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Pediatric minimally invasive surgery in Africa: limitations and current situation

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The second largest and most populous continent, with an exploding pediatric population, Africa has an overwhelming burden on its very limited pediatric surgical services. In an international environment of progressively advancing endoscopic and robotic surgical techniques, the authors focus on the current role of endoscopic surgery on the continent and explore the potential reasons for its delayed acceptance and implementation. They proceed to document the spectrum of what is available and, using their "African experience," expand on financially viable models of further rolling out these techniques, including discussion around suitable training models for surgeons and their teams.

Overview and spectrum of laparoscopy within Africa: rudimentary to First World

Africa is the world's second largest and second most populous continent, after Asia. If adjacent islands are included, it covers 6% of the earth's total surface area, 20% of the total land area, and accounts for approximately 14% of the world's human population. There are 46 countries including Madagascar and 53 including all the island groups. Health care problems in these countries are well known and generally related to limited resources. Facilities are often old and overcrowded, septic complications common, and patients present with advanced stage diseases of a different spectrum to developed countries. With limited availability of special investigations, such as computed tomography and magnetic resonance imaging scans, outdated equipment, consumables that are difficult to obtain or in some instances simply not available, management can be a challenge. Of note is the poor ratio of pediatric surgeon to population, with South Africa, most likely one of the best off nations, having a ratio of approximately 1:1.8 million!

The consequent burden of clinical work is obviously enormous, which in its own right has had a profound impact on the role of minimal access surgery in the region, at the same time presenting a unique opportunity for establishing minimal access units. After the advent of modern endoscopic surgery and its rapid assimilation into adult practice, its uptake and advancement into the pediatric population was relatively slow, on account of numerous obstacles, including smaller patient size and consequent working space, with the subsequent requirement of finer, shorter, and more delicate instrumentation and ports. Not only did this increase the technical difficulty of designing and manufacturing the instrumentation but a direct

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consequence was the associated increase in production costs, obviously transferred on to the end user. Fortunately, once these issues had been resolved, although obviously forever a "work in progress," the use of minimal access procedures was rapidly and widely extended into the pediatric surgical population and numerous units published widely on their experience. At the outset, simple diagnostic procedures formed the vast majority of surgeries,[1] after which, once adequate levels of competence had been achieved, more complex ablative and then reconstructive procedures were undertaken. From an African perspective, the "birth" of pediatric laparoscopy was rapidly assimilated in certain countries, examples, including Egypt, South Africa, and Senegal,[2,3] generally originating in academic centers and slowly spreading as it found wider acceptance. However, in the vast majority of African states, the implementation was delayed, if undertaken at all, and subsequent progress was slow, reason being predominantly "perceived" financial constraints, as well as cultural obstacles to its implementation and subsequent role out. Another significant obstacle in the introduction and implementation of minimal access surgery in the African context has been the workload of a typical pediatric surgical unit. The Department of Pediatric Surgery at the Chris Hani Baragwanath Hospital, Soweto, Johannesburg, is a good example of the clinical burden that many of these institutions face, with the unit at the Chris Hani Baragwanath Hospital performing upward of 180 index cases per month, with waiting lists running up to 6 months in advance! Similarly, The Ain Shams University Hospital performs 200-250 cases on a monthly basis, within similar waiting lists. In conjunction with relative shortages of trained staff, this places an enormous onus on staff to "get the work" done, with far less allocated time available for training and learning of new techniques. That said, these units are currently 2 of the leading laparoscopic units within South Africa, demonstrating what can be achieved when the commitment is there and, more importantly, when simple strategies are carefully planned and meticulously implemented. The literature is clear that, certainly in its inception, endoscopic procedures have longer set up times and, in addition, longer operating times, hence further pressurizing already overburdened operation theater schedules and, on account of completing fewer cases, further delaying access of patients to their allocated operating room slot.[4,5] This undoubtedly acts as a deterrent to implement minimal access surgery.

A further point that colleagues have raised has been the lack of drive from a patient perspective, with poor education on their part not pushing for the benefits of a minimal access approach. However, to counter that argument, one of the most significant driving factors for the establishment of a laparoscopic-related living donor renal harvesting program in Johannesburg over the last 5 years was donor request! It is important to remain clear about ones objectives, however, not allowing patient preference to drive the indication for surgery or optimal method thereof.

In addition to the aforementioned text, one of the most significant purported limitations to its widespread implementation has been the capital and ongoing running costs of an endoscopic suite. However, although this is often perceived as a convincing argument, it has been clearly demonstrated on the African continent that a basic set up can be achieved quite reasonably and very effectively. Furthermore, public–private partnerships, in conjunction with the establishment of good trusting relationships with relevant members of the trade, can allow one to live ones dreams too, as we have described later. What individuals and institutions often fail to realize, however, are the advantages of endoscopic techniques. Although the established benefits of less postoperative pain and shorter hospital stays obviously benefit the patient, the impact on hospitals, with respect to emptying beds and wards and alleviating pressure, and on the community, with significantly early return to work having significant economic benefits, are most important.

