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**An Introduction to the New Online Journal club - 'Surgery in Africa', and First Summary of a Module - Compartment Syndrome and Diagnostic Tests**

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**Background:** *Surgery In Africa (SIA) is a virtual journal club that stimulates Continuous Medical Education (CME) on up to date clinical information and an evidence based approach. SIA is for COSECSA trainees but publishes summaries of the modules to increase access to CME, while also enabling trainees to gain experience at scientific writing. This summary is on Compartment Syndrome (CS).*

**Methods:** *Three expert selected articles were reviewed - A review paper, a research paper and a methods paper on critical appraisal of studies of a diagnostic test. Five senior African surgeons gave their opinions to stimulate the discussion forum.*

**Results:** *Trainees described personal challenging experiences of Compartment Syndrome. The application of best practice evidence from Europe and North America studies presented challenges. The reasons for this include the different causes such as snakebites, overuse of tight circumferential plaster casts and the patterns of disease (delayed referrals) that affect the sensitivity of Compartment Syndrome monitoring and decisions to perform fasciotomy. In snake bites, the underlying disease process is different and associated haematological changes also affect the harm/benefit of fasciotomy pressure monitoring. Infection risk is increased in settings with less sanitation. Misconceptions arose from the articles that were corrected: Intra-compartmental measurement of pressure does not have to be continuous, and where pressure monitoring devices are not available they can be self made. Research to assess a home-made device in African settings would be required. More research is also needed regarding the complications of fasciotomy performed for late presenting compartment syndrome.*

**Conclusions:** *It is important for surgeons to understand that it is not always easy to apply evidence collected in different resourced settings. It would be difficult to justify the use of invasive devices in resource constrained settings unless studies are conducted to prove their safety and efficacy.*

## **Introduction**

Surgery in Africa (SIA) has been re-launched in 2015 as an innovative online educational resource- a virtual Journal Club (JC) that links clinical and evidence based medicine (EBM) topics. Surgery In Africa links surgeons across more than 10 African countries, Canada and the UK and is a collaboration between the College of Surgeons of East, Central and Southern Africa (COSECSA), the Universities of Toronto and McMaster International Surgery Departments, and the Royal College of Surgeons, Ireland (RCSI).

Surgery in Africa has been redeveloped in response to request by COSECSA for assistance in delivering quality training to regional postgraduate surgical programmes amongst a community of widely dispersed surgeons taking their MCS exams in diverse settings with variable resources. Currently SIA is on a password-protected site ([www.schoolforsurgeons.net](http://www.schoolforsurgeons.net)) only accessible to COSECSA members and specifically aimed at MCS level trainees (currently one hundred and twenty surgical postgraduate trainees in year two (for whom it is mandatory to complete a minimum of 6 (out of 10) Surgery in Africa JC modules and fifty five in year one of MCS curriculum. The modules are also useful to FCS orthopaedics, general surgery and plastics and as Continuing Practice Development for all surgeons. This Surgery inAfrica Journal Club summaries are an attempt to make elements of SIA open access.

Initially, in 2005 to 2014, Surgery in Africa was run in a different form with expert led narrative reviews on surgical topics that aimed to make up to date evidence easier to use. SIA was developed in recognition of the information overload that followed initiatives such as Ptolemy Project and HINARI that opened up entire online libraries to surgeons in Africa, Surgery in Africa particularly focused on adapting evidence to make it easily applicable to resource limited settings<sup>1</sup>.

Despite improvements in access to Internet and the literature the health information gap between countries is still great today<sup>2</sup>. The new SIA has been designed in line with current thinking that there needs to be parallel education in all of: 'how to access, appraise and apply this new information'<sup>3</sup>. In addition the new approach focuses on the need for interactive debate and feedback. EBM has most recently been defined as 'the integration of best research evidence with clinical expertise and patient values'<sup>4</sup> and discussion is intended to generate both African clinical consensus and local research. The more collaborative approach and less time consuming model will enable SIA to fulfil its intention of becoming increasingly co-developed by African senior surgeons.

