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ORTHOPEDIC TRAUMA: INNOVATIONS IN BONE HEALING, DEFORMITY CORRECTION, AND PAIN MANAGEMENT

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About Notable Grand Rounds

These assembled papers are edited transcripts of didactic lectures given by mainly senior residents, but also some distinguished attending and guests, at the Grand Rounds of the Michael and Marian Ilitch Department of Surgery at the Wayne State University School of Medicine.

Every week, approximately 50 faculty attending surgeons and surgical residents meet to conduct postmortems on cases that did not go well. That “Mortality and Morbidity” conference is followed immediately by Grand Rounds.

This collection is not intended as a scholarly journal, but in a significant way it is a peer reviewed publication by virtue of the fact that every presentation is examined in great detail by those 50 or so surgeons.

It serves to honor the presenters for their effort, to potentially serve as first draft for an article for submission to a medical journal, to let residents and potential residents see the high standard achieved by their peers and expected of them, and by no means least, to contribute to better patient care.

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Orthopedic Trauma: Innovations in Bone Healing, Deformity Correction, and Pain Management

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Grand Rounds presentation

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Introduction

Orthopedic trauma surgery has evolved significantly in recent decades, with innovations in fracture healing, deformity correction, infection control, and pain management. This paper explores key advancements developed at **Detroit Medical Center**, focusing on improving patient outcomes through novel approaches to bone healing, surgical planning, and the management of chronic pain. These methods are now used worldwide and have changed the way we approach complex orthopedic trauma cases.

Bone Healing and Fixation Techniques

Fracture healing follows three phases: **inflammation, repair, and remodeling**. Inflammation lasts from **0 to 2 weeks**, repair from **2 weeks to 3 months**, and remodeling from **6 weeks to a year or longer**. This timeline is fundamental to understanding how bones heal and how to guide treatment.

We often begin by stabilizing fractures using **lag screws**, which allow for **absolute stability** by compressing bone fragments together. **Lag screw by design** involves screws with threads only on one side, while **lag screw by technique**uses two drills—one for the outer and one for the inner bone cortices. This allows us to compress the bones together, providing the rigidity needed for healing. This method was first pioneered by **Robert Danis** in 1949 with his **compression plate**, which squeezed bones together for **absolute stability** and allowed bones to heal through remodeling, bypassing the need for callus formation.

Secondary bone healing is another method we use, where some movement at the fracture site is allowed, stimulating healing through inflammation, repair, and remodeling. Techniques such as **intramedullary nails** and **external fixators**allow bones to heal with relative stability. Historically, traction was used to maintain **length, alignment, and rotation**until bones healed, but more recent developments like **bridge plates** and the use of **Haversian canal systems** for remodeling have improved outcomes in cases where rigid fixation is not possible.

Historical Context and Cultural Relevance of Limb Deformities

In the past, deformities like limps and improperly healed fractures led to significant cultural stigma. People with deformities were often marginalized. My father, for example, had a limp due to a childhood infection, and his father would beat him, insisting that he learn to walk straight so that he could marry. Limping carried a social stigma, and those with deformities were often labeled "cripples," which had a profound impact on their lives.

Even today, studies show that people can recognize a limp from over **100 feet away**. This cultural recognition of deformity has influenced how we approach deformity correction in modern orthopedic surgery. We now focus on ensuring proper alignment and reducing deformities to allow patients to walk without stigma or functional impairment.

Deformity Correction and Precision in Surgical Planning

Deformity correction requires extreme precision. In one case, a patient came to us with a **5 cm leg length discrepancy**after hip surgery. To correct this, we used a **$1 truck ball bearing**, a measurement tool accurate to **1/1000 of a millimeter**. This replaced expensive commercial tools, allowing us to achieve precision at a fraction of the cost.

Another innovative technique we use is **transparency sheets** for surgical planning. We take an X-ray of the uninjured side, draw out the bone on a transparency, flip it over, and overlay it onto the injured side. This simple method, which costs **30 cents**, ensures precise alignment and has now been adopted globally. We've used this method for major fractures, and the transparency allows us to check the alignment and make necessary adjustments during surgery.

We also developed a **digital protractor** system for correcting rotational discrepancies, achieving corrections within **three to four degrees**. This level of precision has changed the way we approach complex deformity correction, allowing us to tackle cases that would have been impossible just a few years ago. For instance, we treated a patient whose knees were subluxing and had progressively worsened over his life. Initially, I told him there was nothing I could do. But after working with the **Bone Center** program for four years, we managed to correct his deformity, and six weeks post-surgery, his improvement was remarkable.

Innovation in X-ray Measurement and Software Development

When we transitioned from traditional X-rays to **digital X-rays**, we faced challenges with sizing and planning. Commercial software was available, but it came at a high cost—**$8,000 per surgeon per year**. Frustrated by this, I turned to my son, who plays Halo. He pointed out that video games, like Halo, are much more complex and cost only $25. Inspired by this, I reached out to a programmer in **Windsor** and developed our own software, **Bone Center**, which has since been adopted by over **100,000 surgeons worldwide**.

The Bone Center program allows us to plan surgeries, measure bone lengths, and correct deformities with incredible accuracy. We've used it in surgeries where digital measurements are critical, allowing us to avoid errors that could result in lasting deformities. One case involved using the **Bone Center** to correct a patient's rotation and length issues, allowing him to walk normally post-surgery.

