AO Dialogue

Sharing the AO knowledge
82nd/83rd Davos Courses and AONA

Damage control orthopedics
Is it the way to go?
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Welcome to a new AO Dialogue

On behalf of the AO Communications Advisory Board and the AO Dialogue editorial team, I am pleased to bring you an updated, fresher magazine. AO Dialogue has always been for and about the AO community—from people news to scientific articles. Now we’ve made it easier to find what you’re looking for through two clear sections: the Community Zone (news about AO people and events) and the Expert Zone (medical and scientific articles written by and for the experts). We’re also going up to four issues a year. And because dialogue goes two ways, we’d like to hear from you. So please send us your feedback and comments on the new look—we’re always open to dialogue.

The Expert Zone has expanded over the years to stimulate debate. The piece which we now call “The Debate” (formerly “Back Page Debate”) brings subjects of relevance to the practicing surgeon, allowing you to make your own judgment and send us your opinion—we will try to publish your replies. This issue has the contentious problem of the open fracture: “Can open fractures be closed primarily?”, moderated by AO President Jim Kellam. Please comment on the expert opinions—there can’t be a more important question affecting the outcome of these difficult fractures. Other controversial topics are also included on “Damage Control Orthopedics” and “Open reduction of clavicle fractures”, with respective counterpoints.

AO has always been about communication: between surgeons of different specialties, between surgeons and scientists, and between teachers and learners. Since its inception in 1958, AO has been at the forefront of surgical education. At that time, AO equipment couldn’t be used by surgeons who hadn’t completed an AO course, to control the quality of patient care. This was done to reduce the “learning curve”, which unfortunately is still an accepted concept in much of the surgical community. I’ve always asked myself if I or any of my friends would wish to be patients in a surgeon’s learning curve. AO education, with its pioneering work in manual skills teaching, has attempted within reason to reduce that learning curve by working on models rather than live humans.

This issue contains articles from AONA on their efforts to “Teach the Teachers,” through very successful seminars at the Faculty forum in Scottsdale, Arizona.

This is the best of AO education, and quality control is ensured by the presence of professional educators, guaranteeing that the educational process works.

But what of the content? Should we have full control of it, as well as the process? At the basic level, this has largely been achieved, but at the master’s level, and the Regional Trauma seminars, has it? And should it? Obviously at senior levels that can be achieved by having a faculty with varying views and much time for discussion. Unfortunately, that’s not always the case. We need to avoid the pitfalls of technology to prevent the idea that “if you are born a hammer, you see the whole world as a nail”. Because we have a flexible nail for use in pediatric long bones, does every tibia fracture in a 10-year-old child require one, as I’ve heard at courses? Obviously not. The fact that we have locking plates doesn’t mean that every fracture must have one. In fact, traditional AO methods are much better for some fractures. The same is true of Spine: does every herniated disc require a disc replacement, as is now so prevalent? If these new technologies are to be taught as AO principles and methods, they need strong backup in research, but unfortunately this is often lacking.

We’ve been the leader in surgical education for four decades, and to remain so we must continue to improve the process and techniques of teaching and learning, but make certain that the content is equally scrutinized. Where clear differences of opinion exist, the course organizers must ensure ample discussion time within the program, and a diverse faculty to debate these differing viewpoints.

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Colombian-born Luis Javier Parra assumed the position of AOLAT (AO Latin America) Regional Director on February 3, 2006. Mr. Parra is a mechanical and computer engineer from the University of the Andes (Universidad de los Andes) in Bogotá, a PDD graduate (Program for Enterprise Direction Development), and also attended Stanford and Grenoble universities.

Mr. Parra has valuable private and corporate experience; in his last corporate responsibility he was head of Sun Microsystems NOLA (North Latin America).

Mr. Parra will manage the operational activities of the AO Foundation in Latin America, and implement decisions made by the AOLAT Executive Board. He will ensure compliance with international AO activities, regulations and standards and will coordinate activities with license partners. In addition, he will provide support for the educational, development and research activities when needed in the region.

In recognition of his contribution to education and research, Reto Babst has been appointed Professor of Surgery by the Council of the University of Basel, Switzerland.

Reto Babst studied at the Faculty of Medicine, University of Bern, Switzerland, completing his surgical training in the Swiss Cantonal hospitals of Basel, Fribourg, Obwalden and Lucerne, and in the Dortmund Academic Hospital in Germany. In 1990 he received the title of FMH (Swiss Medical Association) Specialist in Surgery, and specialized in the area of trauma surgery at the University of Basel and in specialist clinics in the USA and Germany.

In January 1998 he became Deputy Director of the Surgical Clinic of the Cantonal Hospital of Lucerne. Two years later he acquired his official qualification as a university lecturer from the University of Basel. He has been Director of the Department of Surgery, Head of the Surgical Clinic A, and Chief Physician of Trauma Surgery since 2003, and a member of the hospital management since January 2005.

Reto Babst's specialty is the treatment of injuries and their effects on the musculoskeletal system, with particular focus given to complex articular injuries and the development of minimally invasive methods of fracture treatment. Under his management, the trauma department has developed into an AO reference clinic, which trains guest physicians from all over the world.

In 1999 he received the Recognition Prize of the AO Technical Commission (AOTK) for his exemplary support of the TK System in clinical investigation in planning and implementation of studies, and his help in establishing a new structure and documentation concept for AO Clinical Investigation and Documentation (AOCID). He is regularly asked to speak and lecture at national and international congresses and courses. Reto Babst is also the coeditor of several medical journals and on the board of various medical societies.

Within the AO Reto Babst is a dedicated and highly innovative teacher who developed the teaching concept for minimally invasive surgery (MIS). At the AO Davos Courses 2005 he introduced a brand new interactive format for the AO Masters' Course, which was met with universal enthusiasm.

Congratulations, Professor Babst!
The AOAA Triennial Symposium in Sardinia in 2005 was another milestone event for the Operating Room Personnel (ORP) Alumni Chapter. We were represented at the meeting by 27 out of our now 52 members. Preparations for the meeting began in December 2005 at our executive meeting in Davos, where we learned that ORP would be represented at the triennial symposium for the first time. We developed a program that would not only provide our members with up-to-date information and new advancements, but also enable the group to discuss ORP issues, and improve active communication within the chapter. The symposium would also provide us with the opportunity to commence collaboration on the much anticipated ORT (Operating Room Techniques) manual. It was decided to capitalize on having a large percentage of our members together to discuss aspects of our upcoming book at length, which would have proved difficult and time-consuming via email. The program also presented the opportunity for us to attend relevant presentations from the surgeons’ program, making the symposium extremely worthwhile and productive.

**Instant feedback and lively sessions**

After the acceptances for the symposium were received, members were allocated to groups, each with a group leader and assigned proposed chapters for the ORT manual. The groups were given guidelines of material to be covered in each chapter, but it was up to the groups to interpret this, research the topics and compile the information for a concise 30-minute presentation on their given topic. The topics were presented over three days during the symposium, with time given after each presentation for group comment and discussion of material. These sessions provided some lively discussion and highlighted the diverse perspectives of the Alumni Chapter members. The quantity and quality of “instant” feedback could never have been accomplished by long-distance electronic means. The members are to be congratulated on the material compiled and the level of commitment to this venture.

The variety of information and passion for their topic shown by the presenters ensured that attendance at all sessions was high—despite the lure of the sun and beach. Highlights included news from the TK/Expert Groups and the presentation on the updates to the portal illustrating AO’s commitment to providing an outstanding service to faculty and the AO community. The information currently available through the AO portal is already astonishing, and will be further refined. This information will ensure that anybody with access to the Internet has up-to-date, relevant information to assist not only in the development of better AO courses, but also to assist surgical practice.

As part of our dedicated ORP program we were introduced to the requirements of writing for publications and other materials. This information will be invaluable when the next phase of writing the ORT manual begins.

**An opportunity for team building**

The opportunity to have all the participants staying at one resort deepened the ties within our chapter and enabled us to converse with our surgeon colleagues in a relaxed atmosphere either at the beach or over a meal. The AOAA cup sports activities provided some friendly competition and amusement. Again the overwhelming acceptance of the ORP Chapter and its members at this meeting was evident. The symposium finished with a memorable banquet at a local restaurant, providing a fitting end to a great few days in Sardinia.

The members of the ORP Alumni Executive Committee would like to thank the AO and AOAA for their continued support and for presentation of such a valuable symposium. A special thanks to Antonio Pace for choosing the venue—this was a part of the world that many of us might never have had the opportunity to enjoy otherwise. Our members are already looking forward to the next triennial meeting in 2008.
In August 2005, Hurricane Katrina devastated portions of the US coastlines of Louisiana, Mississippi and Alabama. Levees separating Lake Pontchartrain from New Orleans were breached by the storm surge, ultimately flooding about 80% of the city. Public outrage and criticisms were hurled at FEMA (Federal Emergency Management Agency) and the US government in the slow response to the disaster. An AO member, Kyle Dickson, was in New Orleans at the time—and tells of his own moving experience.
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Since the start of this millennium, human tragedy has been on the rise. My experience with Hurricane Katrina is nothing compared to so many others all around the world. My heart goes out to those who have suffered and continue to suffer. Although my family and I lost all material possessions, we have each other, and are richer human beings for the experience we gained.

From shelter to disaster
Looking back, my error was in not sending my wife and five children away prior to the storm. They wanted to stay with me in the hospital, and they knew I would never leave my patients.

On Sunday, August 28, 2005, with marginal provisions, our family traveled into Tulane/Charity Hospital to ride out the storm. We expected to be home the next day. However, with gusts up to 165 mph, category 5 Katrina had different plans. Early Monday morning, impressive winds were moving cement garbage cans down the street, ripping out window air conditioners, shattering glass, and breaking 100-year-old oak trees in half. By noon the hurricane had passed and I drove around the city determining the best access into Charity and Tulane Hospital for injured patients. Many streets were impassable either from trees or water. However, I felt that New Orleans had “dodged another one”. That evening, crossing the street from Tulane Medical School to the Tulane Hospital, I noticed a storm drain puddle that had grown from 1 foot to 3 feet in diameter in two hours. I mentioned this to my wife but didn’t really think about it. The next morning, I awoke to 5 feet of water on Tulane Avenue. At this point I knew we had missed a window of opportunity and were in serious trouble. The levee had broken, and New Orleans’ bowl was flooding from Lake Pontchartrain.

Initial panic shot through the hospital, with survival mode now in full force. Rationing of water, food, and energy began. Waste management into a red bag with cat litter became routine. We slept when it was dark, and rose at daybreak. My family was kept safely in the orthopedic clinic as I began the task of evacuation. I was torn between staying and protecting my wife and five children (from 2 to 13 years old), or helping evacuate patients. Most of the horror stories sensationalized by the media were true—either seen first-hand or reported to me by either the National Guard or Wildlife and Fishery personnel. Events like this can bring out the worst or the best in people. Although I tried to keep my children protected from the outside elements, they were exposed to a hostage crisis by some looters and even heard gunshot fire. From these events to practicing third-world medicine (ie, bagging some patients for over 48 hours) our experience was full. One of the orthopedic residents had the foresight to bring a canoe in from home (Fig 1). This was truly a lifesaver in transporting two intubated infants to on-ramps to be transferred to Children’s Hospital, and was our transportation for Tulane Orthopedics between University Hospital, Tulane, and Charity.

The author (left) with a team of helpers.