"Providing access to reliable health information' and 'increasing research capacity and training' in low income countries are both priorities and the most cost effective strategy for improving health care globally 'and the Lancet Commission for Global Surgery 2030 report recommends capacity-building partnerships to achieve this<sup>5</sup>.

There is little current evidence about the most effective strategy to achieve this or the benefits of e-learning programmes or journal clubs<sup>6,7</sup>. However we hope that SIA may lead to an improvement in the quality of surgical education and research; provide an opportunity for continuing professional development; improve job satisfaction and lead to the retention of health care workers in LIC<sup>8,9,10</sup>. The SIA model is designed in line with best evidence on how to make virtual journal clubs interesting, relevant and most likely to lead to changing practice<sup>10,11</sup>. Ongoing evaluation is inbuilt in SIA to assess whether any of these aspirations have been met.

SIA's aim is to build quality surgical (both clinical and research) capacity, and so to contribute to improving surgical practice globally. Surgery in Africa is initially working with a broad set of objectives that fall into the following areas:

- To increase understanding and use of EBM with a focus on; keeping up to date with current clinical evidence, developing awareness of the importance of critical appraisal and developing skills in critical appraisal and application of evidence to one's own practice and setting.
- To build a network of surgeons for discussion, asking questions, sharing expertise and opinions and generating consensus. To generate a community of inquiry especially a

social community for dispersed isolated surgeons. To encourage setting up of 'face to face' JCs.

- To encourage/support research ideas arising in SIA discussion forums and scientific writing practice (starting with the publishing of SIA JC summaries)
- To Increase COSECSA members engagement in teaching. To use trainees to identify the best teachers and invite them to join SIA and in this way make SIA increasingly co-developed.
- To raise the importance of population health / prevention and health systems issues and remind surgeons of the role that they have to play in advocating for these<sup>13</sup>.

Surgery in Africaruns ten modules a year over consecutive fortnights between April and September over a two year curriculum. Each SIA module is designed and moderated by an expert surgeon but follows the same model.

- Three expert selected resources; a clinical review article, a focus article (to be critically appraised) and a methods article to help with this appraisal.
- Senior African surgeons opinion and experience on the topic are sought (currently only in the orthopaedic modules) via brief questions directly emailed and the answers presented as a resource.
- Fifteen Multiple Choice Questions (MCQs) both clinical and EBM based, and within depth explanations provided with the answers. The MCQs must be attempted to complete the module.
- An interactive discussion forum with a moderator providing regular feedback
- Some additional resources (including books and audio-visual resources) that often signpost on to other online relevant resources
- A feedback form to seek trainees' feedback on the process and content (we have already responded to feedback by producing a summary of discussion forums and introducing the option of anonymous postings). This feedback is helping to plan future topics and timings as well as COSECSA conference workshops. Trainees are asked to identify senior surgeons who are excellent teachers who we can invite to help design and lead SIA.

### ***Summary of Compartment Syndrome Module***

The results section has here been written by sevenZambian surgeons, who formed a face to face JC as a consequence of SIA (using 'Whatsapp' as an additional resource) and who then contribute to the discussion forum as a group. In the discussion section we present wider opinions as arising from the discussion forum (thirty four surgeons contributed forum posts) and the expert moderator.

The 2<sup>nd</sup> module of SIA JC 2015 was Compartment Syndrome (CS)/ diagnostic tests and ran from April 20<sup>th</sup> to May 10<sup>th</sup> 2015

There were 7 learning objectives –

1. To understand the pathophysiology of compartment syndrome
2. To be aware of potential systemic effect of compartment syndrome, and reperfusion injury
3. To be able to diagnose compartment syndrome, and know of diagnostic adjuvants that could be used in cases of uncertainty
4. To know the relevant anatomy for calf fasciotomy
5. To understand the terminology used when discussing the accuracy of a diagnostic test
6. To appreciate the potential source of bias when assessing a diagnostic test

7. To appreciate how the performance of a test may vary depending on the disease incidence and prevalence.

This summary does not attempt to provide a review of CS but to raise issues relevant to SIA's objectives such as encouraging a critical approach to papers that one reads and recognising the issues in adapting evidence to settings with more constrained resources.