Pelvic Surgery and the Infix Technique

We expanded these precision methods into **pelvic surgery**, where we developed the **infix technique**. This method, now used globally—including in **China**, **India**, and other parts of **Asia**—has drastically reduced infection rates associated with pelvic external fixators, from **50%** to almost none. It's a particularly important innovation in **third-world countries**, where cost and resources are limited.

The **infix technique** reduces infections because the hardware is placed inside the body, avoiding many of the complications associated with traditional external fixation. This method has revolutionized pelvic trauma surgery, providing safer, more effective treatment for patients worldwide.

Silver Coatings and Antibiotic-Loaded Cement in Infection Control

In collaboration with local car manufacturers, we developed the **ABC nail mold**, allowing us to coat nails with **antibiotic cement** to treat infected fractures. After four years of development, this mold can perfectly coat nails with antibiotics, significantly reducing the risk of infections like **osteomyelitis**. We conducted a prospective study that showed **85%**success in eradicating infections and promoting bone healing.

We've also started using **chemotherapy**-coated nails to treat **pathologic fractures**, applying the same dose of chemotherapy that would be given intravenously but with localized control at the fracture site. This novel approach allows us to manage local tumors effectively while minimizing systemic side effects.

One of our pathologists, **Dr. Sallindia**, also developed a **silver product** known as **SAD 18**, which prevents bacterial and fungal growth within **three centimeters** of the cement. This silver coating has been highly effective in managing **prosthetic joint infections** and osteomyelitis. We're planning to conduct trials using this product in joint replacements and other complex surgeries in the coming year.

Trendelenburg Gait and Muscle Weakness

In cases where patients develop **Trendelenburg gait** post-surgery, we need to address the muscle weakness that leads to this abnormal gait. The **abductor muscles** are responsible for balancing the body on one leg, and when they are weak, patients shift their center of gravity to compensate, resulting in an **abductor lurch**.

Physical therapy can help strengthen the muscles in some cases, but often the weakness is permanent. Managing these postoperative gait abnormalities requires careful planning during surgery and post-operative rehabilitation to prevent permanent deformity.

Pain Management: Moving Beyond the Zero-to-Ten Pain Scale

After talking with **Dr. Lucas**, who pointed out the flaws in the traditional **zero-to-ten pain scale**, we developed a simplified **three-point pain scale**:

1. **No pain**
2. **Tolerable pain**
3. **Intolerable pain**

This new scale allows patients to communicate their pain more effectively, and it helps clinicians make more informed decisions about treatment. We've written five papers on this scale, and we've also developed an **app** that tracks patient pain and correlates it with medication use. We found that after two years, only **4%** of our patients are still on narcotics, down from much higher rates when we used the traditional pain scale. If patients are kept on narcotics for more than three months, they are at high risk for addiction, which is why we've cut back on narcotic prescriptions to a maximum of six weeks.

Cement, Polymethylmethacrylate, and Future Directions

The **cement** we use is **polymethylmethacrylate**, essentially **Plexiglas**, the same material used around hockey arenas. In the **1960s**, we began using it in orthopedic surgery, and we continue to mix it in the operating room today. This cement not only provides structural support but can also be infused with **antibiotics** or **chemotherapy** to aid in infection control or tumor treatment.

Our first study on **chemotherapy-loaded nails** was published recently, and though the study wasn't initially well-received due to its novelty, we are moving forward with trials on **pathologic fractures**. The localized release of chemotherapy directly at the fracture site shows promise in controlling tumors without systemic side effects.

Conclusion

The innovations in orthopedic trauma, deformity correction, infection control, and pain management described in this paper represent significant progress in the field. By combining technology, creativity, and collaboration, we've developed methods that are now used worldwide. These advancements are not only improving patient outcomes but also making previously impossible surgeries feasible. Moving forward, we continue to refine our techniques and explore new frontiers in orthopedic surgery.

Postscript: Striving for Excellence

As orthopedic surgeons, we have a responsibility not only to our patients but also to ourselves and our profession. Too often, we become content with being "good enough," but in reality, our field demands excellence. This isn't about competition with others, but about being the best we can be—for our patients, for our own personal satisfaction, and for the future of medicine.

When you were in school, you were likely the top of your class, driven to excel. So why settle for mediocrity now? Why go for the bronze when you can aim for the gold? Every day in practice offers the opportunity to push yourself, to hone your skills, and to deliver better outcomes for your patients. It's not about comparing yourself to your colleagues, but about continually improving upon your own performance.

Our history is filled with examples of surgeons who, by refusing to accept mediocrity, revolutionized our field. From the invention of **shock treatment** to the development of **crash test dummies**, this institution has been at the forefront of medical innovation. These pioneers didn't settle for "good enough"—they strived for greatness, and in doing so, changed the landscape of medicine.

So, I urge you: be the surgeon who goes the extra mile. Whether it's spending a little more time with a patient, conducting extra research, or mastering new techniques, strive to be the best. If you push yourself every day to do better, to be better, you will leave a lasting impact on your patients and on the future of orthopedic surgery. Don't settle for bronze—go for the gold.

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