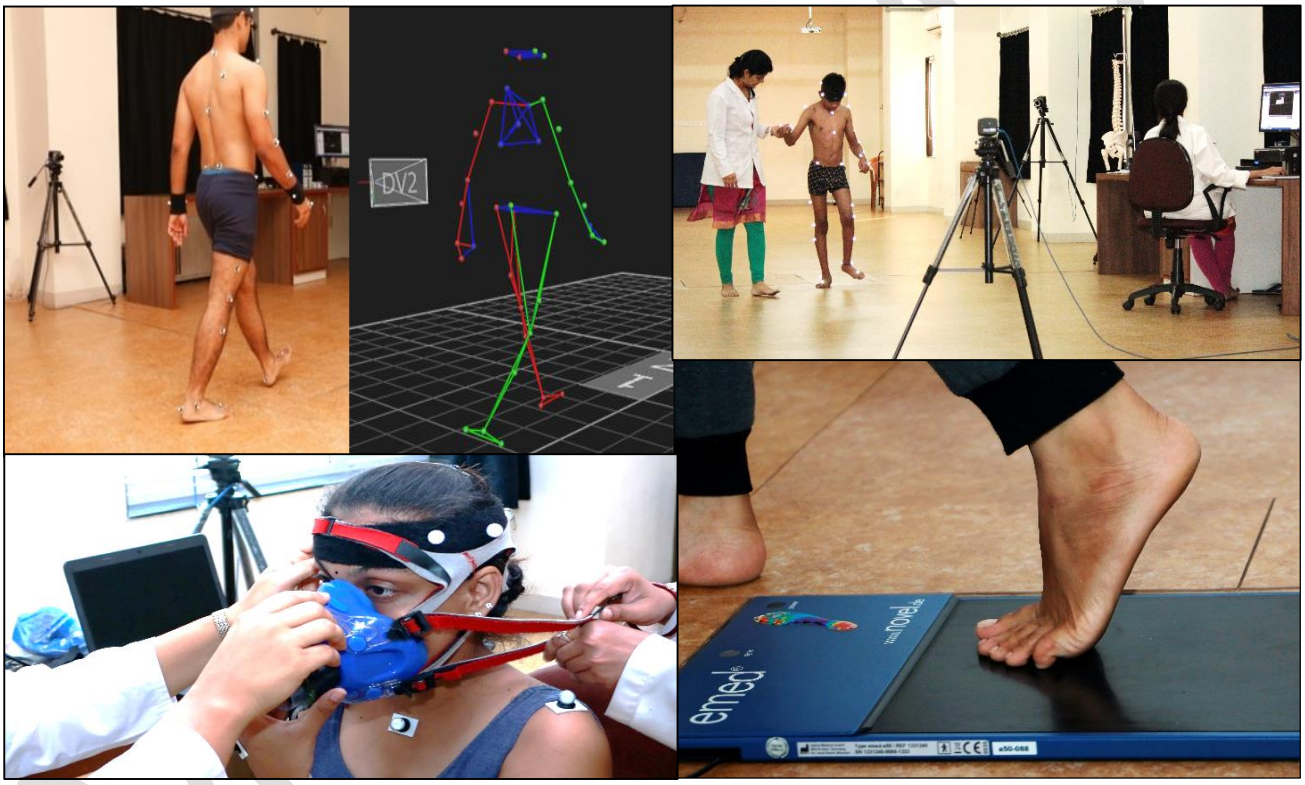
MGM School of Physiotherapy

MGM Institute of Health Sciences, Navi Mumbai

MGM Centre of Human Movement Science



Report: 2015-2020

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Preamble

Human movement science has grown rapidly over the last half a century in the western countries. Scientists from a wide spectrum of healthcare fields (physiotherapy, surgery, prosthetics-orthotics, anatomy, etc.) and engineering (mechanical, biomedical, aeronautical, etc.) have contributed with robust research to evolve this field. Applications of human movement science range from health promotion, clinical rehabilitation, sports and dance injury, orthotic and prosthetic design, medical device innovations, etc.