### **Methods**

Articles reviewed:

1. Donaldson, J., Haddad, B., Khan, W.S., 2014. The pathophysiology, diagnosis and current management of acute compartment syndrome. *Open Orthop. J.* 8, 185–93<sup>14</sup>.
2. McQueen, M.M., Duckworth, A.D., Aitken, S. a, Court-Brown, C.M., 2013. The estimated sensitivity and specificity of compartment pressure monitoring for acute compartment syndrome. *J. Bone Joint Surg. Am.* 95, 673–7<sup>15</sup>.
3. Bhandari, M., Montori, V.M., Swiontkowski, M.F., Guyatt, G.H., 2003. User's guide to the surgical literature: how to use an article about a diagnostic test. *J. Bone Joint Surg. Am.* 85-A, 1133–1140<sup>16</sup>.

Five senior African surgeons were asked their opinion on the management of Compartment Syndrome in resource limited settings, and the role if any of compartment pressure monitoring.

The Discussion forum was then used to ask questions and present issues for debate and to respond to the question '*Please describe an experience you have had relating to either a case of compartment syndrome or a diagnostic test which you feel has not performed well in your setting*'

Two additional resources were provided as further reading and to signpost to useful online resources.

A book, 'Global Orthopedics - Caring for Musculoskeletal Conditions and Injuries in Austere Settings. Gosselin et al 2014 and a resource from Global HELP (Health Education Low-cost Publications) 'Compartment Syndrome In Children - Everything You Need To Know - Dr. Nabil Ebraheim', video <http://global-help.org/videos/>

### **Summary of the Articles**

Diagnosis of CS can be made clinically and also by use of instrumentation to actually measure intra-compartmental pressure.

According to Donaldson et al<sup>14</sup>, Clinical diagnosis of CS is based on signs and symptoms of intra-compartmental ischemia which result from decreased tissue perfusion, and this has been described classically by recognizing the 6 Ps (pain, pallor, pulseless, paralysis and paraesthesia). They also advocate for due consideration to causes of CS to be considered in the history. They described 'Pain out of proportion to the injury requiring high doses of strong analgesia' and 'pain on passive stretch of muscles in the compartment' as the earliest and most reliable symptoms indicating a raised intra-compartmental pressure. The physical signs are described to be late and therefore not reliable. If the diagnosis is in doubt or in the case of unconscious patients, intra-compartmental pressures should be measured<sup>14</sup>.

When using intra-compartmental pressure monitoring devices, Donaldson et al described a normal compartment pressure of 10mmHg, and a difference between diastolic and compartment pressure of less than 30mmHg as a critical threshold above which tissue perfusion is compromised and therefore diagnostic of CS. Some authors advocate for continuous

measurement of intra-compartmental pressures of all patients at risk. Marginal pressure should be repeated with repeat physical examination<sup>14,17</sup>.

The evidence suggests that if fasciotomy is to be performed the results are improved with early intervention, however there is no absolute cut off time after which fasciotomy is unlikely to be of any benefit. In patients who have a delayed presentation/diagnosis the benefit of fasciotomy is less convincing.

