3D model of the patient's head. Angiography-like visualization of vascular structures is provided, and 3D overviews of 9 craniotomies centered on the frontal and temporal regions are available. Correctly positioning the patient on the operating table can also be guided by the Neurosimulator app. Patient head positioning (rotation, flexion-extension, lateral flexion) can also be assisted by the app, which provides the surgeon with an optimal arrangement through which to make a surgical approach. Neurosimulator not only provides interactive models to gain an appreciation for the technique of intracranial dissection, but also comprehensive summaries on each approach. These texts cover indications, techniques, landmarks, red flags and surgical notes from scientific literature (Team, 2018), (Figures 4, 5 and 6).

In a world of rapidly expanding technological ability, it is important to emphasize that a surgeon's intuition and experience has no substitute. No app can replace this. However, we believe that few limitations to the AppSurgeOn series exist and that this platform offers an accessible option to improve familiarity with surgical approaches. One drawback of the system is that some time is required to benefit from the preoperative simulation, and thus it is not suitable for emergency scenarios (Leach, 2005). Although, a good simulation benefits from some simplification and there is no need to include every possible detail concerning a field (Clarke, 1983), a wider variety of approaches should be included in the future. We suggest subsequent volumes focusing on posterior fossa and convexity approaches.

## CONCLUSIONS

The AppSurgeOn – Neurosimulator Vol. I mobile app represents a realistic adjunct for complex neurosurgical procedures and can have an immense impact on the delivery of care and the potentials for patient satisfaction.

## Conflict of interest statement

The authors whose names are listed immediately below certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements) in the subject matter or materials discussed in this manuscript.

We give the right to the corresponding author to make necessary changes as per the request of the journal, perform the rest of the correspondence on our behalf and he will act as the guarantor for the manuscript on our behalf.

All persons who have made substantial contribution to the work presented in the manuscript, and no author has been omit.

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