“Where have you gone, Joe DiMaggio?”
Could it have been prevented?
If we cannot learn something from this, then the experience was worthless. As someone who experienced the disaster first-hand, in my view three fatal errors occurred:

1) Poor emergent management planning. Problems occurred from having the generators in the basement, lack of fuel, the generators’ fuel filling spot below the water line, or having the fuel stored 3 blocks away. Lives could have been saved if various emergent scenarios would have been appropriately planned. Many buses that could have been used for evacuations were seen from the evacuating helicopter with water up to their roofs. Prioritizing patient evacuation over healthy people who refused the mandatory evacuation orders did not happen. We saw healthy civilians being evacuated from the Superdome all day Tuesday and Wednesday while our patients, in miserable conditions, watched in disbelief.

2) Poor security. The dangerous lawless behaviors at the hospitals and the Superdome led to rape and murder. The military needed to intervene, secure the potential helicopter landing pad and run the evacuation.

3) Poor communication. With limited cell phone use, I finally reached a friend on Wednesday with military connections who eventually elicited military support to help us evacuate. He told me CNN had reported on Tuesday that all patients were evacuated from Tulane and Charity—when in fact none had been evacuated. When the evacuation finally began Wednesday, we had no communication with the helicopters. We waited until they landed, talked directly with the pilot to see who they could take (i.e., critical intubated, stretcher, and ambulatory patients, or employee family members), and then send for the appropriate patient instead of having the patients waiting. This was very time-consuming, so I therefore organized lines and created hand signals to make this as efficient as possible.

Late Wednesday afternoon, when most of Tulane’s critical patients had either transferred or passed away, I went to a leadership meeting at Charity. The same mantra was heard: “FEMA (Federal Emergency Management Agency) is in charge.” But the truth was, if we didn’t do something ourselves nothing would happen. Conditions were deteriorating, with medicines running out and sweltering heat. Of particular concern were three young critical trauma patients. I was concerned if they waited for FEMA they would die—like so many other patients. Without any real authority, we waved down an amphibious military vehicle and transferred them over to Tulane where a parking lot was turned into a makeshift helipad. We were met at the garage ramp by a trauma surgeon and a security guard with an assault rifle who told us the Tulane was not taking any new patients. After a small debate, I stated the patients would remain Charity patients; we were just borrowing their helipad. These were the first three patients evacuated out of Charity Hospital.
Our plight was finally known—Columbia HCA Orthopedics did an excellent job in keeping order and getting patients out first, followed by employees and family. The evacuation really started moving Thursday afternoon, attributed to many factors including the arrival of Columbia’s passenger helicopters, and the military Black Hawk helicopters which could now fire back at those who choose to fire at helicopters.

On Friday, my family and I were finally evacuated to a shelter in Lafayette, Louisiana by an armed bus, after a short stop at New Orleans International Airport. Lifting off in the helicopter, the scene was almost too surreal for words. With a view of New Orleans underwater, my entire family surrounding me, and my only possession being 3-day-old scrubs cut to shorts, I was relieved. No words were spoken, but our eyes filled with tears as we left all our possessions and our home. We went through decontamination, were well fed, and for the first time in almost a week, we had clean clothes and clean sheets. I slept like a baby that night. I am saddened that the great Charity Hospital did not make it through the storm. However, visitors were greeted in the lobby by the prophetic words, “Where the unusual occurs and miracles happen”.

So many who cared
I want to say thank you to family and friends from around the world who sent hundreds of calls, notes, and prayers. I have not been able to send thank you notes to all but your love brought tears to my eyes. I also want to thank the thousands of healthcare workers and volunteers around the world that continue to do the right thing for the right reasons and ease the burden of those facing tragedy.

Personal thanks
A special thank you to Randy Wilkinson and Joe Hsu who had my name shot up the military ladder as a “valuable asset” to the Surgeon General and had 20 Black Hawk helicopters sent to rescue me and my family. Thank you to my family away from Tulane, who hired an Israeli SWAT team for our rescue and who continue to give so freely financially, and more importantly, with love. Thank you to Toney Russell and his wife Gina for being Toney and Gina.

It is widely known that baseball great Joe DiMaggio was honest, true and brought honor to the game. I love you all—you will always be my own “Joe DiMaggio”.
The first strains of Swiss folkloric music in the conference center auditorium set the spirit for the 82nd and 83rd AO courses in Davos, held from December 2–15, 2005. Amid blue and yellow mood lighting representing AO’s colors, the roughly 800 participants were welcomed by Thomas Rüedi, President of AO International, and Christian Ryf, Head of Davos Hospital. This was followed by a local welcome and thanks to the organizers from veterinary surgeon Andrea Meisser, Director of Davos Department of Health, Traffic and Energy, who called the event “the biggest and most important congress in Davos”.

Taking the topic of “spirit” in his speech, Meisser compared the “spirit of Davos” to the World Economic Forum.

Participants were then introduced to the AO Center with a video. The next speaker was AO President James Kellam, who introduced founding member Martin Allgöwer to a thrilled and receptive audience. James Kellam explained what the AO could offer participants by outlining the specialties, the Trustee program, relationship with partners, clinical priority program, and how to get involved—ending with the message “become part of us”. Special thanks and gifts were also given to founding member Thomas Rüedi who had organized his last Davos course, and Urs Jann, AO Director of Finance and Administration, who retired at the end of 2005.

Norbert Haasthen presented the TK Award to four surgeons from AO’s main regions for their valuable contributions in development and treatment options: from Europe, Christoph Sommer (Chur, Switzerland), from North America, Timothy Weber (Indianapolis, USA), from Asia, Theerachai Apiwatthakul (Chiang Mai, Thailand), and from Latin America, Anselmo Reyes (Mexico City, Mexico).

“`The spirit of Davos was alive and thriving.”`
A video on the useful course information was then shown, with Christian Ryf describing the courses, features and events. It was clear that participants were made to feel welcome and privileged in an open-minded and relaxing atmosphere. And most of all, they were ready to learn.

**Technological advances**

Each year the AO Davos Courses embrace more technological advances—not only in the courses, but also throughout the entire event. Several new elements were seen at the 2005 courses. In the conference center, the AO booth layout was redesigned and all departments and institutes brought in line with the AO corporate identity, creating a clearer presentation of the AO as the open organization that it is.

The AO Alumni booth was relocated to the entrance area, and for the first time the AO Regions had their own booth, informing people of how to get active in their own regions.

AO’s Knowledge Services department also had its own booth with a sneak preview of the AO Surgery Reference, not yet available to the public.

**Computer-assisted surgery (CAS) and MIPO (Minimally Invasive Plate Osteosynthesis)**

In 2005, Davos was the place to be to experience an operation on a concealed bone using CAS, never before shown in an AO Masters Course. The idea originated as an exercise for computer-assisted surgery based on AO topics; in this case sacroiliac screws and femoral nailing, both exercise components of AO courses. To demonstrate the differences in navigation, it was necessary to create a bone model with a soft-tissue mantle, concealing the bone. The surgeon then inserts the screw through the soft tissue into the pelvis or an intramedullary nail into the femur.

The MIPO courses took place for the first time in Davos after successful launch by the AO East Asian group.

**Pelvis course**

For the pelvis course by Tim Pohleman, the AO Development Institute (ADI) developed, in collaboration with the course organizers, the new pelvic trainer model, providing a spectacular addition to this course (see photo below).

**QuickPlace**

QuickPlace is a web interface with restricted access for selected groups such as faculty members for a given course. After a test run the previous year on selected courses, QuickPlace was available in 2005 for all Davos courses. In addition to the course program, the QuickPlace included news from the chairman and extracurricular activities. An interactive message board kept chairmen, lecturers and instructors up to date on any room changes or ad hoc meetings, etc.

**Online registration**

In 2005, on a test basis, participants were able to register for the AO Principles Course online. Over 50% took advantage of this option.

**Popular sessions**

Two “hot topics” sessions were held each week in the evening, which proved so overwhelmingly popular that it was difficult to find a place to stand!

And one of the more impressive things from the Davos courses was the option course on clinical studies led by Beate Hanson and Erich Schneider. These courses were met with an outstanding interest and attendance, despite the exceptionally early morning start!

From skiing enthusiasts braving the winter chill between courses to the buzz of a crowd eager to learn, it was quite clear to anyone there that the spirit of Davos was alive and thriving.
Expanding roles

Starting with the Electronic Presentation Workshops held in Scottsdale in 2001 and formalized at the first AONA Faculty Development Forum in Amelia Island, Florida in 2003, NAMTEC has recognized the importance of providing AO Faculty with opportunities to further develop their teaching skills in the roles required at AO Courses. Over the past five years, not only have all faculty roles in our courses been expanded and responsibilities better defined, but the educational requirements of our courses have also taken on increased scrutiny to maintain accreditation. The AONA CMED department has greatly expanded in size and complexity in order to provide the support for our courses. The Principles and Advanced courses have undergone a metamorphosis of content and presentation. In addition, our...

The First AONA Course Chairmen and Directors’ Symposium was held at the Fairmont Scottsdale Princess Hotel and Resort in Scottsdale, Arizona on November 10, 2005, immediately prior to the Second Faculty Development Forum. This inaugural Symposium was organized specifically for prospective Course Chairmen and Course Directors of AO Courses in North America.

The 28 invited attendees included the Course Chairmen and Course Directors for all AO North America Courses scheduled for the next two years. All ten faculty members were either members of NAMTEC (North America Musculoskeletal Trauma Committee) or the AONA CMED (Continuing Medical Education Department), and assisted by professional educational consultant, Joseph Green.

First AONA Course Chairmen and Directors’ Symposium

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course offerings have expanded to include the Solutions Course and multiple specialty courses. Consequently, the roles of Course Chairman and Course Director have taken on increased importance, complexity and workload.

NAMTEC recognized the importance of planning and preparation in running an AO course as well as coordination between the Chairman, Director and staff at AONA CMED. We believe that a successful course requires a team approach, with cooperation and integration between all levels of faculty and staff.

Setting clear goals
The goals of this symposium were to provide the Course Chairmen and Directors with the information, knowledge and resources to:

- Effectively organize a successful AONA Course.
- Apply the educational principles, philosophy and resources necessary to provide an effective learning experience.
- Use AONA faculty effectively, applying their unique talents and expertise.
- Utilize AONA CMED for maximum benefit in course orchestration.
- Make use of the knowledge and appreciation of resources available for successful course implementation.
- Understand and implement the 360-degree evaluation method.
- Understand responsibilities for all faculty roles.

Specifically, the information included the structure and function of NAMTEC, course organization and planning (AONA CMED course leadership responsibilities, course faculty responsibilities, and structural elements of a course), and presentation and moderating skills which focused on “The Art of Moderating” and the effective use of ARS (Audio Response System).

“Our idea will be to add to and improve this offering with each Faculty Development Forum in the future.”

Tools for teaching
The Symposium was supported with some useful tools. A “Course Chairman and Director Manual” was developed and provided as a guideline for organization and management of an AO Course in North America. In addition, the eRoom website structure has been modified to provide “online” resources and support specifically for the Course Chairmen and Directors.

This course and handbook were not developed as a finished product, but with the hope that they will serve as the beginning of a continual work-in-progress to which additions of the best ideas and improvements from each course in the future will be added.

Our idea will be to add to and improve this offering with each Faculty Development Forum in the future.

Happy trails
The Symposium ended with a well deserved team building exercise that showcased the fruits of the Southwest geography with a presentation and tasting of several regional specialties.
Since its founding in 1992, AO North America has enjoyed significant growth and success. Over 58 courses were offered in 2005, involving over 4,000 participants. To support these offerings, the faculty grew to 961.