In India, the science of human movement is growing gradually. Health and Engineering Institutes like IITs (mechanical, biomedical and aeronautical engineering departments), IISc, Bangalore; BARC; DRDO, NITIE, SRASSC, Manipal Academy, Physiotherapy Institutes, SAI etc. are pursuing academic and research activities in human movement science. However, each institute is working in isolation within a specific mandate of funded projects; resulting in scattered growth of biomechanics throughout India. High-end fundamental research and elite applied clinical work is going on at a few health and engineering institutes, in addition to focused efforts towards indigenous development of robust and affordable prosthesis. However, a need for concerted, cohesive inter-disciplinary effort to develop appropriate healthcare solutions is still perceived.

Engineers and healthcare professionals need to work together to achieve this goal. Medical device innovation has already gained momentum in India with dedicated Centre's like BETiC, TCS Innovation Labs, etc. which seek complementary support from MGM Centre of Human Movement Science. An exemplary partnership between MGM Centre of Human Movement Science and BETiC, IITB is trying to address an urgent need of integrating clinical biomechanics in healthcare for past 5 years.

MGM Centre of Human Movement Science is committed to develop this science in India, disseminate fundamental knowledge and study applications of movement science in health promotion and rehabilitation, to address unmet local and global needs of people from across all economic strata of society. The Team of enthusiastic Physiotherapists, Human movement scientists and Mechanical engineers is working towards creating indigenous simple bold healthcare solutions; designed to engage the mechanical marvel of human body itself to keep people mobile and functionally independent. The philosophy is driven by the fact that technology cannot afford to reach every part of the world, which is challenged by health problems caused by movement disorders. Hence, we explore movement to promote it as a therapeutic device for health promotion and clinical rehabilitation.

On the other hand, The Centre is engaged in applying knowledge of human movement science in design and validation of technology for health promotion, early detection and rehabilitation of people living with movement impairments. Collaboration with national and international health and engineering institutes with high research repute strengthens our multidisciplinary approach to develop relevant movement science applications.

Our 5 year report encompasses the progress of MGM Centre of Human Movement Science since 2015. We present this report to students, researchers and professionals from health care and engineering fields with an aim of engaging them in the goal of generating a multi-disciplinary task force within the country for undertaking research and developing movement science further in India.

Dr. Rajani Mullerpatan & Team of MGM Centre of Human Movement Scienc

Preface

Dr. Anil Kakodkar
Chairman, Rajiv Gandhi Science and Technology Commission

"I have participated in most of your annual meetings if not all of them. Every time I have been watching progress and new things. Today I get a sense that the Centre has got an existence of its own. The Centre is growing with its collaborative work not just with Indian Institutes but across various nodes even abroad. I am extremely delighted to be a part of this discussion. I want to make a few suggestions and comments for your consideration. Healthcare program that we have around is essentially a sick care program and not a healthcare program. Healthcare program should have preventive part which is currently missing. We can look at the program as human wellness program which can include biomechanics, human movement science, traditional Indian and art such as classical Indian dance forms. The field is quiet broad and everything can't be brought under this umbrella on day 1. But things can be started off in this direction. For example, at one centre there was a research conducted on postures of Suryanamaskar by an orthopaedic surgeon who suggested addition of relevant poses for better joint mobility in existing 12-pose Suryanamaskar cycle and named it as Samarthanamaskar as he was a devotee of Swami Samartha Ramdas. Several people complain of knee problems and the Indian habit of squatting and how it becomes difficult after total knee arthroplasty. I have seen surgeons performing hemi-replacements of knee joint and patients are able to perform squatting post-operatively. I think these are some of the benefits of understanding human movement science. The Centre that you have created has a huge potential in developing human movement science. The ecosystem that you have built around the Centre with several partner institutions in various areas of specialization and different disciplines, gives us a great opportunity to move forward in that direction. In that context, I want to endorse what Dr. Ravi said earlier. You have within MGM campus, various institutions such as engineering colleges, medical colleges and you are a University in itself and I think you must leverage your autonomy by creating academic, research, research translation and industry engagement programmes where human movement science can be looked at in a very holistic way. Centre is already conducting activities for academic training, research, technology and device validation. The Centre has already started research on traditional sports, classical dance and day to day ground level activities. While talking about the overall subject of human wellness, we should also integrate biomechanics, biochemical aspects and neural connection of human body. There is a great connection between artificial intelligence to human health. Creating facilities for supporting human wellness for people who are differently-abled rather than apparently mechanical looking gadgets incorporating human intelligence with artificial intelligence technology. Relationship between human brain and external computer can work in coordination. These can be some powerful tools for development. In terms of Human

