An Orthopedic Surgeon's View on Using Carbon Fiber Composite Technology in Complex Traumas

An Interview with Mr. James Youngman,* Orthopedic Consultant at University College Hospital London, Hospital of St. John and Elizabeth and Wellington Hospital, London UK

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Mr. James Youngman, an orthopedic surgeon in the UK, has successfully implanted devices made with Invibio's PEEK-OPTIMA™ Ultra-Reinforced polymer, a carbon fiber composite for many complex trauma cases, including UK Olympic sprinter James Ellington.** Recently, I spoke with Mr. Youngman to learn about his experiences with composites, complex trauma cases, and why he chose carbon fiber technology over metal for Mr. Ellington.

Mr. Youngman has been an orthopedic consultant (surgeon) for 12 years at several London area hospitals. His special interests are complex trauma and trauma reconstruction. He enjoys both utilizing and developing medical innovations for the continual advancement of surgical orthopedics.

Mr. James Youngman, MBBS, FRCS (Tr and Orth)

Q. DEVINE: What additional surgical challenges do complex trauma cases present compared to simple trauma cases?

A. YOUNGMAN: Complex trauma patients are very variable and present with difficult bone problems resulting in prolonged healing times. More often than not, bone has been weakened by previous trauma or osteoporosis. In fact, I'm seeing complex osteoporotic bone fracture trauma cases in epidemic proportions. Complex trauma fractures also have multi-fragmentary break patterns. Consequently, proper healing and long-term stability is heavily dependent on implants or fixed metal devices such as external fixation frames or intramedullary devices. Moreover, complex trauma patients present with potentially poor vascularity and present surgeons with uniquely difficult challenges with regard to balancing absolute and relative stability.

Q. DEVINE: What are absolute and relative stability and how do you strive to achieve them in surgery?

A. YOUNGMAN: Absolute stability is where we aim to compress the fragments together rigidly, and not allow any inter-fragmentary movement, and then bone heals with remodeling. We have traditionally achieved that with compression plating, where it's a simple fracture pattern and we're aiming to compress two fragments together. The challenge has always been how to generate relative stability, which is when you have controlled movement of the fracture site to create callus. This is the body's natural way of healing without surgical intervention. The body produces a callus response that is stimulated by the mechanical environment. Getting the mechanical environment right is challenging. If it's too flexible, you may get fibrous tissue, and if it's too rigid, you might get no bone formation at all, and it stops the process. Ideally, you create limited controlled movement. With metal plates, for example, relative stability occurs when you leave a longer space between fixation points.

Q. DEVINE: How has achieving relative stability within the mechanical environment been easier with the introduction of carbon fiber composite technology?

A. YOUNGMAN: For starters, carbon fiber composite technology is more flexible by nature. Unlike metals, its material properties are more akin to that of cortical bone. It has a different feel and "give" than stainless steel or titanium during surgery, especially with screw insertion. It allows more elastic movement than stainless steel. Even titanium, which is a bit more flexible, has a different give. Ultimately, carbon fiber composite technology helps surgeons achieve the mechanical environment.

Q. DEVINE: In which clinical applications did you initially use carbon fiber composites?

A. YOUNGMAN: Carbon fiber composites, especially CarboFix implants, have demonstrated significant patient benefits throughout the clinical literature. Such evidence initially eased any worries I had about this newer technology, but then especially after using it for a couple of cases.

Originally, I saw benefits for using carbon fiber composite technology in difficult tumor-based cases because of the radiotherapy advantages and radiolucency, which would ease tumor visibility in metastatic cancer cases. My first case utilizing carbon fiber composite technology was a metastatic breast cancer patient in her early forties. The operation itself went well and the fracture stabilized nicely with the carbon fiber composite implant. Similar good clinical outcomes resulted when I used carbon fiber composite technology in several additional cases. Since those initial cases, my primary usage of carbon fiber composite technology has been in complex standard

trauma, where patients have also experienced excellent clinical outcomes.

Q. DEVINE: Specifically, what benefits does carbon fiber composite technology offer vs. traditional metal?

A. YOUNGMAN: Before carbon fiber composite technology, metal was pretty much our only option for one of the most complex traumas, the proximal humeral fracture. However, carbon fiber composites provide a new, potential option for this and many other complex traumas. In fact, carbon fiber composites have shown good long-term resistance to fatigue fracture which is a key benefit in terms of longevity.

Unlike metals, carbon fiber composites are radiolucent providing better intra- and post-operative visualization. For complex traumas like periarticular fractures, radiolucency can be extremely beneficial. For example, for highly complex distal tibia fractures into the joint, being able to see the joint on a lateral X-ray when the fibula is plated is a potentially enormous advantage. I have seen malunions of the post-malleolus, where visualization has been poor, that may have been avoided had a radiolucent plate on the lateral side been used.

Traditional metal can obscure the detail of fracture healing on follow-up X-rays. These implants fatigue fracture, and when loaded, it's a race between metalwork failing and bone healing. There can be a reticence by the surgeon to actually allow loading, and I think that limits some people's post-op mobility. I think if you've got an implant you know is very unlikely to fail mechanically, you can push on the rehabilitation during the early healing phase because you can see what's going on with confidence that the implant's not going to fail. Consequently, surgeons are more likely to limit early loading and delay post-op mobility.