Looking again at Cape to Cairo, or "North versus South," we have learnt numerous lessons from the implementation and advancement of our respective endoscopic programs, and using rational decision-making trees and technical alternatives, we have grown our units, incorporating major endoscopic procedures into our busy schedules. Core concepts have included clearly defining the indications for surgery, appropriate training on models other than the live human patient, using techniques aimed at reducing cost as opposed to those used at the current "cutting edge" (GIA staplers, retrieval bags, single-use ports), ensuring that a designated person or team looks after the equipment, and most importantly, ensuring that the entire operating room team is appropriately trained not only in all aspects of the technical set up but also on the specifics of the operation being performed.

The current African experience is that in both the northern and southern regions of the continent, many centers are well equipped and trained to perform a wide spectrum of endoscopic procedures, including complex reconstructive operations. In Egypt, 5 such centers exist, with numerous centers providing a more basic service; however, all centers provide for at least basic training of their trainees. The South African experience is not dissimilar, with all the 7 university training centers having established endoscopic units, interested surgical staff, and various training programs aimed at equipping staff members and trainees with the necessary skills to safely operate on their patients, without putting the human subject at risk during the steep initial learning curve. One aspect of minimal access surgery that the South Africans have not embraced has been the role of robotic surgery. There are 2 reasons for this: prohibitive cost and the fact that this technology, like previous aspects of pediatric endoscopy, still requires significant development, with the current incisions and port requirements making its use a poor choice, both cosmetically and from a logistical perspective.

Centers in both North and Southern Africa have recently, significantly, committed to national education forums in endoscopic surgical techniques, including the installation of advanced skills laboratories as well as running regular live-

surgery workshops and congresses, and are in the process of rolling these education strategies out to the rest of Africa via the Pan African Pediatric Surgery Association. This will be greatly facilitated by the significant advances in information technology (IT) infrastructure on both the East and West Coasts, with establishment of new internet links with increased bandwidth at a cheaper cost. Although numerous other centers exist throughout this vast landmass, the majority are either not using endoscopic techniques or are limiting themselves to relatively simple diagnostic procedures. With all of the proven benefits of minimal access surgery, when undertaken for the correct indication, this obviously needs to change!

Establishing the "New Unit"

Probably, the most important aspect of establishing an endoscopic unit is the decision-making process, before capital expenditure, around exactly what functions the unit will fulfill. Availability of expertise in performing endoscopic procedures, technical support both in-hospital and from the industry, and availability of consumables are important considerations. Other critical components include ongoing maintenance (ideally structured as long-term contracts), staffing availability, and comprehensive ongoing education. This is obviously very much dependent on the availability of funding, and an appropriate, accurate budget is essential in the planning phases. As stated previously, the establishment of "Public Private Partnerships," involvement of nongovernment organizations, and establishing a good rapport with the trade are critical steps in obtaining maximal return on your investment. Although departments are daunted by the concept and anticipated expense, which can be exorbitant, it is also very feasible to set up relatively economically viable systems that provide the operating team with everything necessary to complete the most complex of endoscopic operations. As alluded earlier, it is the planning phase before purchasing that is probably the most crucial, and attention to the specifics of the technical and engineering specifications is crucial. There is nothing to beat involving clinicians experienced in the set up of their own units to prevent one making the same mistakes and reinventing the wheel!

Ideal endoscopic systems for resource limited environments should focus on reusable and interchangeable components and use hardware that is less sophisticated and relatively low maintenance. As technology rapidly develops, improving functionality, but increasing cost, earlier generations of equipment, used successfully for many years, become significantly cheaper and are perfectly adequate for performing many complex procedures. It is important to closely collaborate with the industry producing such equipment and instruments, the relationship often extending beyond instrumentation to include aspects of training and education.

With regards to extent of the unit, one must decide which of the following functions are to be included:

1. Basic service provision;
2. Data capture and patient information system;
3. In-house training facility;
4. Formal training center teaching with broadcast facility.

Although obviously 4 separate silos, the aforementioned functions can all be dove tailed, with training leading to good service provision, which by definition will translate into good quality data and subsequent publication of results. This then starts to drive a financial business model, attracting paying delegates from smaller units to the center of excellence, hopefully able to fund small projects within the host unit!

A wide range of equipment is available. A basic endoscopic stack, including single-chip camera system, insufflator, CO_2 cylinder, light source, and monitor, will be adequate for diagnostic procedures and basic operations, and a basic laparoscopic set, including needle holders, atraumatic graspers, ports, hook diathermia, and lens, is essential. At the other end of the spectrum is the option of a fully integrated digital operating room. The African continent is home to the entire spectrum of these systems, although the high-end digitalized modules are only installed in a few hospitals. Options to consider with respect to reducing cost include buying reusable instruments and using simple operative techniques, for example hook diathermia dissection, which largely eliminates the need for the more expensive clip applicators and vessel sealing devices. Other novel techniques to overcome use of expensive consumables include homemade endoloops and ties with intracorporal knotting instead of clips and staplers, ziplock plastic bags for specimen retrieval, and portless instrument insertion.