The quality of the courses has consistently improved throughout the years, with new and innovative techniques for both surgery and teaching incorporated into the curricula. With these advances have come increased complexity, responsibility and expectations.

AO North America is dedicated to continually providing the highest quality educational experience for both the participants and the faculty in this rapidly expanding field. Advanced faculty education and development is mandatory to achieve this goal. To support this goal, two events were held in North America in 2005: the Musculoskeletal Trauma Faculty Development Forum and the AONA Course Chairmen and Directors’ Symposium (see article on page 12 by Steven Schelkun).

The second “Musculoskeletal Trauma Faculty Development Forum” was held at the Fairmont Scottsdale Princess Hotel and Resort in Scottsdale, Arizona in November. The first such forum was held in Amelia Island, Florida in 2003 and resulted in several major initiatives further improving AONA, its educational programs and faculty. The Chairmen, consisting of Jorge Alonso, Joseph Borrelli, Michael Stover and John Wilber, carefully selected 120 faculty to attend. This represented a cross-section of new, middle-level and senior faculty from a variety of subspecialties and practice settings. Families were also invited and encouraged to attend.
A full program
The program included working sessions in the morning and recreational activities later in the day. The first day began with reports from the various committees which included updates on all the advances that had been made since the previous Faculty Development Forum, current programs and future priorities. These reports were very informative and allowed time for questions and discussions, and prepared the participants for the work to be done in the “Breakout Sessions”. The topics included: Principles Course, Advanced Course, Foot and Ankle, Hand, Future Educational Offerings, AO Alumni, Research and Faculty Issues. The discussions were very lively and productive and each group came back to the general session with three top “Action Items”. They were then presented, discussed, prioritized and forwarded to the appropriate committee for action. Work is already underway to establish these initiatives.

One day prior to the start of the Faculty Forum, a brand new educational program, inspired by the successful “Tips for Trainers Course”, was offered. 37 senior AO Faculty attended the inaugural “AONA Course Chairmen and Course Directors Symposium” organized and chaired by Steven Schelkun. This symposium was specifically designed for the “leaders” in AONA education: the prospective Chairman and Directors of courses being held over the next two years. Though it is the intent to educate at all levels, it was decided to start from the top down, creating a talent and brain trust for future educational offerings.

“The highest quality of education is a priority for AONA. Our faculty is our greatest resource and will continue to remain the focus of our educational and developmental programs.”

Other highlights included a “Technological Advances” session followed by a Product Fair, and informative reports from James Kellam, President of the AO Foundation, Thomas Ruedi, then President of AO International, and Hansjörg Wyss, Chairman and CEO of Synthes. Though all aspects of the Forum were felt to be successful and the stated goals achieved, the greatest benefit derived by all was the opportunity to interact and further develop relationships, thus extending the “AO Family”.

Time for discussion
The lectures, which included all aspects of organizing a successful course, were given by senior faculty members, most of whom were members of NAMTEC (North American Musculoskeletal Trauma Education Committee). The course was organized to allow significant time for discussion which was lively and productive—and resulted in not only teaching but also being taught. The universal consensus from all the participants was that the course was a tremendous success and will positively impact all future courses. A detailed handbook covering all aspects of this course was provided and will act as a working document for future courses. This course will be offered semiannually and will be required for all faculty who are promoted to course Chairman or Director in North America.
How it started
Research is a major pillar of AO. In 1958, our founders recognized the need to understand at a cellular level what effect injury and treatment methods had on musculoskeletal tissue, thus forming the basis for principles of internal fixation and the future development of these principles, techniques and implants for fracture surgery. In 1959, Martin Allgöwer established the AO Research Institute (ARI) in Davos followed by Herbert Fleisch who launched a program in bone and bone healing. Stephan Perren focused on the mechanical and biological influences of bone remodeling and developed the concept of tissue-friendly surgical procedures and implants. Since 1997, AO’s lab has been led by Erich Schneider with four areas of focus: Biomaterials and Tissue Engineering, Mechanobiology, BioPerformance, and Contract Research which contribute to the overall basic knowledge of musculoskeletal injury and treatment research through a collaborative interaction of AO researchers. ARI has been extremely successful, with 51 peer-reviewed publications and 9 finished dissertations in 2005. However, there remains a need for AO to address specific relevant clinical problems for the surgeon.

Research based on surgeon needs
Therefore the Academic Council (AcC) initiated the Clinical Priority Programs to assure that our research is based on clinical needs of surgeons, who identify relevant clinical needs that must be solved to better treat their patients. These needs are then translated into a research program taking into account the strengths and services of the AO research organization. Areas of needed expertise outside of this umbrella are sought from other successful researchers, creating a network of scientists to enhance the potential of finding a solution for this clinical problem. Program teams consist of a surgeon champion to assure the program remains online and addresses the clinical issue in a relevant manner, and an AO scientist from the research institute who acts as scientific director and coordinates the basic research portion of the program. The programs are designed to be completed within 3 to 5 years, with a demand by the AcC to meet the present scientific standard of review required by major research granting agencies in the USA and Europe. This has been performed through our Biotechnology Advisory Board and outside independent reviewers, with two Clinical Priority Programs currently underway. The osteoporotic fracture treatment program, led by Michael Blauth from Innsbruck, Austria and Norbert Suhm, Head of the AO Development Institute, is designed to assess the mechanical strength of the bone both in a clinical diagnostic realm and intraoperatively in order to determine the need for implant modification and different implant techniques. The second program is aimed at an off-the-shelf solution to heal a critical defect in diaphyseal long bones, and is presently in the peer review phase, under the direction of Mark Vrahas, Harvard and Mauro Alini, ARI. Craniomaxillofacial (CMF) surgeons are now investigating the potential of a priority program in image analysis to help in preoperative planning of complex CMF deformities. AOSpine completed the original Clinical Priority Programs on basic research into the disc and its degeneration and regeneration potential, led by Max Aebi and Norbert Boos. This proved the importance of establishing an integrated network consisting of AO researchers and individuals with different strengths to increase the benefits to all participants in the research outcome. This necessary initiative will better address the clinical needs of surgeons, thus fulfilling our mission of improving care and treatment of patients with musculoskeletal disease and injury.

A Message from the Board
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“Surgeons identify relevant clinical needs that must be solved.”
The AO Foundation (AOF) prides itself on being one of the best, largest and most influential institutions for research in and teaching of fracture management. Treatment is understood almost exclusively as operative, and all effort has been to remain at the cutting edge of such research and teaching. The implants and methods are of the finest quality—but only affordable in developed countries or to the rich.

In actual fact, 85% of the world’s population live in poverty, and half of that 85% are so poor that they go hungry every day. The children are undernourished, and a large number of them die before the age of three.

In many cases, the governments in these countries have been or remain corrupt, and essentially not interested in the well-being of the population. Health Care facilities are poor and dysfunctional and geared to primary Health Care. As a result, doctors, nurses and other Health Care professionals have become demotivated and seek work in developed countries.

Getting aid to the right places
Although billions have been poured into developing countries, and most of the functioning Health Care now funded and delivered by nongovernmental organizations (NGO), developing countries are actually poorer—and with even more sickness than 50 years ago. This leads us to conclude that the aid given has not been the correct help.

In response to this, the management of the AO Foundation has charged the members of the SEC (Socio Economic Committee) to define, develop and maintain its relationship with developing countries. In 2001, as experienced by SEC members, the image of AO in the minds of doctors treating musculoskeletal injuries in developing countries was “not for us”. And they were right. The preconditions for operative fracture care as advocated by AO are nonexistent in most hospitals in developing countries, and their budgets could not afford the products. Furthermore, the skill to use those products is only available in a few private hospitals, and even fewer teaching hospitals.

The strategy of the SEC-AOF is to work closely with the local medical associations and find out what the real needs are, rather than what surgeons from developed countries think is needed, as well as to avoid “prestige projects” as requested by politicians. The need essentially is twofold: 1.) to have standard AO teaching for those colleagues working in an environment where operative fracture care is affordable and safe, and 2.) in other environments, teach correct and diligent non-operative fracture management until the preconditions for bone surgery are established.

Showing signs of progress
Since the AOVA has supported this approach, substantial progress has been made in correcting the image of AO in developing countries. In cooperation with national and regional surgical associations and supported by other NGOs with the same philosophy as ours, we are organizing appropriate courses and projects that teach local Health Care personnel to become self-reliant and self-sufficient. The long term projects and regular teaching events are listed and described on the SEC website at www.aofoundation.org/sec.

As a result, orthopedic and trauma surgeons in developing countries greatly appreciate the support that is now derived from the AO Foundation.
AO in Germany

A brief history of AO’s first section

In 1958 when the AO had just been formed, philosophies and principles of stable osteosynthesis with plates, screws and nails were met with some opposition. But in neighboring Germany, a group of supporters was already forming led by Herman Krauss, professor of surgery at the University of Freiburg. Thanks to founding member Hans Willenegger, then president of the German Association of Transfusions, Krauss was given access to the AO clinics in Switzerland and received implants upon completion of the AO course in Davos. On March 5–6, 1960 a trauma congress took place in Freiburg, Germany, where German ties with AO were strengthened. A few years later, Germany held its first AO course from November 18–21, 1965 in Freiburg.

On May 26, 1970, a first meeting for those interested in setting up a German section of AO took place in Ettlingen, initiated by Professor Koslowski of the University Hospital in Tübingen. That was followed by a founding assembly in Frankfurt on November 19, 1970 with 14 surgeons and 8 orthopedic surgeons in attendance. At that meeting, Siegfried Weller was elected chairman, Carl-Heinz Schweikert was elected secretary, and Fritz Brussatis was elected treasurer. An additional German section was founded in 1976 in former East Germany. The unification of both sections took place on October 3, 1991 in Berlin.

Numerous clinical studies surrounding the AO were discussed at national and international congresses. The treatment of polytraumatic patients in intensive conditions in Hannover and other places profited from the AO principles for rehabilitation of articular fractures. Absolute stability was soon broadened with “relative stability”. German AO clinics were essential in the development of minimally invasive osteosynthesis techniques and realization of retrograde nailing of femur and humerus fractures.

The AO Research Institute in Davos, as well as the University of Ulm (Burri Institute) and the Maurice E Müller Foundation in Bern delivered solid experimental research to complement these developments. A wide range of work supported by the AO Foundation led to conferral of a doctorate and professorship at German universities. Many international scholarship holders could now gain further experience abroad and find exposure and training in German AO clinics.

Today, the German section of AO includes over 200 members. These individuals, made up of trauma, orthopedic, CMF (craniomaxillofacial) and veterinary surgeons, continue to implement and enhance the AO principles every day.
The European trauma world lost a legend when Viennese surgeon and teacher Jörg Böhler passed away on December 11, 2005, just four days before his 88th birthday.

Jörg Böhler was born on December 15, 1917 in Gries near Bozen in the South Tyrol to Lorenz Böhler, founder of the modern trauma management, and his wife Leopoldine. He completed his medical studies in Innsbruck and Vienna and became a doctor of general medicine in 1941. The same year, he served the AUVA (Austrian Social Insurance for Occupational Risks) at the Arbeiterunfallkrankenhaus Webergasse, and completed his education as a specialist for trauma surgery in 1948.

In 1951 he was appointed Chairman of the UKH Linz, a position he held until the end of 1970. On January 1, 1971 he assumed management of AUKH XX, which was later relocated to the new “Lorenz Böhler Trauma Hospital” building in Vienna, and which he managed until the end of 1983.

In 1957 he received the venia legendi for surgery from the University of Vienna and was named outstanding professor in 1964.

