Fiscal Year:	FY 2014	**Task Last Updated:**	FY 04/04/2014
PI Name:	Deymier, Alix C. Ph.D.		
Project Title:	Effect of Unloading on the Structure and Mechanics of the Rotator Cuff Tendon-to-Bone Insertion		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	NSBRI--Musculoskeletal Alterations Team		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Bone Fracture**:Risk of Bone Fracture due to Spaceflight-induced Changes to Bone (2) **Osteo**:Risk Of Early Onset Osteoporosis Due To Spaceflight		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Comments:	NOTE: Also known as Alix Deymier-Black; former affiliation Washington University School of Medicine (Ed., 3/8/17)		
Project Type:	Ground	**Solicitation / Funding Source:**	2013 NSBRI-RFA-13-01 Postdoctoral Fellowships
Start Date:	11/01/2013	**End Date:**	10/31/2015
No. of Post Docs:	1	**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Thomopoulos, Stavros Ph.D. (MENTOR/ Washington University)		
Grant/Contract No.:	NCC 9-58-PF03503		
Performance Goal No.:			
Performance Goal Text:			

POSTDOCTORAL FELLOWSHIP
Rotator cuff injuries often occur at the site of tendon-to-bone attachments, also called the insertion site or enthesis. Long-term changes in mechanical loading on joints, such as may be experienced during extended space travel, may magnify the injury risk to the tendons. Even in the best conditions on Earth, these injuries do not heal well and will severely debilitate an injured astronaut. Unloading the musculoskeletal system leads to rapid bone resorption, loss of bone mass, and decreased mechanical properties.

However, much less is known about the results of extended weightlessness or unloading on the interfaces between hard and soft tissues. The tendon-to-bone attachment site achieves an effective connection between tendon and bone through

Task Description:	a multi-scale structural organization. On the nanometer scale, mineralized collagen fibrils serve as templates for mineral deposition, which provides stiffness to the attachment. On the micrometer scale, these mineralized fibrils create gradients in both mineral content and collagen fibril orientation. These are responsible for dissipating stress concentrations, thus limiting the risk of failure. Changes to this structure caused by unloading can result in changes to the mechanics of the attachment. The overall objective of this project is to determine the effect of unloading on the structural, and in turn mechanical, properties of the tendon-to-bone attachment. To achieve this goal, mouse rotator cuff attachments will be unloaded via botulinum toxin injections and examined using cutting edge techniques. At the nanoscale, we will determine the effects of unloading on the mineral organization in relation to the collagen fibril and in turn how it affects the mechanics. We expect that the unloading will cause a decrease in mineral at the attachment. This mineral is necessary to stiffen and toughen the attachment; therefore, unloading is expected to cause a decrease in these properties. At the micrometer scale, previous work has shown that unloading causes a decrease in collagen fibril alignment. Since the collagen serves as the template for mineralization, we will examine how unloading affects the mineral organization and how that may affect the mechanics. We expect that increased collagen disorder will lead to increased mineral disorder. In turn, this increased disorder will decrease the load-bearing efficiency of the structure. As a result, the strength of the insertion will decrease with unloading. With a better understanding of the effects of unloading on the tendon-to-bone insertion, we can start to develop preventative measures to maintain the health of the tendon-to-bone attachments in astronauts exposed to long-term microgravity.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Rotator cuff tears are extremely prevalent, especially in the elderly population (~50% prevalence in individuals over 80 years). Even in the best of situations these tears are difficult to repair with a failure rate for repaired rotator cuffs as high as 94%. Rotator cuff tears tend to occur at the interface between tendon and bone. Such interfaces between dissimilar materials are prone to stress concentrations and increased failure risk. In healthy tissue, a number of structural mechanisms such as gradients in mineral content, collagen orientation, and matrix composition serve to dissipate these stress concentrations. The increased occurrence of rotator cuff injuries in the elderly population suggests that there may be changes in the interfacial structure due to unloading as a result of disuse or decreased use of the shoulder. Understanding how changes in the enthesis structure affect the mechanics of the insertion in loaded and unloaded systems will help us to develop enhanced techniques for treatment and repair. Therefore, the research performed in this project will not only help the astronaut population, but will also provide essential information in regards to the mechanics of rotator cuff tissues and how they respond to use and disuse.
Task Progress:	New project for FY2014.
Bibliography Type:	Description: (Last Updated: 10/19/2020)