Lenses and instruments are significantly different in the set up of a pediatric facility. Most adult surgeons use 10-mm lenses, typically 35 cm in length, with various angles (0-45°) available at the tip. Pediatric surgeons typically prefer shorter 5-mm lenses, with the 30° lens providing the most versatility. As the size of the patient drops to that of infants and neonates, smaller diameter (3 mm) and shorter (20 cm) lenses become necessary. In addition, finer, more precise, 3-mm instruments are mandatory.

Finance and logistics undoubtedly limit the resources that can be implemented on the African Continent, and although we have already emphasized that the entire spectrum of endoscopic procedures can be performed using a very basic set up, experience and better understanding of ergonomics and flow issues have resulted in the development of so-called fully integrated digital theaters. Ideal operating room ergonomics require camera, patient, and monitor to be in the same optical line, which is best achieved with installation of pendant-mounted monitors wired to a laparoscopic portable stack. The pendant-mounted monitors allow perfect orientation of the telescope and working instruments via the surgical field to the screen, which can be variably positioned and altered intraoperatively. Additionally, all equipment can be stored on similar ceiling-mounted pendants, allowing versatility of position during the procedure, and an ultimate benefit of complete

digitalization is the ability of the scrub team to control all aspects of the intra- and perioperative environment. The aforementioned systems immediately identify the operating room as an endoscopic facility, helping with the change in mind-set and eliminating the need for transporting endoscopic equipment from the storage area, increasing patient turnover, and decreasing risk of breakages.

Training

Obviously, with the new laparoscopic unit and equipment, comes the absolute necessity to train all involved. Superficially seen as aimed at both resident surgeons and their trainees, this is a far more extensive process, requiring adequate training of the entire operative team, including issues related to anesthesiology, particularly elevations in compartment pressures, elevated CO_2, and longer surgical times. In addition to physicians, scrub and supplementary nursing staff as well as theater technicians require comprehensive training, often concentrating more on the technical aspects of the equipment set up and maintenance. Basic troubleshooting is an absolute necessity. In the ideal situation where electronic image capturing IT facilities exist, a dedicated IT person should be formally trained to take responsibility for this aspect of the equipment.

Although the traditional method of open surgical training which involves the apprentice learning at the side of the "master crafter,"[6,7] obviously continues to play a vital role, the introduction of endoscopic surgery to an established surgical unit often precludes this option, necessitating alternate training options.[8] This is a particular issue in regions, like Africa, where established endoscopic experts are few and far between. Suitable pathology to consider for "live" options include cholecystectomy and antireflux procedures,[9] whereas appendicectomy, ideal in the First World environment, may not always be suitable in the Third World because patients often present with more advanced disease. Uncomplicated appendicitis is widely used as a laparoscopic training tool in Egypt[3]; however, the Red Cross Children's Hospital, Cape Town, has found the laparoscopic salvage and insertion of peritoneal dialysis catheters to be a superb way of starting training registrars in the fundamentals of port placement, instrument handling, and knot tying.[10] Numerous alternatives to the live "mentor program" exist, including "dry labs" and skills training centers as at the Red Cross Children's Hospital, Cape Town, live animal laboratories as at the University of the Witwatersrand, Johannesburg, various electronic software solutions, and, obviously, using the concept of the "traveling surgeon," where outside experts are brought in for congresses and live surgery workshops to demonstrate specific techniques and operations.[11-13] All the aforementioned options are used within South Africa, all to good effect.

An important aspect to consider, and a problem that is by no means unique to the African Continent, is that of maintaining expertise in traditional surgical approaches. It is well established that as endoscopic programs progress and competence in particular procedures improves, the proportion of cases performed "traditionally" decreases, often to a point where trainees become more familiar with the endoscopic approach; however, they remain insecure when it comes to performing the same operation by means of open surgery.[14] How to balance this training remains a serious concern.

Thus, it is clear that the spectrum and availability of endoscopic surgery throughout Africa is vast, varying from nonexistent, through basic, to being on a par with leading units within the First World.[13,15] Thus, it remains incumbent on the more advanced centers within Africa to avail themselves to educating and supporting their African colleagues from less-advantaged centers. This work is well on track, stemming from the North (Egypt) and South (South Africa) of the continent. Various congresses and other academic forums have taken place, and there are undoubtedly more planned for the future that will enable us to harness our "African Expertise" and spread knowledge and experience from centers of "laparoscopic excellence" to other centers throughout Africa.

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