The theme of his professorial dissertation was “The management of fresh hand injuries with particular consideration of the tendon”. Over 500 speeches worldwide, 360 publications as well as numerous text books made Jörg Böhler unforgettable.

In 1969 he was invited to hold the “Sterling Bun nell Memorial Lecture” at the University of San Francisco, a distinction that is only bestowed to the greatest hand surgeons in the world.

Jörg Böhler was an exceptional teacher. In his hand courses he put his knowledge and experience at our disposal with the use of all audio and visual possibilities. After his retirement, Jörg Böhler furthered his “Vienna Hand Course” to perfection and enormous dedication. He was repeatedly invited as an instructor and guest of honor at the Davos Courses. Besides his main focus of hand surgery, the areas of diagnostics and global poly-trauma management as well as cranial injuries and burns were very close to his heart.

Jörg Böhler was a member and supporter of countless professional societies in and out of Austria. He was Honorary President of the Austrian Society for Traumatology, receiver of the Lorenz Böhler Medal and a member of AO Austria. His diverse merits in traumatology, the continuation of his father’s life work and the many ways in which he continuously influenced traumatology in Austria and beyond, will make him irreplaceable.

Jörg was a charismatic person. With his constant pursuit of quality and perfection in traumatology, he will always remain an unforgettable role model as a doctor and teacher. The loss for the trauma world and the AO is enormous, and impossible to put into words.
Maurice E Müller receives awards and honors

AO members and employees residing in Switzerland had a proud moment in January when founder Maurice E Müller, 87, received the SwissAward in the category “Culture”. Maurice E Müller was honored for his role as patron of the Paul Klee Museum in Bern, Switzerland—to which he donated the majority of his family fortune in 2005, and thus realizing his life’s vision.

The “SwissAward” is an event organized by Swiss television and the Swiss lottery in collaboration with various partners. 18 Swiss people are nominated each year from the areas of politics, culture, economy, show business, sports and enterprise. The SwissAward honors outstanding individuals who have made remarkable contributions through courage, innovation, creativity or originality.

One of the most moving moments of the gala event was Maurice E Müller’s acceptance speech, when his voice broke with emotion. His wife, Martha was beside him. The moment was even more special given that the couple was celebrating their 60th wedding anniversary that same day.

And, for the first time in the history of Bern, Switzerland, the town council has awarded honorary citizenship. Livia Klee-Meyer, who donated 682 works by her famous father-in-law, and Maurice E Müller and his wife Martha Müller-Lüthi were honored for their extraordinary commitment in support of the Paul Klee Museum.

“The SwissAward honors outstanding individuals who have made remarkable contributions through courage, innovation, creativity or originality.”
The 22nd AO Course in Thailand was held in August 2005 by excellent teachers under the direction of the dynamic Suthorn Bavonratanavech. Along with his well-trained staff, Suthorn once again organized “a perfect AO Course” in his attractive Bumrungrad Hospital in Bangkok. 80 second-year residents in a 5-year training program in orthopedic surgery participated. Most came from Thailand, while others came from Vietnam and Myanmar.

The course consisted of a clear and well-prepared agenda with morning lectures and practical exercises in the afternoon.

“We as faculty learned a lot from the students.”

The Bumrungrad Hospital, one of 500 Thai Hospitals using AO equipment and implants, offers perfect teaching facilities, attractive lecture halls and ideal rooms for workshops in large, bright rooms on the building’s top floor.

As usual, Suthorn had a skilled faculty, with Jürgen Stadler and Domenic Scharplatz invited as European faculty. But as it happens with Suthorn, we as faculty learned a lot from the Thai students.

The course registration fee and expenses are partially sponsored by the Royal College of Orthopedic Surgeons of Thailand and Synthes. We are all very grateful that Suthorn organizes an AO course for doctors as well as two ORP courses each year.
A contrary view on the controversial issue of Damage Control Orthopedics, with additional commentary on the following page.

Robert N Meek and Peter J O'Brien

Damage control orthopedic surgery
A contrary view

Introduction  There have already been some publications in AO Dialogue relating to Damage Control Orthopedics (DCO). DCO is a spin-off term from Damage Control Surgery which is popular in abdominal surgery. It is based on the predication that certain patients with multiple injuries are “too sick” to have their long bone fractures stabilized with intramedullary nails or plates. Instead, it is recommended that they have their fractures, particularly those of the femur, stabilized with an external fixation device and then have a secondary intramedullary nail.

Evidence  In our view, there is no evidence that DCO is either a good thing or a bad thing to do. The idea that patients with multiple injuries are “too sick” to have their long bones stabilized with operative treatment is not a new one. It was very prevalent in the 1970s, but in the 1980s there were several publications from a variety of centers in Europe and North America that showed decreased mortality and morbidity when the long bone fractures were primarily stabilized.

The various publications, including those in AO Dialogue which support the use of DCO, cite as their evidence data presented in the following publication:


Surgeons interested in this subject should read this paper very carefully, as the conclusions reached by the authors do not seem to follow from the data presented.

Pape et al published a historical review of patients treated in Hannover, Germany in three different time periods. The crux in the misunderstanding about these data is found in Table 2 and Table 7 of their data.

Their philosophy from 1981 to 1989 was, to a large degree, to nail or plate the fractured femurs early—called the ETC (Early Total Care Group). In this group, there were 235 patients, 60% of whom were treated with rapid intramedullary nailing, 16.6% with primary external fixation followed by intramedullary nailing, and 23.4% with plating.

From 1990 to 1992 they looked at a second group called INT (Intermediate)—a smaller group of 88 patients. In this group the primary nailings reduced to 40.9%, the primary ex fixes went up to 23.9% and the plating went up to 35.2%.

A third reported group was from 1993 to 2000 which they called the Damage Control Orthopedic (DCO) group. In this group they had a 57.6% nailing rate, with the ex fixes at 35.6% and platings at 6.8%.

The authors use MOF to indicate Multiple Organ Failure, IMN to indicate early intramedullary nailing of the femur and...
1º EF (or sometimes 1º EF, IIº IMN) to indicate those patients treated with “damage control”. The authors write: “Moreover, there was a significantly higher incidence of MOF in comparing the Iº IMN and Iº EF in the DCO subgroup. A similar distribution occurred regarding the incidence of ARDS (Table 7).”

In Table 7 of their paper, they report percentages for the complications of ARDS and MOF, but in our view they are using the wrong denominator in calculating the percentages of complication. For instance, in the ETC subgroup (1981 to 1989), they treated 39 patients with Iº EF. All 39 (or 100%) got MOF, however in Table 7 they report the percentage as 16.6%. The 16.6% comes from dividing 39 by 235, which is the total number in the group treated by all methods. But, what we want to know is what percentage of the group of patients treated by any one method (Iº EF) got MOF? In this example it is 100%, not 16.6%. One might reasonably ask, why, when 100% of the patients got the complication of Multiple Organ Failure, they changed their policy in the direction of using it more frequently?

Multiple Organ Failure  In the DCO subgroup (the patients treated most recently from 1993 to 2000), they treated 110 patients with primary nailing (Iº IMN), and 31(28.2%) got MOF. In Table 7 they put the percentage as 16.2%, but this is calculated using as the denominator, not the 110 patients treated with primary nailing, but the whole group of 191 patients in the DCO era. The problem with using the number in the whole group as the denominator is that the complication rate of any of the subgroups varies with the number in the whole group. For example, if they had used ex fix on 291 patients instead of 191, the rate of MOF in the Iº IMN group would be 31/291 which is equal to 10.6%. Clearly, one cannot decrease (or increase) the rate of a complication for a procedure by doing more (or less) patients using another procedure. Using what we consider to be the correct denominators, the MOF rate for primary nailing is 31/110 (28.2%), for ex fix 22/68(32.3%) and for plating 8/13 (61.5%).

ARDS  The rates for ARDS (acute respiratory distress syndrome) in the primary nailing group is 29/110 (26.4%), in the ex fix group 15/68(22%) and for plating 4/13(30.7%).

The results of DCO would be even worse if the “intention to treat” patients were placed in the ex fix group, as several of them died. One cannot conclude, however, that they died from having an ex fix instead of an intramedullary nail. Neither can one conclude that they would have died had a primary IM nail been used. We simply don’t know.

Scalea also reported on two groups of multiple trauma patients, one treated with primary ex fix and later IM nail and the other with primary intramedullary nailing. However, the groups were very pre-selected so that the more injured patients were in the ex fix group. He stated that no death was due to the method of fracture treatment selected and concluded that Damage Control Orthopedics was a viable alternative to primary nailing.

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<td>IM Nail Primary</td>
<td>141 51 77</td>
<td>36 17 20</td>
<td>110 31 29</td>
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<td>% (%)</td>
<td>60 36.2 54.6</td>
<td>41 47.2 55.6</td>
<td>58 28.2 26.4</td>
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<td>Ex Fix then IM Nail</td>
<td>39 39 38</td>
<td>21 14 10</td>
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<td>% (%)</td>
<td>17 100 97.4</td>
<td>24 66.7 47.6</td>
<td>36 32.4 22.1</td>
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<td>Plate</td>
<td>55 46 45</td>
<td>31 17 14</td>
<td>13 8 4</td>
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<td>% (%)</td>
<td>23 83.6 81.8</td>
<td>35 54.8 45.2</td>
<td>7 61.5 30.8</td>
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Table 1 Percentages of MOF and ARDS for individual treatment types

MOF  Multiple Organ Failure
ARDs  Acute Respiratory Distress Syndrome
Conclusion  There is no difference in the rate of MOF between 28.2% in the primary nailing group and 32.3% in the ex fix group. Similarly, we do not think that there is a difference in the ARDS group between 26.4% for the primary nailing group and 22% for the ex fix group. The plating numbers are quite small and probably not of much significance. The small increase in percentage of MOF in the exfix group may be due to a slightly higher average injury severity score (35.8 vs 39.1) or a higher abdominal and chest injury rate in the ex fix group due to selection of these patients for this treatment. We do not think there is a clinically significant difference between an ISS of 36 and one of 39 and don’t expect many surgeons would change their treatment because of it. Table 1 is a modification of Table 7 from the cited paper, which we think reflects the more accurate percentages of ARDS and MOF for each individual type of treatment in each of the time periods.

We don’t think we should teach that “DCO is the way to go” until we have some real evidence. Trainees and practicing surgeons should not be criticized in examinations, teaching sessions and the courts if they chose not to “go DCO”. An individual surgeon should be encouraged to do what he thinks is best for the patient being treated at the time; using the “art” of medicine, since in this case the “science” of medicine is inconclusive.

Commentary by Otmar Trentz

As a convinced supporter of the concept “Damage Control” (DC) in strictly selected patients with polytrauma, I was asked to comment on the preceding article “Damage Control Orthopedic Surgery—A Contrary View” by Robert Meek and Peter O’Brien.

Yes, I agree with the authors’ conclusion that there is no sufficient base of evidence by “Randomized Controlled Trials” (RCT) how primary fixation of femoral shaft fractures in severe polytrauma should be done. Chris Pape’s paper has indeed some weak points and demonstrates more the growing of the concept and the evolution towards “Damage Control Orthopedics” (DCO) than convincing evidence. So far I know there is a large multicenter RCT under investigation in Germany which may bring clear evidence into the discussion about this topic. In General Surgery, DC is well established in trauma management although with a weak level of evidence. The article in AO Dialogue, Vol. 18, Issue I (June 2005) about “Polytrauma management” describes our policy in selecting DC. In a retrospective analysis of 622 severely injured polytrauma patients we found 205 patients (33%) managed with DC and 417 (67%) with “Early Total Care” (Keel et al 2005 Eur J Trauma; 31:212–221).