Carbon fiber composite technology eliminates the healing guesswork, and affords surgeon visibility during and after surgery. As a result, surgeons can spot and intervene early on any potential problems, and initiate the loading, patient mobility and rehabilitation processes earlier without a worry of implant failure.

Q. DEVINE: In what type of trauma cases or procedures have you used CarboFix carbon fiber composite implants?

A. YOUNGMAN: Today, side-specific specialist plates, specifically locking plates, are increasingly used for highly complex fractures previously treated with metallic external fixators. I have used one such carbon fiber composite plate, the CarboFix "Piccolo" Proximal Humerus Locking plate, to successfully treat proximal humeral complex fractures.

The extremely lightweight CarboFix implants exhibited good stability, the material felt tactically appropriate, the locking screws were easily applied, and their use has yielded excellent clinical outcomes. Its unique give provided more flexibility for better stress distribution and yet provided strong, reliable unions.

I've used CarboFix technology in a host of other complex upper and lower limb fractures, and other anatomical locations, positions and modes. Corresponding with the literature, carbon fiber composite technology provides distinct advantages and excellent patient outcomes in complex traumas.

Q. DEVINE:
I understand you had an opportunity to take care of James Ellington, British Olympic sprinter (Figure 1), last year after his traffic accident in Tenerife. What was your assessment of his leg injuries?

Figure 1: James Ellington, British Olympic sprinter, the first professional athlete to have a trauma composite technology implant.

A. YOUNGMAN:
James presented with one of the most complex tibial fractures, a right leg open tibial fracture with bone loss. There were no significant neurovascular deficits, nor did he require blood vessel or nerve-repair. Despite significant muscle damage, there was good muscle crossing the fracture side. The accident occurred in another country, and despite being immediately "set" to prevent compartment syndrome, it was a late presentation, which was not ideal. Surgery occurred 2-3 days post-accident.

Q. DEVINE: Why was James Ellington a good candidate for the CarboFix Tibia Nail (Figure 2), and ultimately, why did you select it over traditional metal implants?

A. YOUNGMAN: James was one of my early CarboFix composite patients. James wanted to not only walk, but run at an elite level. Given his career and determination, I knew carbon fiber composite technology wouldn't weigh him down and presented an ideal solution.

Figure 2: CarboFix Piccolo Tibia Nail made with PEEK-OPTIMA™ Ultra-Reinforced composite polymer.
Provided courtesy of CarboFix Orthopedics

From a technology point of view, it was the appropriate choice because of the feather-like weight of the implant, the resistance to multiple stress and fatigue fracture resistance. I thought these were very important benefits for him so that we could potentially get him up walking and running earlier than we would if he had a metal implant.

We discussed the benefits of both technologies, and James was very interested in the carbon fiber composite option. A car aficionado, James knew about carbon fiber's use in fast cars and some of its benefits, namely its light weight and strength. After our discussion he said, "Yes, go for that. It sounds just the right idea." So he was happy to go along with the CarboFix composite technology.

Q. DEVINE: How has James' recovery progressed?

A. YOUNGMAN: After a successful surgery, post-surgery rehab has gone amazingly well. James was able to mobilize weight bearing rather quickly. As soon as his pelvic fracture healed, he was able to walk and bear weight on the leg. We have placed increased demands on the leg over the course of his rehab, first walking, then running on the treadmill. The fractures have continued to heal and remain stabilized. In fact, James has made significantly better rehab progress than the average patient.

James' physiotherapy and sports therapists' encouragement and input, along with his own personal drive, determination and positive outlook have also been fundamental in his recovery. James and his team continue to work hard and push both medical and rehab boundaries in the hopes of the ultimate comeback. ▲

ABOUT THE AUTHOR

John Devine, PhD

Dr. John Devine is the Business Director for Invibio Biomaterial Solutions and is responsible for identifying and executing the market strategy for the adoption of Invibio materials and components. His leadership in identifying unmet clinical needs and the creation of new products and business models has contributed greatly to a portfolio of innovations for the device industry. He is a named inventor on a number of patented inventions, is a frequent contributor to papers at key biomaterials and industry conferences, and has authored numerous peer reviewed articles. Dr. Devine holds a doctorate in the field of organic polymer synthesis and structure property relationships from the University of St. Andrews, United Kingdom, a Masters degree in Process Technology and Management from the University of Strathclyde, United Kingdom and a degree in Chemistry from the University of Glasgow, Scotland.

To learn more about Mr. Youngman's experience with carbon fiber composite technology and James Ellington's recovery, please visit http://www.trustthetech.com.

* During 2017, James Youngman, MBBS, FRCS provided ad hoc consultancy services to Invibio Ltd.

* The testimonial presented has been provided by a practicing orthopedic surgeon. His view and experiences are his own and do not necessarily reflect those of others. "Invibio" disclaims any liabilities or loss in connection with the information herein.

** During 2017, James Ellington contracted with Invibio Ltd. as a consumer endorser.

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