McQueen et al performed a continuous monitoring of intra-compartmental pressures monitoring study of 850 patients admitted with tibial fractures, based on their old unit protocol where all patients with tibial fractures undergo immediate continuous pressure monitoring<sup>15</sup>. A slit catheter was inserted in the anterior compartment of the affected leg at admission. Intra-compartmental pressure was measured by a transducer through a static column of normal saline for at least 24 hours or until the differential pressure (diastolic pressure - intra-compartmental pressure) was rising steadily. McQueen et al considered a diagnosis of acute compartment syndrome (ACS) if the differential pressure remained less than 30 mmHg for more than two hours. The diagnosis of ACS was confirmed intraoperatively at fasciotomy by the escape of muscles or presence of necrosis documented by the operating surgeons. The diagnosis was considered incorrect if it was possible to close the wound primarily at 48 hours, and the absence of compartment syndrome was confirmed by absence of neurological sequelae or contracture on clinical follow up. A false positive was defined as a diagnostic differential pressure but with negative findings at fasciotomy or no fasciotomy and no sequelae on the latest clinic review. All patients with compartment syndrome underwent fasciotomy with decompression of all four compartments of the leg with a standard double incision technique. They checked for viability and debrided devitalized tissues. Patients were taken for second look debridement 48 hours later. Primary closure was attempted and secondary wound closure or skin grafting planned for wounds that didn't close primarily<sup>15</sup>.

McQueen et al calculated sensitivity and specificity of measuring intra-compartmental pressures, based on table III as 94% and 98% respectively. They estimated positive predictive value was 93% and negative predictive value was 99%. Positive likelihood ratio was 60 and negative likelihood ratio was 0<sup>15</sup>.

### ***Critique of the McQueen Article***

On the primary guides, the results are valid because of the presence of an independent, blinding comparison with a reference standard being the state of the tissues on performing the fasciotomy, and that large number of patients was used.

On the secondary guides there was selection bias of patients. The diagnosis of acute CS diagnosed by continuous intra compartmental monitoring influenced the decision to perform the reference standard, in this case fasciotomy. Cases were only of adult patients, and the feasibility of using this protocol in children/adolescents is not assessed (these patients both have different physiology and different tolerance to the monitoring). The patients were all assessed very early following injury, there are no late presenting patients, therefore the results may not be applicable to the African setting, finally in settings with less strict sanitation, the pressure monitoring may be at risk of introducing infection and causing harm.

There was also verification bias in their study. Patients with safe differential pressures did not undergo fasciotomy, and therefore did not undergo the gold standard assessment. Though unavoidable, this distorts results of false positive and true positive.

The insertion of the slit catheter was not explained in detail in this article, however we have concerns that these results may not be transferrable to centres that are not as familiar with the 'Styker' pressure monitoring system or use another system<sup>17</sup>. Seeing their result replicated in another setting would improve their validity.

We also have some concern regarding the assessment of only the anterior compartment raising the possibility of missing CS in the other compartments, which possibility they acknowledge. The rationale for the single compartment monitoring is predominantly to simplify the test, and anatomically the anterior compartment is the most commonly affected. Isolated CS of the other compartments has been reported before.

For the false negatives and false positives, McQueen did not give inter- and intra- observer reliability for the clinicians involved in the study, and these clinicians were not blinded to the study. This raises questions of bias in confirming the diagnosis at fasciotomy and follow-up review of these patients.

In conclusion we accept the results of continuous intracompartmental measuring as helpful in diagnosing acute CS in the anterior compartment of the leg due to diaphyseal fractures of the tibia with acknowledged limitations discussed above.

### ***Discussion Forum Summary***

Many MCS level surgeons have first-hand experience of cases of CS and in most cases the outcome was poor.

Different causes, patterns of disease (such as delayed referrals) and underlying health systems factors were discussed that affect the sensitivity of CS monitoring, decisions over fasciotomies and balance of harm benefit in both of these procedures.

A combination of health systems factors may be key to both the prevalence and the outcome of CS in these settings. For example, the overuse of tight circumferential plasters in locations where acute fractures are treated and delayed referral of CS due to misdiagnosis and mistreatment by traditional healers and regional health centres, were raised repeatedly as issues. There was discussion on how to impact at these levels, with suggestions including:

- Limiting the availability of plaster roles in peripheral locations so only backslaps could be used.
- Health worker education as to the risk of CS developing from this practice
- Patient education with regard to the symptoms of CS.
- Improved links and interactions with peripheral health centres, which could lead to both an improvement in the above factors and reduce transfer/referral times.

