

(Revised 07/09)

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(please insert ref. above)

NSFC/RGC Joint Research Scheme
Joint Completion Report

*(Please attach a copy of the completion report submitted to the NSFC
by the Mainland researcher)*

Part A: The Project and Investigator(s)

1. Project Title

Novel Strategy for Prevention of Disuse Bone Loss by Using Implantable Micro-Electrical Stimulators

2. Investigator(s) and Academic Department/Units Involved

	Hong Kong Team	Mainland Team
Name of Principal Investigator <i>(with title)</i>	Dr. Guo Xia	Prof. Li Lu-Ming
Post	Associate Professor	Professor
Unit / Department / Institution	Department of Rehabilitation Sciences, The HK PolyU	Department of Aeronautics & Astronautics Engineering, Tsinghua University, Beijing
Co-investigator(s) <i>(with title)</i>	Prof. Qin Ling Department of Orthopaedics & Traumatology, CUHK	Dr. Hao Hongwei ¹ Dr. Zhao Hucheng ¹ ¹ School of Aerospace, Tsinghua University, Beijing

3. Project Duration

	Original	Revised	Date of RGC/ Institution Approval <i>(must be quoted)</i>
Project Start date	01-01-2011		
Project Completion date	31-12-2012	31-12-2013	01-06-2012
Duration <i>(in month)</i>	24	36	

Part B: The Completion Report

5. Project Objectives

5.1 Objectives as per original application

- 1. To investigate the effectiveness and efficacy of electrical stimulation to sensory nerves in prevention of disuse osteoporosis;*
- 2. To compare the effect of different electrical stimulating parameters;*
- 3. To investigate the role of sensory neural feedback in bone mechanobiology and pathomechanics.*

5.2 Revised Objectives

Date of approval from the RGC: _____

Reasons for the change: _____

- 1.*
- 2.*
- 3.*

6. Research Outcome

Major findings and research outcome

(maximum 1 page; please make reference to Part C where necessary)

The effects of DRG stimulation in promoting CGRP expression and promotion of bone maintenance in hindlimb unloaded rats. This study has important implications for developing treatments to prevent disuse osteoporosis. It has been found that stimulation to the DRG can also induce spinal fusion. This finding suggested a potential application of using electrical stimulation to enhance spinal fusion

Potential for further development of the research and the proposed course of action
(maximum half a page)

The effect of electrical stimulation to DRG on preventing bone loss has been proved. The potential application of electrical stimulation to DRG on fracture healing will be further studied.

7. The Layman's Summary

(describe in layman's language the nature, significance and value of the research project, in no more than 200 words)

Osteoporosis is characterized by extensive decline in bone mass and deteriorated bone micro-architecture leading to increased risk of fracture.

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Calcitonin gene-related peptide (CGRP) is a neural peptide secreted by sensory neurons. Previous reports have suggested that CGRP might serve as a local regulator of bone cell function.

CGRP secretion from the dorsal horn could be stimulated by electrical stimulation of a dorsal root. Hence, electrical stimulation of a sensory nerve at its dorsal root in order to trigger CGRP secretion would be a possible treatment for preventing bone loss. Thus, the aim of this study is to investigate the impact of electrical stimulation at dorsal root ganglia on disuse osteoporosis and the underlying mechanism.

The results of the current study proved that direct electrical stimulation at DRG by an implantable device preserves bone mineral density and bone micro-architecture in unloaded tibia by enhancing expression of CGRP+ neurons in DRG and proximal metaphysis. The enhancement in CGRP+ neurons, in turn, suppresses activity of osteoclasts but enhances activity of osteoblasts.

Part C: Research Output

8. Peer-reviewed journal publication(s) arising directly from this research project
(Please attach a copy of each publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.)

The Latest Status of Publications				Author(s) <i>(bold the authors belonging to the project teams and denote the corresponding author with an asterisk*)</i>	Title and Journal/Book <i>(with the volume, pages and other necessary publishing details specified)</i>	Submitted to RGC <i>(indicate the year ending of the relevant progress report)</i>	Attached to this report <i>(Yes or No)</i>	Acknowledged the support of this Joint Research Scheme <i>(Yes or No)</i>
Year of publication	Year of Acceptance <i>(For paper accepted but not yet published)</i>	Under Review	Under Preparation <i>(optional)</i>					
2011				Lau YC Guo X*	"A Review on Current Osteoporosis Research: With Special Focus on Disuse Bone Loss" Journal of Osteoporosis, Published online 2011 Aug 16 doi: 10.4061/2011/293808	2011	yes	No, as this is a review paper.
2012				Qian X, Hao HW, Ma BZ, Wen XW, Hu CH, Li LM*, Lau YC, Guo X*	"Programmable and implantable neurostimulator with novel stimulus waveforms for rat models" ELECTRONICS LETTERS 2012 Vol. 48 No. 17	2013	Yes	Yes

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2014				Lau YC, Lai YM, Po KT, Qian X, Hao HW, Zhao HC, Li LM, Guo X*	Dorsal root ganglion electrical stimulation promoted intertransverse process spinal fusion without decortications and bone grafting: A proof-of-concept study, Spine Journal	No	yes	Yes
	2014			Lau YC, Po KM, Qian X, Li LM, Guo X*	Electrical stimulation at the dorsal root ganglion preserves trabecular bone mass and microarchitecture of the tibia in hindlimb-unloaded rats, Osteoporosis Int. , DOI: 10.1007/s00198-014-2866-3	No	yes	Yes
			√	Lau YC, Qian X, Po KM, Li LM, Guo X	Dynamic changes of bone density following electrical stimulation at dorsal root ganglion.	No	No	Yes

9. Recognized International conference(s) in which paper(s) related to this research project was/were delivered *(Please attach a copy of each delivered paper)*

Month/Year/Place	Title	Conference Name	Submitted to RGC <i>(indicate the year ending of the relevant progress report)</i>	Attached to this report <i>(Yes or No)</i>	Acknowledged the support of this Joint Research Scheme <i>(Yes or No)</i>
08/2011/Taiwan	“Application of Implantable Micro-electrical Stimulator (IMES) on Reduction of Disuse Bone Loss”	2 nd World Cup of Computer Implemented Inventions (CIIs)	2011	No	Yes
San Antonio, Texas, USA., 26-28 January, 2013	Design and Implantation of Implantable Micro-electrical Stimulator for Osteoporosis Prevention,	Orthopaedic Research Society 2013 Annual Meeting	No	yes	Yes

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San Antonio, Texas, USA., 26-28 January, 2013	Electrical Stimulation at Dorsal Root Ganglion by Means of Implantable Micro-electrical Stimulator Preserves Bone Mineral Content in Hindimb Unloaded Rats	Orthopaedic Reseach Society 2013 Annual Meeting	No	yes	Yes
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10. Student(s) trained *(Please attach a copy of the title page of the thesis.)*

Name	Degree registered for	Date of registration	Date of thesis submission/ graduation
Lau YC	PhD	1Sep 2010	April 2014

11. Other impact *(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, etc.)*

12. TIII Award and (2) Special Innovation Award in the 2nd World Cup of Computer Implemented Inventions, Kao Hsiung, Taiwan, Aug 2011. (Certificates are attached)