The axiom of primary fixation of long bone fractures in polytrauma is by no means challenged by “going DCO”. The fact of stressing the pulmonary endothelium with embolization during reaming and/or nailing is generally accepted and well proven in literature. Especially in an occult state of hypoperfusion (not to mention manifest shock states), pulmonary embolization loads a significant “second hit” on our defence system. (Gerhard Küntscher already warned against femoral nailing in shock and recommended from his valuable experience to fix the fracture with a “distractor” and to postpone nailing to day 6 or 7.)

Clinical and experimental research has proven the consumption of immunocompetent cells and “acute-phase proteins” after severe trauma and hemorrhage.

Cell recruitment, respectively de-novo-synthesis of proteins, takes a couple of days. Between day 5 and 10 after severe trauma there is a time slot or window of opportunity which allows a relatively safe performance of definitive surgical procedures. With a strict selection of “patients at risk” for DC you will have a larger margin of safety. Who wants to advocate primary femoral nailing in a patient with hypothermia, acidosis, and coagulopathy? Even after quick resuscitation, patients with a heavy trauma load have often an occult hypoperfusion state and remain at risk for unnecessary “second hits”. At least in our setting we are confronted with such trauma patterns. Even if the evidence base for “going DC” may be weak, the nil nocere should be our maxim when we are in doubt over the physiological state or the defence reserve of a severely injured patient.

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Introduction A 28-year-old surgical resident presents to your fracture clinic having fallen off his mountain bike going down a steep hill. He sustained an isolated, closed neuro-vascularly intact mid-shaft fracture of his left clavicle seen in Fig 1. Medically, he is otherwise completely well. On examination, there is an obvious clinical deformity with a droopy, protracted shoulder. The left shoulder is, by clinical measurement (sterno-clavicular joint to acromio-clavicular joint), two centimeters short. He stresses that rapid return to function (and his surgical duties) is very important to him, and points out that, like many modern physicians, his interests outside medicine are many and he is very active in mountain-biking, skiing and rock-climbing. He has gleaned some information from standard textbooks and discussions with colleagues and has a number of questions:

Is it true the incidence of nonunion after a displaced mid-shaft clavicle fracture is 1% or less? The incidence of nonunion of the clavicle following mid-shaft fracture has traditionally been described as 1% or less, based on two landmark studies from the 1960s [1-4]. This figure has been used as a reason to avoid primary operative intervention. However, times have changed. A number of recent studies that have concentrated on completely displaced, mid-shaft fractures of the clavicle reveal nonunion rates between 15% and 20% [5, 6]. These studies were recently summarized in a meta-analysis that found a nonunion rate of 15.1% following nonoperative care of these fractures [7]. There may be many reasons for this exponential increase in nonunion: better follow-up, inclusion of more severe fractures, elimination of children from the series (with their intrinsically good prognosis) patient reluctance to remain immobilized, etc. [5, 8]. I would tell this patient: the chance of his fracture not healing by one year is 15% to 20%.

Fig 1 X-ray of displaced clavicular shaft fracture in 28-year-old surgical resident.
Is malunion of the clavicle of radiographic interest only? This is certainly what has been promoted in the past. However, through the pioneering efforts of surgeons like Carl Basamania, Jesse Jupiter and Lynn Crosby it is now apparent that clavicular malunion is a distinct clinical entity with characteristic orthopedic (weakness, easy fatigability, scapular winging), neurologic (thoracic outlet syndrome) and cosmetic (droopy, asymmetric shoulder, difficulty with backpacks, shoulder straps, etc.) symptoms [9-12]. Our series identified shortening (mean 2.9 cm) as a risk factor for the development of this condition, and showed that corrective osteotomy was a reliable treatment method for restoration of upper extremity function [13]. I would tell this patient that he had a 15% to 20% risk of developing a malunion symptomatic enough that he would request corrective osteotomy.

He has heard it said that “The only clavicle fractures that don’t heal are the ones that are operated on”. This statement was based on studies from the 1960s that included surgery for only the worst fractures (selection bias) and used soft-tissue management and fracture fixation techniques that would be considered suboptimal by modern standards. There are multiple, modern studies from North America, Europe and Asia which clearly show that plate fixation is an extremely effective technique for treatment of clavicular shaft fractures with a low complication and nonunion rate [14, 15]. In fact, the meta-analysis quoted earlier described a nonunion rate with plate fixation of 2.2%, which represents an 86% risk reduction for nonunion compared to the same fracture treated nonoperatively (nonunion rate 15.1%) [7].

Will my shoulder be as strong as it was before my injury if it heals like this? Prior studies of outcome following clavicle injuries did not describe any strength deficits following nonoperative care of displaced mid-shaft fractures, and tended to concentrate on radiographic and surgeon-based results. Hill et al were one of the first to use a patient-oriented outcome measure, and found 31% of patients were unhappy after nonoperative care [6]. This may be due to the fact that there are significant residual strength deficits following the conservative treatment of these fractures. Using an objective strength testing protocol for both maximal effort and endurance (which had not been done previously), we found strength deficits ranging from 10% to 35% in patients an average of 54 months after nonoperative care of a displaced fracture of the clavicular shaft [16]. This can have a significant effect on an active young person recreationally or occupationally.

Will a figure of eight bandage reduce my fracture and improve my outcome? The first recorded description of the closed reduction of a clavicle fracture was in the “Edwin Smith” surgical papyrus from the 30th century BC, and there have been over 200 methods described since: there are so many because none of them work. There is little evidence that any closed method can reliably obtain and maintain reduction of a displaced mid-shaft clavicle fracture. A randomized trial by Andersen et al comparing a simple sling to a figure of eight bandage showed no functional or radiographic difference at final follow-up, and patients preferred the sling [17]. Essentially, if nonoperative care is selected, I would treat this patient in a sling and tell him that his fracture alignment will not change much from the initial x-ray.

If I choose nonoperative care, and develop a nonunion, is fixing it later as good as primary fracture fixation? It has always been thought that the delayed reconstruction of a clavicular nonunion or symptomatic malunion will produce results as good as immediate fracture repair, i.e. delayed reconstruction is as good as primary fixation. However, this may not be the case. In addition to the delay and period of disability, patients undergoing delayed reconstruction face a higher complication rate, a potential requirement for iliac crest bone grafting, and their final result may be inferior to that which would have been achieved with primary fracture fixation. We compared the patient-oriented outcome and objective muscle strength in a matched group of patients with delayed reconstruction to those who had primary fixation and found significant deficits, especially in endurance strength [18]. I would tell this patient that delayed reconstruction, if necessary, is effective but inferior to primary fixation.

Will surgery get me back to work or sports any quicker? There is increasing evidence that primary operative care returns patients to functional status earlier, on average, than nonoperative care. A recent randomized clinical trial conducted by the Canadian Orthopedic Trauma Society of 111 patients comparing primary plate fixation to nonoperative care (a sling) showed not only an overall improvement (at one year) in shoulder function, but also a much more rapid return of function and decrease in pain in the operative group [19].
Summary  The choice to proceed with operative intervention for a displaced mid-shaft fracture of the clavicle will be a decision made between surgeon and patient. There is a much higher likelihood that both parties will be satisfied with their decision if it is based on fact from modern prospective and/or randomized studies with objective and patient-related outcome measures rather than fallacy. After a discussion, our patient elected to undergo surgical intervention (Figs 2 and 3) and was back at work in two weeks. His final result is excellent.

Fig 2 An intra-operative x-ray following open reduction and internal fixation with a small fragment LC-DCP. Note that the soft-tissue attachment to the comminuted fragment(s) has been left intact, and these pieces positioned under the plate without excessive stripping. If possible, a lag screw can be placed through the plate into this fragment.

Fig 3 Final x-ray revealing solid union.

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Commentary by Jesse B J Jupiter

Michael McKee has clearly and convincingly outlined the rationale for reevaluating many heretofore well accepted concepts regarding fractures of the clavicle. So many of us were taught that these are “benign injuries; almost all heal; deformity is not a functional problem; and/or operative intervention is meddlesome and fraught with complications.” McKee and colleagues in several excellent studies have challenged these concepts utilizing both physician and patient rated outcome tools [1-3]. To further support his perspectives of “fallacies,” in a prospective study published in 2004, Nowak et al followed 208 patients who sustained clavicular fractures from 1988-1991 in Uppsala, Sweden for 9-10 years post injury [4]. While 112 (54%) recovered “completely,” 96 patients (46%) still experienced sequelae including pain at rest or with exertion, as well as cosmetic complaints.

Having been somewhat of a mentor to Michael McKee, I would be hard pressed to offer any alternative viewpoints, yet—lest the pendulum swing too precipitously towards the operative suite, it behooves us to try to define most clearly some aspects of his “facts.” First off, one must ask the question of just how much “displacement” is required to be considered sufficient to warrant operative treatment, especially if these concepts become widely accepted? Certainly, few would object to considering surgical management for the illustrated case of the 28-year-old surgical resident whose fracture includes a displaced segmental fragment. Here, too, the study of Nowak et al identified this pattern as one that was a predictor of adverse outcome along with those fractures without any bony contact or fractures in the older aged patient.

Is a standard anteroposterior x-ray sufficient to quantify “displacement”? Should we not require at least a 45º angled anteroposterior view and perhaps, when unsure, a 3D CT reconstruction?

What about “shortening” as an indication for operative intervention? While both Michael McKee and I have seen and treated with an osteotomy symptomatic patients with malunions characterized by shortening, what are the limits of shortening that are acceptable? Here, prior literature may be inadequate to define this parameter. Nordquist et al in 1997 followed 85 patients and did not find shortening to be a symptomatic problem [5] and likewise with the study of Nowak et al. Yet, in 1986, Eskola described an association of pain and diminished shoulder function in those fractures which healed with greater than 12 mm of shortening [6], while in 1997, Hill et al found that greater than 20 mm of shortening led to symptoms [7].

McKee and other members of the Canadian Orthopedic Trauma Society identified few complications and a high rate of union in the operative cohort in their prospective randomized study. Can we expect the same from those who may have far less experience in this anatomic region? Should we begin to urge operative care of “displaced fractures”? Furthermore, plates applied on the superior surface of the clavicle may prove problematic or unsightly requiring a second procedure for later plate removal. As suggested by Kloen et al, anteroinferior plate placement may avoid some of these problems [8].

The subcutaneous nature of the clavicle should lend itself to less invasive surgical techniques. Witness the results of the experience of Rehm and colleagues in Köln, Germany, who reported on 136 fractures in 132 patients treated with a flexible titanium nail with 78 placed entirely percutaneously, and the remaining requiring a limited exposure for fracture reduction [9]. All but one healed, with follow-up revealing outstanding functional results.

In summary, I agree with the observations and recommendations by Michael McKee, but caution that we strive to establish defined criteria for those fractures requiring intervention and continue to document our outcomes in a careful manner.

Bibliography


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Most frequent fractures of the carpus and tarsus in racing greyhounds
Part I

Introduction  The racing greyhound is an elite athlete that in the last hundred years has been selectively bred for speed on a circular track. The track shape is usually oval; the average radius of the turns varies from 23-33m in the UK and Ireland to 45m in the USA and Australia. In the past, the racing surface was grass, or a mixed surface with grass in the straights and sand in the turns; in recent years almost all tracks in the UK and Ireland have been converted entirely to sand. The turns are banked at variable degrees to help the dogs counteract the enormous centrifugal forces and to maintain their trajectory without an excess of leaning into the turns. The greyhounds race in a counter-clockwise direction and the number of dogs per race varies from the traditional six in the UK and Ireland to nine in the USA and Australia.