movement science, there can be human neurological control or artificial control. Since you are an inter-disciplinary team, people doing PhD and Masters level projects in a joint mode i.e. medical fraternity and engineering fraternity working together is an area you might like to carry forward. The last point that I wish to make is more general. You have come this far and if I had to ask you what's your strength. Your strength is the great ecosystem that you have built around. The point is that suppose it was Dr. Rajani, faculty member in Physiotherapy Department of MGM doing a regular job, clearly all this was not possible. Suppose Dr. Rajani had interest in research in the area of biomechanics and you would have decided to do the possible research in your department then you would have not come this far. The main reason for success of this Centre is the ecosystem that you have built. For Indian Science and technology to go forward, the so called "Atmanirbhar Bharat" will not be possible by creating slogans. Atmanirbhar Bharat will only be possible by creating such ecosystems. All complimentary elements which are required for translation of technology/information from lab to market, all of them should be a part of that ecosystem. And you have successfully created a fairly good ecosystem. If you are broadening your vision, you probably need to expand your ecosystem around you. You have come this far by yourself with your excellent work. You are on a jumping board now. So you can jump very high and I wish you all the very best for your success. Last year we championed saying let's take this society forward, take it along with everybody who is involved. If there is difficulty in making that happen then I suggest you change the name of the society Biomechanics to a broader version Human Wellness or Human wellness or science and create a new initiative. Let the old thing remain where it is and create a new Centre because sometimes the old becomes a bottle neck and a hurdle. So you have given enough opportunity to take everybody along. If you see a quick success then you go along with it. If you don't see that happening, then broaden the horizon and create a new society by its own name."

Dr. Anil Kakodkar
Chairman, Rajiv Gandhi Science and Technology Commission

An Indian nuclear physicist and mechanical engineer awarded Padma Shri (1998), Padma Bhushan (1999), Padma Vibhushan (2009).

Former Chairman, Atomic Energy Commission of India
Former Secretary to the Government of India
Former Director of Bhabha Atomic Research Centre
Former Chairman, Board of Governors of the Indian Institute of Technology, Bombay

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Executive Summary

MGM Centre of Human Movement Science (MGMCHMS) has accomplished 5 successful years since its establishment in 2015. It was established by MGM School of Physiotherapy, a Constituent Unit of MGM Institute of Health Sciences, Navi Mumbai on 5th Oct 2015. The Centre was funded by International Society of Biomechanics and BETiC, IIT-Bombay to address an urgent need to integrate clinical biomechanics in Indian healthcare.

The vision is to generate a task force within the country to undertake research and develop human movement science in India, by conducting integrated training for clinicians and engineers. The Centre assumes uniqueness in India, by conducting four major activities under one roof in parallel, namely: training, research, clinical service and technology design and validation.

In past 5 years, the Centre gained recognition for its work in training clinicians and engineers across various states of India in clinical biomechanics and commonly adopted applications of biomechanics such as human gait. Guided tours to higher secondary school and junior college students and short-term demonstrations are regularly conducted to spread awareness and disseminate knowledge of biomechanics within Maharashtra and outside, among clinicians, students and faculty members of health care and engineering.

