A DEMONSTRATION OF THE FIRST TIME USE OF THE VITOM TO PROVIDE POST LACERATION REPAIR FOLLOW UP USING TELEMEDICINE TECHNOLOGY - A USEFUL METHODOLOGY FOR FAR FORWARD SURGICAL TELEMENTORING

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Abstract
Surgical care must often be provided in remote areas where surgical subspecialists are not available. Telemedicine offers a means of linking a specialist with a remote medical provider to virtually provide the highest level of expertise. This paper describes the first known clinical usage of the Vitom exoscope to transmit images from a remote site to a specialty care provider for surgical evaluation. The Vitom is a low cost, portable endoscopic solution for linking remote general medical providers with specialists in tertiary care centres. This system has high potential utility for the far forward battlefield area.

Keywords: Vitom; telemedicine; remote surgery

Introduction
Telemedicine has been deployed to provide specialty care to remote or austere sites for both civilian and military uses.¹⁻⁵ An example of such use would be rapid assessment of a hand injury by a hand specialist in a tertiary care centre achieved through the use of telemedicine linking to the remote primary care provider. This communication could allow the specialist to guide the care plan or coordinate evacuation of the patient for surgical repair.

The United States military introduced a formal orthopaedic teleconsultation program in 2007 and performed a retrospective review of cases from this system between April 2009 and December 2012.⁶ They reported that over half of all injuries generating a consult involved the upper extremity with hand injuries contributing more than any other anatomic area.⁵ An imaging system is necessary to support telemedicine. Such telemedicine imaging capabilities may not be commonly in place at rural practice (or site of injury) locations. Due to the common availability of cell phones which are capable of sending an image, that communications modality could be useful in supporting telemedicine for hand injury. A small study with cell phones was performed in rural Australia which demonstrated that images of hand injuries could be transmitted by cell phone image and the images were reported by the investigators to have been valuable in describing the lesion to the distant referral site as opposed to just a verbal description.²⁻³ This study was an example of a very low cost telemedicine communication system.²⁻³

This paper describes the first known use of the Vitom endoscopic microscope (Karl Storz Endoscopy America, Inc. El Segundo, CA) to provide surgical microscopy images of a hand wound for telemedicine care. The Vitom is approximately the weight of a standard cell phone. Its small weight and cubic size make it ideal to support military telemedical wound imaging at far forward areas. (Figure 1)

Figure 1. Vitom endoscopic microscope (Karl Storz Endoscopy America, Inc. El Segundo, CA).
Methods and Materials

A hand injury was sustained in a remote area of Wyoming. Lacerations over the flexor surfaces of the right thumb, index and middle fingers, approximately 1 cm, long were present. Images of the injury were taken by cell phone and shared with a distant site emergency room physician. (Figure 2a) Results of a physical examination reporting no apparent loss of flexor or extension function were shared to an emergency room physician by telephone. Sensory loss on the ulnar aspect of the right middle finger was noted. A nurse practitioner sutured the lacerations at the rural site. Follow up was performed one week later in the Temple University Medical Centre. The lacerations were healing normally and motor function was preserved. Numbness was present on the tip of the ulnar aspect of the third digit but was improving so nerve repair was deemed unnecessary. (Figure 2b)

At week two, the patient was examined virtually by a physician at Temple University via a telemedicine encounter with the patient located at the University of Nebraska Emergency Department, Omaha NE. Images of the hand were visualised using the VITOM® Telescope (Karl Storz Endoscopy America, Inc. El Segundo, CA) linked by a C CAM (Karl Storz Endoscopy America, Inc. El Segundo, CA) and C HUB (Karl Storz Endoscopy America, Inc. El Segundo, CA) to a computer by USB port. The VITOM is a surgical exoscope with working distance of 25-75 cm providing a high definition and microscopic view of a surgical field. The instrument is small weight and small cube (diameter 10 mm, length 11 cm), making it easily transportable for use in austere military environments. (Figure 3)

A HIPPA secure audio-visual link was established between Temple University Medical Centre and the UNMC Emergency Department using Vidyo Desktop (Vidyo, Inc., Hackensack, NJ). Images were shared via the Vitom as shown in Figure 2. A real time video encounter was made with a Temple physician to demonstrate supporting adequate images to allow evaluation of the healing injury. These real time images from the Vitom were transmitted using a computer to both the Temple University physician and to the UNMC emergency room staff physicians for evaluation on iPhones. In addition to real time viewing of the post laceration repair injury, store and forward pictures were taken for evaluation of the quality of the image.

Results

The Vitom provided high quality images supporting a follow up evaluation of a hand injury. These images were sent to both distant site computers and to
 iPhones. The images provided, as shown in Figure 2, were of adequate quality to permit evaluation of a laceration. In addition to streaming, real time images, still photographs were taken with the Vitom, to support store and forward telemedicine care and real time video images. Comparison of the Vitom images to the iPhone images taken at the time of injury show higher quality images were generated by the Vitom.

**Discussion**

Hand injuries are a common orthopedic injury with these patients frequently presenting to the emergency department for care. Emergency departments are reporting an inadequate number of orthopedic specialists to provide required orthopedic consultation services. For military medical providers, the shortage of specialty providers at a remote deployed location is especially challenging. Teleconsultation could be used as a venue to alleviate this specialty shortage. An example of how telemedicine has been useful in alleviating a specialty shortage is presented in a teledermatology paper from Australia. Dermatologists are concentrated in urban areas in Australia. Patients requiring dermatology consultation were required to travel long distances to the nearest dermatologists. Due to a shortage of dermatologists, wait times for care were often over six months. Establishing teledermatology enabled local general practitioners to link patients virtually with the dermatologist specialist, eliminating the need for travel and enhancing access to the specialist. The local general practitioner could support dermatologic treatment by performing biopsies or excisions as directed by the dermatologist.

Military uses of telemedicine for consultation have demonstrated cost savings by preventing unnecessary evacuations for care that could be provided locally when virtually guided by the specialist. During wound care, it is often an advantage for the specialist to observe the healing injury site daily. With telemedicine, the practitioner can virtually view the wound from the patient’s home via a cell phone or from a local practitioner’s office using more sophisticated imaging devices. Telemedicine for wound care has been reported to be useful for postoperative wound management, trauma and accidental injury, burns, diabetes, pressure sores and ulcers.

It can be anticipated that telemedicine will be used with increased frequency in the future to provide tele-orthopedic consultations for problems such as the hand laceration described in this paper and access to specialty care will be enhanced.

**Conclusions**

This demonstration showed that the Vitom could be used to provide high image quality for post surgical repair evaluation of a patient via a HIPPA secure videoconferencing network connecting multiple locations and multiple communication devices (laptop and cell phone). The Vitom offers advantages over other imaging modalities in that it can be secured over a surgical field to provide continuous imaging of the operation while still being more portable, due to its small cubic size and low weight. Using the system described in this paper, telesurgical mentoring could be accomplished at distant sites from subject matter experts in a tertiary care centre. Far forward deployment of a Vitom could allow a remote site medic to obtain specialty consultation from a hand surgeon during evaluation and repair of a hand injury. This could allow improved evaluation of the injury by the hand specialist telementoring the general practitioner through the examination. Triage to higher echelons of care could be improved to prevent unnecessary evacuation or consultation. If surgical repair is required, specialty suture type and size selection could potentially be modified by the specialist to improve outcomes. Telementoring could potentially be done for tendon repair. Follow up care, to include hand physical therapy could be provided by telemedicine. This concept could also be applied to essentially any surgical or procedure based specialty to enhance specialty care access to the far forward battlefield.

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