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Utility of Carbon Fiber Implants in Orthopedic Surgery

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Carbon fiber (CF) offers many unique physical, chemical and biological characteristics which will be exploited for several diverse applications. CF components can be found in aerospace systems, structural elements in civil engineering projects, automotive components, lighting filaments, energy production systems, power transmission systems, energy storage, sporting goods and recently, their use has expanded into the surgical implant space. Material Properties of CF offers many unique physical and chemical properties to include high heat tolerance, high strength to weight ratio, resistance to corrosion, & conductivity. One measure of stiffness is modulus of elasticity coefficient of elasticity = stress/strain Modulus is measured in units of pressure like Pascal or pounds per sq. in (PSI). It is typical for giant measurements to be listed as thousands or millions KSI and MSI respectively [1]. The modulus of carbon fiber is normally 20 MSI, significantly greater than comparable materials such as 2024-T3 aluminum or steel, which have moduli of 10 and 30 MSI respectively. Nevada Orthopedic and Spine Center 2650 North Tenaya Way, Suite 301, Las Vegas, NV 89128 Touro University Nevada, College of Osteopathic Medicine 874 American Pacific Drive, Henderson, NV 89014 Utility of Carbon Fiber Implants in Orthopedic Surgery: Literature Review Ronald Hillock, MD, Shain Howard, BS† Abstract Carbon fiber (CF) consists of a multitude of unique physical, chemical and biological characteristics which will be utilized and exploited for variety of diverse applications. Found in aerospace systems, structural elements, energy storage and other products, the foremost recent application of CF has expanded into the realm of surgical implants. The material properties of CF, historical development and applications and methods of producing are illustrated upon. The various surgical applications of CF are defined, from biocompatibility within the physical body and wound healing products to numerous surgical implantations. Keywords: carbon fiber; orthopedics; historical review the tensile strength of CF is greater than comparable metallic materials [2]. The ultimate lastingness of CF is 500 KSI, significantly stronger than 2024-T3 aluminum 65 KSI or steel 125 KSI. The added advantage of a lower density than comparable materials is responsible for the increased strength to weight ratio. The strength of CF devices is further augmented by the layout and orientation of the carbon fibers and therefore the ratio of CF to polymer, like carbon fiber reinforced polymer (CFRP), which is comprised of a mixture of CF and polyethylene. CF materials generally have a rise in lastingness and stiffness when layers of CF fibers embedded in polymer are oriented at different angles. Of note it is difficult to compare CF to metallic devices for endurance limits, as CF does not have a definable endurance limit. A lack of a predictable stress cycle failure makes engineering calculations more difficult. This is overcome by allowing a greater margin than would typically be used with non-CF structural materials. All rights reserved. JISRF gives permission for copy of articles as long as notification and recognition is provided. 24 JISRF Reconstructive Review Joint Implant Surgery & Research Foundation, the first industrial enterprise dedicated to the use and manufacture of CF materials was the National Carbon Company in Cleveland, Ohio, established 1886. The physical and chemical properties of CF were studied in detail and published in 1956 by R Bacon of the Parma Technical Center. Bacon later went on the develop CF Nano tubules, small segments of CF filament that resume their original shape and orientation in the face of mechanical deformation. Nano tubules have been shown to be the strongest material per mass ever fabricated by humans. Later developments in CF applications came within the 1960s with the event of the method referred to as "hot stretching." When heated to extremely high temperatures, CF might be molded and pulled into a carbon yarn that would be formed into heat resistant components. The aerospace industry was then able to exploit this feature in the fabrication rocket nozzles, missile protective tip covers, heat resistant gaskets, and heat-resistant aircraft structural members and spacecraft heat shields. When compared to metallic devices, CF offered reduced mass, increased strength and increased heat resistance. CF materials were ideal for aerospace applications allowing the creation of more novel vehicles with increased performance characteristics also as savings in fuel consumption. Further advances in CF materials came out via the addition of polyacrylonitirel (PAN) [3].

As reported in spine imaging CF-PEEK implants in long bone applications offer superior imaging characteristics over similar metallic implants. Though no study to date has been published quantifying the clarity of imaging features of CF-PEEK implants in long bone settings, the imaging benefits are obvious. Fracture reduction is clearly seen in the preceding clinical cases reviewed in this publication. Experience has shown that MRI's and CT scans obtained in after implantation of a CF-PEEK device have virtually no artifact or image distortion. Fractures stabilized with CF-PEEK devices can be evaluated for healing more precisely. Oncologic lesions treated with CF-PEEK devices can be imaged for progression or regression with higher acuity due to the lack artifact as well, see figure 9 related to images [4].

CF implants has advanced a very broad and far reaching collection of industries. Its main limitation of cost is being slowly whittled down by its increased demand. In the field of orthopedics, it has provided innovative internal fixation to a wide variety of indications, fractures, joint arthrodesis and neoplastic lesion treatments. As in other industries, its physical properties of superior tensile strength, fatigue strength, and strength to weight ratio have challenged conventional materials and conferred novel advantages. Its elastic modulus has lessened the degree of stress shielding, allowing better callous formation and stronger union. Its radiolucency quickly brought it to the forefront of successful spine procedures. Radiolucency has also been particularly advantageous in the subspecialty of orthopedic oncology, where it has allowed superior monitoring of pathological fracture and the progression or regression of bone malignant lesions [5]. Finally CF implants have no allergic reaction, an advantage when one considers the reported cases of nickel hypersensitivity related to some metallic

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implants. The use of CF implants in orthopedics will continue to improve current procedures and confer new advantages as it continues to be researched and employed in new applications.

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Conflict of Interest

None

References

1. Aidoo J, HKA, Petrou MF (2004) Fatigue Behavior of Carbon Fiber Reinforced Polymer-Strengthened Concrete Bridge Girders. J Compo Constr 8: 501-509.
2. Kurtz SM, Devine JN (2007) PEEK biomaterials in trauma, orthopedic, and spinal implants. Biomat 28: 4845-4869.
3. Czaderski CM (2004) Flexural Behaviour of Concrete Beams Strengthened with Pre-stressed Carbon Fibre Reinforced Polymer Sheets Subjected to Sustained Loading and Low Temperature. Mat Struc 38: 39-46
4. Huang WY, Yeh CL (2012) Development of fibroblast culture in three-dimensional activated carbon fiber-based scaffold for wound healing. J Mater Sci Mater Med 23: 1465-1478.
5. Utzschneider S, Becker F (2010) Inflammatory response against different carbon fiber-reinforced PEEK wear particles compared with UHMWPE in vivo. Acta Biomaterialia 6: 4296-4304.