The Centre has trained several clinicians and engineers in clinical biomechanics across Maharashtra, Gujarat, Karnataka, Kerala & Delhi through 11 training courses. Participants reported an excellent feedback on knowledge base and awareness of applications of biomechanics in clinical evaluation and rehabilitation; research and technology design. Additionally, over 1200 students from Physiotherapy (including BPT & MPT), Prosthetics & Orthotics(BPO) and Orthopedics(MS) benefitted from biomechanics training.

Research activities designed for biomechanical exploration of indigenous movements and postures practiced in India, namely: Yoga, indigenous daily life postures, traditional sports and Indian classical dance forms (11) and clinical rehabilitation (6) have yielded 17 original scientific papers in peer reviewed Scopus/PubMed indexed journals. The Centre was invited to publish research findings in a special volume of Journal of Critical Reviews™ in Physical and Rehabilitation Medicine (Volume 31, 2019 Issue 1: indexed in Scopus), with a theme 'Physical Fitness and Functional Performance in People with Musculoskeletal and Neurologic Disorders and Challenges to Rehabilitation in Middle-Income Countries'. Furthermore, the research output is compiled into a chapter titled 'Biomechanics of Indigenous Postures' in the Textbook of Basic Biomechanics of the Musculoskeletal System, 5ed, Publishers: Wolters Kluwer which is due for publication in Jan 2021.

Original fundamental and applied research was conducted to study over 3000 healthy volunteers to generate normative reference values for Indian population (of all age groups ranging from pediatric to geriatric), which are copyrighted. Two patents are filed for design of technology pertinent to rehabilitation.

Inter-disciplinary collaborative research between Department of Mechanical Engineering, IIT Bombay and MGM School of Physiotherapy, Navi Mumbai resulted in development of a powered trans-tibial prosthesis for people with below knee amputation which was funded by Department of Biotechnology.

An external, self-wearable, low-cost, spring loaded passive exoskeleton was designed to reduce trunk muscle fatigue in manual laborers. The device was tested on healthy people and Mathadi workers with and without low back pain and results revealed 25% reduction in onset of fatigue. A proposal is shortlisted by Early Translation Accelerator (ETA) (established at BETIC, IIT Bombay), supported by BIRAC, New Delhi, to support its further development in a commercially viable product and license it to an industry partner. Pilot work is in process for clinical testing of a device for early detection of risk to ulceration among people with diabetic neuropathy.

Our efforts continue to explore-i) the value of squat, a traditionally practiced Indian movement for maintenance of lower extremity muscle strength, joint motion, mobility and walking capacity among people with knee osteoarthritis; ii) to help children with cerebral palsy undergoing single event multiple level surgery, a tool is being developed for home based monitoring of function; iii) biomechanics and energy cost of two modifications of traditional Suryanamaskar for application in elderly people (a collaborative project with Sancheti College of Physiotherapy, Pune).

Nearly 500 patients (traumatic sports/dance or mechanical injury, cerebral palsy, stroke, Parkinson's disease, amputations, diabetic neuropathy, osteoarthritis, joint replacement) have benefitted from robust evaluation for gait analysis (at one-third of prevailing cost), balance assessment,foot geometry and pressure evaluation at markedly subsidized cost. Quantified objective reports helped surgeons, physiotherapists and prostheticians and orthoticians to plan targeted surgical interventions and therapy to optimize function after trauma/disorder.