During the race, the back legs provide the propulsion and speed, while the front legs steer the direction. In the straight, the greyhounds tend to lead with their front left foot; as they negotiate the bends they switch the stride and the front right takes over, becoming the leading leg. Recent studies show that, unlike human athletes, racing greyhounds do not need to slow down when racing around tight turns, because they change their foot-contact timing [1]. This way, the body mass experiences gravity as well as centripetal acceleration that allow the legs to withstand a 65% increase in loading forces. Based on these observations, it is easy to understand why racing injuries are not necessarily only correlated to collisions or falls, but are also caused by a failure of the musculoskeletal structures to withstand the forces developed during the race. Another frequent cause of fractures in greyhounds is related to the physiologic response to racing in counter-clockwise direction known as “asymmetric adaptive remodelling”, well described in humans and horses. This mechanism consists in a change of the bone mineral density and consequently strength to adapt to the new workload. Unfortunately this adaptive response is quite slow, requiring time, regular training and racing. If the optimal conditions are not guaranteed, the bone can sustain a catastrophic failure, described as a fatigue fracture due to the presence of microcracks.

In this article we will describe a selection of fractures affecting racing greyhounds and their treatment.
Dorsal articular margin fractures of the distal radius  These fractures were first described by Ferguson in 1986 [2] and are very common in the authors’ experience, probably second only to the fractures of the accessory carpal bone. The fractures are usually located at the origin of the dorsal radiocarpal ligament that joins the dorsal articular margin of the radius with the ulnar carpal bone. The fracture can consist of an avulsed chip of 2 to 4 mm in size, or can be an incomplete fracture of variable size. Multiple radiographic views must be taken including standard and oblique views. The straight mediolateral view is usually diagnostic [3] with some exceptions, as some fractures can only be appreciated on skyline (tangent) views taken at different angles (Fig 1).

The surgical approach is through a very small incision between the extensor carpi radialis—and the common digital extensor tendon. Small fragments are removed surgically with a curet; larger fragments and incomplete fractures are repaired with the help of screws inserted in lag fashion (Fig 2). Removal of the small fragments creates damage to the dorsal radiocarpal ligament that will heal with formation of fibrous tissue.

The involvement of this small ligament in the pathogenesis of these types of fractures and its importance in the joint stability is yet to be clarified. Prognosis is usually from good to excellent for a complete return to the performance.

ACB  Accessory Carpal Bone (ACB) Fractures of the accessory carpal bone are among the most common carpal injuries in racing greyhounds and can easily terminate the racing career of the dog. Bateman, (1950) was the first to report on these fractures [4] and K. Johnson et al (1988) [5] have classified them in five types on the basis of their radiographic and pathologic features (Fig 3).

The ACB must withstand the severe tensile stresses that develop while the carpal joint region hyperextends during the weight-bearing phase of the stride. The result of vectorial forces, acting along the long axis of the bone creates a compression of its articular surface on the other carpal bones contributing probably to the ethiopatho-genesis of some of these injuries (Fig 4).

The avulsion fractures of the ACB may affect either limb and may involve the proximal dorsal or ventral border of the bone (intra-articular) or the distal dorsal or ventral border (extra-articular). According to some authors the right ACB is involved in 80% of the dogs sustaining this injury [6].

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**Type I** represents an avulsion fracture of the distal articular margin involving the insertion of the accessoroor-ulnar ligament (type IB: palmaro-medial). It is the most common of the five types; the fragment may vary in size, from a single large slab to multiple chips. A variation of the type I fracture involving the lateral articular prominence of the bone (type IA: palmarolateral) has been recently described and its diagnosis can be quite challenging, because the fragment(s) is/are only visible in the dorsolateral-palmarodorsal oblique radiographic view.

**Type II** represents an avulsion fracture of the proximal articular margin at the insertion of the palmar ulnocarpal— and radiocarpal ligaments. The fragment is usually well defined, single and wedge-shaped.

**Type III** represents an avulsion fracture of the distal palmar border of the bone involving the origins of the accessorometacarpal ligaments that insert on the fourth and fifth metacarpal bones. The fragment can be a single slab involving one ligament, or multiple fragments involving both ligaments may be present. This type of fracture can be seen in conjunction with types I and IV.

**Type IV** represents a strain avulsion fracture of the insertion of the flexor carpi ulnaris tendon on the proximal surface of the palmar border of the bone. Fragments are usually small.

**Type V** represents a multi-fragment fracture of the bone. The fracture can involve the articular surface with a combination of Types I/II and Types III/IV, or the bone can be split along the transverse plane.

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**Fig 3** Classification of accessory carpal bone fractures. (Courtesy of KA Johnson)

![Fig 3](image)

**Fig 5a-c** A Type I fracture (a) was repaired with a 1.5 mm cortex screw in lag fashion (b). The intraoperative picture (c) shows the small surgical field and the very small fragment.

**Fig 6a-c** Combination of Type II and III fractures (a) repaired with lag screws and a small wire suture (b). Follow up 3 years later (c).
Clinical signs are variable; in acute Type I and II injuries the area of the ACB is associated by oedematous swelling that creates a lack of definition of the fovea between the flexor carpi ulnaris tendon and the bone, decreased range of motion with pain upon flexion and direct palpation. In Types III and V crepitus may be detected during palpation. In chronic cases only minimal or no swelling may be encountered and pain is elicited only with firm pressure during forced flexion of the carpus.

Radiographic examination is imperative to determine the type of fracture. Mediolateral views in semi-flexion and extension are usually diagnostic, although dorsopalmar and oblique views can be very useful in the identification of the fragments (Types I and II).

Treatment for Type I and III fractures consists of fragment excision for small chips and whenever possible screw fixation in lag fashion (Fig 5).

The operative space is very restricted by the small surgical approach and the fragment fixation can be technically demanding. Fixation of the fragment offers the best prognosis according to published data [7] and the authors’ experience. Unfortunately the technique requires a long learning curve and the complications are numerous. Small fragments can be carefully excised taking care not to further damage the intact portions of the ligament.

In Type II fractures, small avulsed fragments are generally excised and internal fixation of large fragments may be attempted (Fig 6). Type IV fractures are best treated with fragment excision and tendon repair. Type V fractures are so devastating and variable that they are usually career-ending, although in selected cases an attempt to surgically repair these fractures, may be worthwhile.

Following surgery, the carpus is placed in a flex bandage or under a half fibreglass splint applied on the palmar aspect. After three weeks it is possible to gradually extend the carpus, each time changing the splint or bandage until an extended weight bearing position is achieved. After six weeks the bandage or cast is removed, and depending on the radiographic signs of healing, physiotherapy and controlled exercise are initiated. Full training can start between 12 and 16 weeks postoperatively. There are insufficient data not yet published to define a proper prognosis for the ACB fractures. A revision of the classification, based on CT imaging and three-dimensional reconstruction associated with a re-evaluation of the prognosis for each type of fractures for larger numbers, is probable in the near future.

Bibliography

Update on AO-sponsored research in biotechnology

Background  The AO Biotechnology Advisory Board (BAB) was founded in 2003 in response to an expressed desire and AcC (Academic Council) endorsement to support ongoing AO clinical research priorities with new contributions from innovative and impacting biotechnologies. Biotechnology is a generally descriptive term for an evolving, complex and diverse technical field, with no clearly accepted single definition. Nevertheless, in most biotechnology strategies applicable to medicine, at least one of the following technological components is involved:

- Nucleic acids (DNA, RNA): the genetic code for the proteome; genomics, pharmacogenetics, gene probes, DNA sequencing/synthesis/amplification, genetic engineering and alterations (shuffling), recombinant expression technology, non-natural transcription, PCR, gene therapy and delivery vectors;
- Proteins and biomolecules (the functional physiological building blocks): modulating protein/peptide sequencing/synthesis/expression (recombinant methods), protein delivery, lipid/protein glycol-engineering, proteomics, hormone modulation, growth factor expression/delivery, altering cell receptors/signaling/phenotypes;
- Cell culture and tissue engineering: cell sorting, cell phenotypic modulation, cell/tissue culture methods, tissue engineering, cell fusion strategies, vaccine/immune modulation, inflammatory modulation, cell-surface engineering and cell-biomaterial interfacing;
- Bioprocess technologies: development and application of in vitro bioreactors, real-time dynamic culture methods (morphological, hydrodynamic, mechanical stimuli), organism fermentation, bioprocessing innovations, biofiltration, material matrices for cell attachment and proliferative responses;
- Subcellular targeting: specific targeting of intracellular organelles with novel delivery systems and pharmaceutical approaches;
- Direct interfacing and integration of living (physiological) and synthetic systems to exploit biological mechanisms for hybrid device function (eg molecular beacons, biosensors, medical implants).

Frequently used in the context of bone generation, tissue engineering refers to interdisciplinary applications combining principles of engineering, biotechnology and other life sciences to develop functionally competent biological surrogates intended to restore, maintain, or improve tissue function. This includes exploitation of growth factors or other cell signaling molecules, biomaterials scaffolds to provide form and support, seeded cell populations capable of tissue regeneration, and appropriate bioreactors that promote recapitulation of viable tissue form and function. Tissue engineering is rapidly merging with regenerative medicine, often used synonymously to signify the unified goal and strategy for reproducing lost tissue or physiological functions with therapeutic and clinical potential. To date, virtually every major human organ type has been targeted with tissue engineering approaches: bone remains a primary, popular target for functional osteogenesis with varying degrees of success and failure.
For success, an integrated understanding of intrinsic biological factors that govern tissue development in vivo, and their appropriate therapeutic exploitation and functional control in situ are essential. Tissue engineering and modern pharmaceutical research now have similar foundations, drawing increasingly on advances in materials science, cellular and molecular biology to identify therapeutic targets, produce bioactive substances and deliver them specifically to tissue sites (either in vivo or in vitro in bioreactors) to promote specific biological responses. A broad appreciation of biomaterials, normal tissue physiology, developmental cell biology, control of implant site integration (inflammatory and healing responses), application of appropriate biotechnological tools, and desired clinical requirements for target tissue function are required for progress. Integrating tissue engineering with bioactive factors allows stimulation of host cells towards clinically useful endpoints for regenerative medicine. Controlled local dosing of bioactive proteins to stimulate desired cellular responses such as recruitment, proliferation and reliable bone formation is used to promote tissue reconstruction or regeneration. Musculoskeletal tissue engineering strategies usually integrate combinations of:

- Porous, low-density biomaterials scaffolds (e.g., resorbable biomaterials) to provide shape and structure, then degrade reliably with appropriate kinetics;
- Potent bioactive cues that transform cultured cells to bone-like phenotypes and resulting osteoid tissue formation within scaffolds;
- Targeting and release mechanisms for bioactive substances with appropriate dosing and timing for cells to induce osteogenesis;
- Versatile options to incorporate different (mesenchymal stem) cells for different functional endpoints;
- Tissue construct transformation in a biological context: in vitro bioreactors, or in vivo within a patient.

Tissues, including bone, are complex structures involving multiple cell types in tightly controlled, interactive organization and architectures, with complex tactile and biochemical feedback pathways that produce unique, enduring functions characteristic of each organ. Critical requirements for any therapeutically relevant tissue mass are the production of competent organized vascular and neural networks within the regenerated mass as it evolves. To date, few tissue engineering approaches claim reliable vasculogenesis and therefore are limited in their ability to produce three-dimensional products without necrosis and viability issues. While promising with exciting potential for clinical orthopedics, trauma and spine therapies, biotechnological enhancement of conventional approaches to bone formation and regeneration requires much further work. Enter: the AO BAB and its call to implement biotechnological innovation within the AO research programs across clinical priorities.