COSECSA surgeons reported a variety of causes of CS ranging from infections, snake bites, electrical burns and trauma. Most patients were described as presenting late especially those with snake bites and infections, and this seems to lead to a difficulty in determining when compartment syndrome became established.

It was felt that measuring continuous (24 hour) compartmental pressures in these patients would put more pressure on the already inadequate infrastructure. After reading the resources surgeons felt that whilst compartment pressure monitoring would be useful it was out of their reach due to constraints in the availability of the measurement devices.

Several misconceptions of many of the trainees, not corrected by the articles were discussed:

Intra-compartmental measurement of pressure does not have to be continuous, and where pressure monitoring devices are not available they can be self-made. This led to additional papers being suggested during the forum that detailed different devices that can be constructed to measure pressures. In addition it was suggested that it would be useful to have a session at the COSECSA conference on how to make one of these. Several individuals cited an interest in being involved in the assessment of such a device in their setting, either in a single centre or multi centre study and these ideas are being pursued with these trainees.

Concern was raised about the greater risks of introducing infection when performing the pressure monitoring, especially in cases of snakebite, and late presenting compartment syndrome due to lower levels of sterility in some settings.

Discussion also focused on the need for more research regarding the complications of fasciotomy performed for late presenting CS. The Zambian JC group state that 'Our seniors are of the view that compartment syndrome should be diagnosed clinically by considering the history and physical examination, and where in doubt fasciotomy should be done. There appears to be no consensus in our setting on fasciotomy for delayed CS. Some older seniors believe fasciotomy should be done for all CS cases because the timing of CS being established is usually unknown and one can salvage some muscles. Others feel the complications that arise when fasciotomy is done for delayed CS are grave and therefore it's better to avoid delayed fasciotomy. In most facilities gadgets for compartmental pressure measurements are lacking and even when present some senior surgeons have expressed unreliability of the gadgets and have resorted to going back to clinical diagnosis. In view of the above we are of the opinion that CS cannot be diagnosed by continuous intra compartmental monitoring in our setting at present'.

The lack of data of pressure monitoring in snake bites was discussed, as well as the controversy regarding the use of fasciotomy in these patients. This is another area for research. The conclusion from expert seniors that emerged was that fasciotomy is rarely needed as it is not a true CS but a localized necrosis in the majority of cases. Where fasciotomy is needed there are many contraindications associated with the snake bite, such as the metabolic derangement, low haemoglobin levels, coagulopathy and difficulty with wound closure, that all mean that fasciotomy may do more harm than good and that leaving these cases and focusing on splinting contractures may be better.

### **Conclusion**

In conclusion, it is important for surgeons to understand how to critically appraise papers and apply evidence to their local setting. It is not always easy to apply evidence collected in different resourced settings.

The compartment syndrome discussion forum has raised many new issues and solutions that aren't raised in the literature but are relevant to Africa. Statements suggest that some may change their practice as a result – for example, this quote from an MCS surgeon on the CS discussion forum:

***'Following this discussion, there are 100 things I will do differently considering there are sequelae of acute compartment syndrome that I know I missed, let alone under-diagnosis'***

Some health systems changes, which may be more important than the clinical diagnostic precision, are also discussed here. Most importantly the surgeons involved may now be in a position to advocate for change.

***'Africa needs to engage and be involved with research, collate data relevant to the African populations, and publish the findings'***

***'Should Africa do its own research in its own environment, disease spectrum and resources? Yes it should, why not? Just one to start and that is me and you'***

(Quotes from discussion forum)

It would be difficult to justify the use of invasive devices in resource constrained settings unless studies are conducted to prove their safety and efficacy in these settings. Several trainees have expressed interest in pursuing this and the other research ideas arising in this module: to assess a self-made pressure monitoring device in African settings, to determine the complications of fasciotomy performed for late presenting compartment syndrome, compartment syndrome management in snake bites.

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