Three years after BAB’s founding, the board has established a biotechnology research program through several specific research proposal calls within the current set of AO clinical research priorities. Also, the BAB has produced rigorous proposal peer review, feedback processes and guidelines for intellectual property sharing with out-of-network research projects.

Importantly, as another technical advisory board responsible for all AO activities implementing biotechnology, the BAB was designed, unlike other traditional AO boards, to remain external to the AO network. Specifically, the BAB is asked to exert an independent, "outside" influence on AO selection of biotechnologies. This sought to impart objective, unbiased and validating expertise, judgment and oversight in facilitating integration of biotechnology research into AO priorities.

Membership The current BAB members have 3-year appointments with possible continuation:

- Margarethe Hofmann, Mat Search, Pully, Switzerland (Chairwoman)
- Stephen E Feinberg, University of Michigan, USA
Qualifications for BAB membership appointment include demonstrated requisite expertise and international recognition for contributions to biotechnology in medicine, specifically aspects of musculoskeletal repair and bone regeneration, as well as broad exposure to aspects of biotechnology commercialization, regulatory requirements, product development and inter-disciplinary research team building. Ad hoc reviewing in areas required to support BAB function is provided through guest expert invitations to BAB proposal review sessions. Strategically, BAB represents:

- Direct access to an international network of experts in these and peripheral, related biomedical research areas.
- Primary "compass" for establishing, directing and coordinating biomaterials and biotechnology priorities within AO research programs.
- Ability to create new networks of high-quality research to cover breadth and expertise relevant to AO mission in biotech.
- Access to new technology doors for AO in areas previously not within the AO focus.
- International standards of research proposal formulation, rigorous reviews and project accountability by outside experts.

BAB's activity seeks increased coordination between AcC, BAB, AORB, and the AORF in producing a unified vision, concerted efforts, and coordinated AO action in biotechnology research integration into clinical research. Specifically, BAB's primary action has been the new BAB-initiated research calls, using a new open, international structure to recruit the best quality projects possible. A new proposal submission process has been instituted that is rigorous and uniform, involving a shorter pre-proposal, a BAB-based pre-screening to further request only qualified full proposals, and full proposal submission following a strict format. Proposal content, format and criteria for excellence have been designed to be the same as many other leading research agencies.

Proposal evaluation process

The BAB proposal evaluation process consists of an advanced mail-out review to all BAB members, their full written evaluation plus oral BAB consensus discussion at the BAB review meeting. A minimum of 2 BAB experts from research fields closest to the proposal is assigned to act as primary reviewers. In addition, other BAB or externally appointed experts read the proposal and prepare a short technical summary evaluation. Carefully selected external reviewers are used for additional expertise or possible conflict of interest in BAB. BAB written decisions are deemed to be final. Proposals are ranked for priority based on review, and funded from the highest to lowest, based on the budget. Since many of the current proposals and currently funded projects are from out-of-network PIs, new legally binding contracts with non-traditional AO partners must be individually negotiated. The AO has worked diligently with universities, through BAB leadership, to negotiate mutually acceptable contracts where intellectual property is protected and made available for AO license and use. The contracts contain enforceable mandates for research and technical performance, including annual reporting, checkpoints and technical milestones. This allows a clear project monitoring process, including clear deliverables, and accountability combined with the work contract. The annual budget renewal depends on technical milestones achieved and results delivered. Follow-on reporting to the AO beyond project completion is also requested so that changes in intellectual property generated under the project might be monitored and possibly exploited for AO use. Lastly, the AO must be formally acknowledged in public presentations and publications of BAB-supported research reporting with the statement: "This research has been supported..."
by the AO Foundation (Switzerland) through a grant from the AO Biotechnology Advisory Board.”

Annual research calls were issued worldwide using AO network research contacts and out-of-network research contacts generated through BAB. Calls in 2003 and 2004 requested orthopedic or bone biotechnology-related research proposals generally relevant to stated AO clinical priorities in bone defects, spine, trauma and craniomaxillofacial repair. In summary, during 2003 to 2005, 83 pre-proposal applications were received, and 8 projects were finally granted, funding rates approximating 10%, commensurate with those in the United Kingdom, Sweden and the United States for major peer-reviewed clinically related research projects sponsored by either public or private agencies. Funded projects from the University and ETH (Swiss Federal Institute of Technology) Zürich, Charité Berlin, Cardiff University, University of Michigan, and ETH Lausanne cover topics from resorbable scaffolds (silk), mesenchymal stem cells in long bone healing, cartilage repair using cartilage progenitor cells; gene therapy in craniomaxillofacial regeneration, small chemicals to enhance bone repair, viral and nonviral DNA vectors in bone regeneration; and fetal cell therapy for nonunions. The last three projects came from the 2005 call entitled “Osteoinductive factors for the stimulation of bone formation”. This specifically mentioned biotechnology approaches involving innovative biomaterials, pharmaceutics and bioengineering, pre-clinical animal models for investigating bone repair, bone regenerative medicine and tissue engineering as priority areas of interest. Due to the wide breadth of expertise necessary to competently take biotechnology projects forward, proposals in these fields could be integrated into single, team-based projects using multi-investigator, multi-disciplinary approaches.

Future activities  BAB’s planned 2006 activities include new AO proposal reviews, current project progress reviews, project reporting reviews, consulting roles with other AO clinical research initiatives (bone defect healing, fracture fixation in osteoporosis projects), assistance with research proposals to other AO boards (e.g. AORF), and implementation of a working contract and advisory structure with Synthes research and development efforts. The BAB has consistently offered its expertise and services to other AO efforts in an attempt to unify process and coordinate research protocols across AO programs. In addition, the BAB has begun work on producing a new “Workshop on Biotechnology Projects” to coordinate recognition, communication and interaction among all AO-sponsored biotechnology research projects. The workshop is scheduled for October 27-28, 2006 in Lausanne, Switzerland, and will involve research presentations and proposals for future research collaboration by AO PIs. The goal is to stimulate networking, joint work, partnering and possible synergistic elements among funded projects and future proposals. Lastly and perhaps most importantly, the BAB considers it a foremost priority to implement and enforce consistent, rigorous processes of research selection and review across all AO programs. All AO research projects should be peer-reviewed using similar expectations for impact and merit, in a defined process, and consistent standards of excellence. Proposal critique standards for all AO research projects should be based on anonymous unbiased recommendations of international experts from different fields. All AO-funded projects should be monitored for progress, to identify problems and to maintain high research quality across the entire project. Annual reviews of research progress should be judged as negative or positive, producing the appropriate enforcement action to produce optimal benefit for AO.

Summary  In summary, BAB functions within and outside AO are maturing. Its initial projects are now implemented and visible. In this regard, specific functions, regular BAB products and routines are emerging, including coordination with other AO boards and consolidation of biotechnology efforts under AO sponsorship. This is all occurring under the goal of implementing a structure to provide consistency for AO research expectations, quality, and impact within the clinical mission.

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The Debate: Should open fractures have their wound primarily closed?

Introduction It has been the tradition and accepted standard of care that open wounds caused by or associated with a fracture have been left open and closed on a delayed basis. With the growing use of evidence-based care, this management plan has been questioned due to its lack of credible clinical evidence. There are many reasons for considering a challenge to this standard, ranging from cost to the potential of untreatable infections. Two cases are presented as examples for discussion concerning closure of the open wound from a fracture.

Case 1

The first case involves a 57-year-old male who fell from a 20-foot ladder landing on his foot. He presents with no other injury and has no neurological or vascular problems in this extremity. His open wound is demonstrated in Fig 1 and his x-rays are shown in Fig 2. The patient is advised of his injury and taken to the operating room for debridement of his open wound and a spanning articular external fixator to maintain the reduction and stabilization of the soft tissue. At the time of debridement, the wound is found to be clean. There is no contamination, there is a moderate amount of damaged muscle on the planter aspect of his foot, and the soft tissues, particularly the subcutaneous tissue, have been stripped from the fibula for approximately 10 to 15 centimeters proximately. At the conclusion of the case, the wound was felt to be adequately debrided and closed. Over the ensuing two weeks, the patient remained on elevation and his wound demonstrated no evidence of infection. However, the avulsed portion of skin did become necrotic and that required further plastic reconstructive surgery.
Case 2

The second case is a 30-year-old male, who was cut off while riding a motorcycle with the vehicle landing on his leg. He had a mild concussion but was otherwise stable, and presented to the emergency department after transfer from a local hospital about 7 hours after the injury. His examination showed no neurological or vascular injury to his lower extremity. He had no evidence of a compartment syndrome. His wounds demonstrated in Fig 3 and his x-ray in Fig 4.

After appropriate trauma work-up, he was taken to the operating room where debridement was carried out. The wound was extended to both sides to allow adequate access to the zone of injury. There was some muscle damage to the tibialis anterior muscle which was debrided. The posterior tibial muscle seen through the fracture site was noted to be contused with some necrotic muscle, but not more than about 10 to 15% of the muscle mass was removed and the remaining muscle was viable. There was no evidence of severe contamination although there were some minor flecks of paint on the bone surface which were removed.

At the conclusion of the debridement and irrigation, the wound was considered clean and viable, and was closed (Fig 5). The patient subsequently had his tibial treated with a statically reamed locked nail and progressed uneventfully to union with no evidence of infection.

Both these cases bring up controversy. These cases were treated by primary closure. Both had relatively significant soft tissue injuries and the end of debridement, the surgeons felt that they were adequately debrided and cleaned of any contamination. The wounds could easily be closed without tension.

Herein lies the debate: There is a clean, viable, closeable wound, so why shouldn’t a patient have their own biological soft tissue dressing? On the following pages, Peter O’Brien and Michael Bosse will address their concerns, comments and criticisms concerning this issue. Peter O’Brien favors leaving open fracture wounds open while Michael Bosse is an advocate of closure.
The case for leaving the wound open
Peter J O’Brien

Case 1  The patient is a 57-year-old male who has fallen 20 feet and suffered an open left tibial pilon fracture. A thorough history is necessary prior to making any management decisions. In this case we will assume that the patient does not have any significant medical comorbidities (diabetes, smoking, etc.) and that the injury occurred in a relatively clean environment. He has an AO 43 C3 fracture that I would classify as Gustillo-Anderson type IIIA because it has a high energy mechanism and fracture pattern. We assume that the patient has received the correct tetanus prophylaxis and that he has been started on an appropriate antibiotic regime.

The patient has been taken to the operating room on an emergency basis and has been treated with meticulous wound debridement and irrigation. The fracture pattern is complex and would be treated by most orthopedic surgeons with closed reduction, possibly limited open reduction of major articular fragments and fixation with an external fixator. Definitive fracture reduction and fixation would be performed on a delayed basis once the acute soft tissue swelling has subsided and an expert orthopedic trauma surgical team is available.

At the completion of the initial surgical procedure, a decision must be made about the primary management of the traumatic open wound. Surgical extensions of the wound can usually be closed primarily. The scenario indicates that the traumatic wound can be closed without tension. The clinical photographs do not appear to support that statement. There is a suture in the most distal portion of the wound, but the remainder does not look as though it could be closed without tension. If the wound requires more than a 5-0 suture to close at this stage, I believe there is too much tension. The midportion of the proximal edge of the wound looks to have questionable viability. Closure of the traumatic wound at the initial surgical procedure may be possible in this case, however I suspect that there would be some tension at the skin edges. Certainly over the first few days I would expect the zone of injury in this ankle and foot to become more swollen. As the swelling increases there will be more tension at the wound margin, resulting in more local ischemia of the tissues. This ischemia can lead to a failure of wound healing and will increase the risk of wound infection.

I would plan to leave the wound open at the end of the initial surgical intervention. The wound should be lightly packed with antibiotic loaded acrylic cement beads. I would use 4 mm beads with 2.4 grams of tobramycin in one package of methacrylate cement. A 1/8 inch overflow drain should be inserted into the traumatic wound and the wound would then be sealed with a sterile adhesive drape. This technique avoids any tension in the soft tissue and prevents any iatrogenic wound ischemia.

The patient should be returned to the operating room, when the soft tissue swelling has subsided, for definitive fracture care, repeat wound debridement and irrigation, and definitive wound coverage. In this case I would anticipate that delayed primary closure would be effective.

Case 2  The patient is a 30-year-old male who has sustained a closed head injury and a high energy open fracture of his tibia and fibula. The injury is an AO 42 A2.3 fracture that I would classify as Gustillo-Anderson IIIA based on the high energy mechanism. He is at a high risk of developing a compartment syndrome (age, gender and fracture site) and should be carefully monitored.

The treatment of the open fracture should follow the principles that were outlined in the discussion of Case 1. Following wound debridement and irrigation, I would manage the tibia fracture with reduction and interlocked intramedullary nail fixation. The surgical extensions of the traumatic wound could be closed primarily, but the open wound should be left open. An antibiotic bead pouch should be constructed and the patient should be treated with systemic antibiotics. The patient would be returned to the operating room in three to five days for a second look, repeat debridement if necessary, irrigation and delayed primary wound closure.

The clinical photographs that accompany this case show a relatively innocuous looking skin wound (which is uncommon in motorcycle-related open tibia fractures) and it appears that the wound could be closed primarily without tension. The concern I have for primary wound closure in this type of injury is that the inexperienced surgeon may compromise the thoroughness of the debridement and may unknowingly leave nonviable tissue or foreign material in the wound in order to achieve primary wound closure.

The patient described in this case deserves a second look procedure. There was documented necrotic muscle in the anterior compartment at the initial procedure in this case. The surgeon must remove all necrotic tissue in the initial management of an open tibia fracture. The assessment of viability of muscle that is contused is difficult. It is important to make sure that all dead muscle is removed, but it is inappropriate to be overly aggressive and excise muscle tissue that is viable. In addition, there is documented road debris in the wound. The combination of dirt and muscle necrosis is the environment that can produce a life threatening anaerobic infection. Providing a high concentration of antibiotics with a bead pouch and performing a second look debridement and irrigation at the time of delayed primary closure eliminates that possibility.
Discussion Coverage of the open wound is controversial in terms of timing and technique. The generally accepted principle is that the open wound should be left open. This will prevent anaerobic conditions in the wound, facilitate drainage and allow repeat debridements [1].

Recently there has been renewed interest in primary closure of the open traumatic wound. Primary wound closure may be associated with less surgical morbidity, shorter hospital stay and less cost without an increase in wound infection [2]. There is ongoing research into the safety and efficacy of primary wound closure. The concern about routine use of primary wound closure is that surgeons may begin to compromise the basic principles of wound care in an attempt to accomplish it. Debridement may be inadequate, the wound closure may be done with some tension leading to local ischemia and the use of serial debridement may be limited. Each of these conditions may lead to an increased risk of serious wound infection, especially clostridial myonecrosis.

Currently the standard of care is that all open fracture wounds be left open initially. Delayed wound closure is accomplished within three to seven days. This technique minimizes the risk of anaerobic conditions in the wound, allows drainage and encourages serial debridement when necessary. There are several strategies available for temporary coverage of the open wound between the initial procedure and the subsequent debridement and the eventual definitive coverage.

The antibiotic bead pouch technique has been described. Sealing the wound with the bead pouch prevents secondary contamination, keeps the wound moist (including vital structures if exposed) and provides a high level of antibiotic concentration in the open wound. The technique may be associated with a reduced risk of wound infection [3, 4].

In a series of 1,085 open fractures, Ostermann et al demonstrated that the additional use of local aminoglycoside-impregnated polymethylmethacrylate (PMMA) beads significantly (P < 0.001) reduced the overall infection rate to 3.7% in comparison with 12% when only intravenous antibiotics were used [4]. In another study looking at open tibial shaft fractures the antibiotic bead pouch technique resulted in reducing the wound infection rate by one half [4].

Two recent studies have supported the concept of primary closure of open fracture wounds [5, 6]. It is clear that the strategy is safe in many cases; what is not clear are the exact situations in which primary wound closure is safe. The data presented indicates that the technique of primary wound closure is associated with a higher incidence of wound infection than would be anticipated with delayed closure using the antibiotic bead pouch technique. The recent prospective randomized trial (PRCT) of primary wound closure reported a wound infection rate of about 10% in open tibia fractures. Historical information from a prospective randomized trial of tibial nailing of open fractures using the antibiotic bead pouch technique recorded an infection rate of 3.5% [7].

The recently reported multicenter PRCT [6] comparing primary with delayed primary wound closure did not use the bead pouch technique or VAC for the delayed closure group and rather used a strategy of wound neglect. The finding of the study is that the outcomes of primary and delayed primary closure are similar. The study design that utilized inappropriate wound management techniques in the delayed group makes any conclusions hard to interpret.

Over the last 25 years we have made many improvements in the management of open fractures. The concept of primary wound closure is probably appropriate in some situations. Until those situations are clearly defined, orthopedic surgeons should continue to manage open fractures with the well established principles of treatment that includes delayed wound coverage.

Bibliography

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The case for the immediate closure of open fractures
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The current practice guidelines for the management of wounds associated with open fractures are based on principles established prior to World War II. Because of a concern for an increased risk of deep infection, the orthopedic doctrine mandates that wounds associated with long bone fractures should not be closed primarily. Despite significant clinical advances in wound, fracture and antimicrobial therapies over the past 60 years, the delayed wound closure strategy has survived, relatively uncontested and poorly researched. Many modern orthopedic surgeons would argue that, in most cases, the wound associated with an open fracture may be as clean as it is going to be at the completion of the initial debridement process.

The delayed closure of fracture wounds, however, has two major drawbacks in current orthopedic practice. The most significant is the change of the hospital environment, especially in the critical care areas over the last 20 years. While open wounds are naturally colonized, the nosocomial flora now are increasingly resistant to first generation antibiotics. A hospital-acquired fracture site infection adds significant morbidity and expense to the patient’s care. Secondly, the delayed wound closure strategy also presents an economic drawback. Employment of this strategy is expensive both in terms of dollars invested and in utilization of resources (surgeon time, bed days and operating room time). This practice may account for up to USD 200 million in annual additional healthcare charges in the United States.

The translation of the dogmatic approach to the open fracture learned by military surgeons to non-battlefield-like injuries (>90% of open fractures treated in the United States) is not appropriate. Deviations from the doctrine that resulted in complications were interpreted as substandard fracture care. Brown and Kinman’s [1] 1974 report of 27 cases of clostridial wound infection associated with the primary closure of massively contaminated (battlefield-like) wounds emphasized the timing of wound closure, rather than probable inadequate debridement and poor decision-making in the evaluation of the cleanliness of the wound for primary closure, as the causative clinical error.

The bacteriology of the open fracture has changed. In 2000, Patzakis [2] found that only 18% of organisms cultured from infection sites were the same organism initially isolated from the injury wound culture, in contrast to a 73% correlation reported in an earlier study (1974) [3]. Today, most infections that occur after open fractures are caused by pathogens acquired in the hospital, and many of these are resistant strains. The recognition of the impact of perioperative antibiotic therapy on the reduction of open fracture site infections, the identification of new antibiotics and the understanding of tissue and bone antibiotic penetration pharmacokinetics have enhanced the ability to prevent infections and to treat those infections that do occur.

Similarly, wound care strategies have evolved past the 1939 tissue debridement recommendations. Surgeons now recognize the importance of defining, exploring and debriding the entire “zone of injury” associated with the open fracture. As surgeons gained confidence that large bone defects could be routinely reconstructed, they discarded all devascularized cortical bone fragments, regardless of size. Removal of the necrotic cortical “nidus” is considered to be a critical factor in minimizing acute and late infections. The importance of the contaminants from the fracture wound was recognized by all surgeons. Water irrigation, delivered by “turkey baster-like” syringes was the standard method prior to the Vietnam War. Low pressure pulsed irrigation devices were then introduced as a wound decontamination method and, with refinements, are now the standard wound therapy for open fractures in the United States. Anglen found that the use of power irrigation increased the removal of bacteria by a factor of 100 from contaminated tissues [4-6].

Fracture stabilization techniques have changed dramatically since the enclosed plaster methods advocated by most combat surgeons prior to the Vietnam War. External fixation evolved as a minimally invasive, soft tissue-friendly technique for the management of both the fracture and the associated wound. In the early 1990s, refined intramedullary nail technology and implantation techniques, coupled with a growing confidence in the ability to adequately debride the open fracture, stimulated a shift to the immediate use of intramedullary nails as the treatment of most open long bone fractures in the lower extremity [7, 8].

As microsurgical tissue transfer techniques developed over the past 20 years, the treatment approach to fractures with major tissue loss has dramatically changed. Many plastic surgeons now believe that immediate coverage of the fracture provides the optimal clinical outcome. Gopal reports 33 immediate free flap procedures for open fractures with 1 (3%) infection [9].

Surgeons have adjusted their wound closure strategy based on their interpretation of practice changes since the wound closure doctrine was developed in 1939. In general, the results reported for primary closure of the open fracture compare favorably with or are better than historic delayed wound closure series [10-14]. The Orthopedic Trauma Association recently completed a prospective, randomized study of the impact of immediate fracture wound closure in Grade II and IIIA tibial diaphyseal fractures in 30 US Trauma Centers [15]. 202 immediate and 197 delayed closure patients were fol-
Fracture wounds should be closed when the tissue bed is free of foreign debris and dead or dying tissue. In 90% of my practice, I can close the Grade II and IIIA fractures immediately. Fractures that are heavily contaminated (war wound-like) or that have been immersed in water are closed after a second debridement.

**Summary** by James F Kellam

The most important aspect of the management of the soft tissue injury from a fracture is the result of the debridement: achieving a clean wound with viable tissue both in the muscle and at the level of the skin and subcutaneous tissue, and that is closeable without tension. If this is possible, and the surgeon truly feels this has been accomplished, then there is ample evidence that primary closure of the wound is acceptable. Closure of the wound does not preclude that the wound cannot be re-debrided at a later date as a planned procedure. This provides the wound with a biological dressing. The closed wound must be followed closely to assure an infection does not occur in the first two weeks. However, should the surgeon not feel confident or have any doubt that he has not achieved this goal, there is no reason for closure of the wound. The techniques as described by Peter O’Brien for wound management are all acceptable. The issue with regards to primary closure has to do with the confidence and the honesty that a surgeon has at the end of his debridement coupled with the clinical situation and etiology of the injury.

So in conclusion, the issue of primary closure rests with the adequacy of the debridement, the cleanliness of the wound and the viability of the soft tissue—in essence, the ability to close the wound without tension. Good soft tissue management will lead the surgeon to the appropriate decision with regards to the management of open wounds.

Bibliography

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