In addition to patient care, the Centre has supported individual innovators and organizations to validate 9 ingeniously designed devices against gold standard to address unmet needs in clinical rehabilitation of patients with poliomyelitis (1), lower extremity amputations (3), diabetes (1), backache (1), health promotion (1), athletic performance (1) and gait (1). Amongst these 9 devices, 'Diabetic Foot Screening Device' and 'Mechanical Actuated Stance Control Knee Ankle Foot Orthosis' for people with polio' attracted funding from BIRAC for small-scale production and commercialization. Individual innovators ranged from entrepreneurs to our youngest listed innovator who was a standard X school student, who bagged Grand Prize at the Initiative for Research and Innovation in Science (IRIS) National Fair 2016 (New Delhi) and qualified to represent India at the Intel International Science and Engineering Fair 2017 held in Los Angeles, USA.

The dedicated team of 4 Physiotherapy faculty members and 1 Research Associate complemented by mechanical Engineers from IIT Bombay, Queen's University, Canada; Human movement scientists from Cardiff University, UK along with 4 Ph.D. scholars, 14 MPT scholars, 7 M. Tech scholars and 24 BPT Scholars contributed to the growth of MGMCHMS in the past 5 years. A cohesive inter-disciplinary effort between healthcare professionals and engineers is a highlight of the team work at MGMCHMS resulting in translational healthcare research.

Presently it is geared to be recognized as the Centre of Excellence in Human Movement Science at national level. Additionally, it is equipped with expertise, skill and resources to assume position of a National Centre for validation of technology in the area of rehabilitation of movement disorders.

In the future, we envisage scaling our efforts for training and research to promote movement as a therapeutic device for health promotion and rehabilitation of people through a culturally palatable approach.

Dr. Rajani Mullerpatan

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Origin

MGM Centre of Human Movement Science grew 5-years old on 5th Oct 2020. On attaining this landmark milestone, it is our pleasure to share the story of its inception and growth over 5 years.

Motivated by a dream to develop the science of human movement in India and integrate it into health care, a 3- year old MGM School of Physiotherapy at MGMIHS embarked on a challenging task of exploring resources in 2011.

After a series of thoughtful discussions, the support began at home. Visionaries of MGM Trust: Shri Kamalkishore Kadamji, Dr Sudhir Kadam and Dr Nitin Kadam placed immense faith in our aspiration of integrating biomechanics in healthcare and munificently designated required space and offered resources in the upcoming MGM Super Specialty Hospital at Vashi, Navi Mumbai where the Centre stands proudly today.

Guru of Indian technology who propagates that- masses of India should benefit from innovations in technology- Dr Anil Kakodkar and technology mentor of MGMIHS, our Former Chancellor Prof. Narayan Khedkar encouraged and supported us with thoughts that, this science is relevant and it is time that we work on this science in India, before the rest of the world works on our problems. Our then Vice-Chancellor Prof. Ravindra Bapat always supported integration of clinical biomechanics in Indian health care.

But we needed more… engineering support! Our congruent search to find enthusiasts interested in biomechanics to form a robust interdisciplinary team with complementary engineering skills ended when Dr Rajani Mullerpatan was referred to Prof B. Ravi at BETiC; who is haunted with an ambition to develop medical device innovation in India. We discovered that clinical biomechanics is our common territory and, to complement each other's skills we shook hands!

Then, began the memorable struggle to seek funding for necessary equipment. Four rounds of persuasive submissions to DST (Department of Science and Technology, Govt. of India) over a period of 18 months. with a relevant project designed to analyze traditional Indian movements with an inter-disciplinary team of Mechanical Engineers, Physiotherapist and Human Movement Scientists did not attract funding. Hence we approached International Society of Biomechanics(ISB) in 2012. The ESM conference in Aug 2012 at Denmark provided an opportunity to discuss the intention of approaching ISB with a proposal to establish a Human Movement Science Centre in Navi Mumbai through the Economically Developing Countries (EDC) program with Prof. Julie Steele (ISB President 2009-2011) and other members of ISB. Prof. Steele was supportive of the plan and recognized the value of our proposal.

We were introduced to Dr Andrea Hemmerich, a highly enthusiastic, supportive and focused EDC Officer, to identify the objectives and outcome of such a Centre in India. Continued skype discussions over a year helped to draft a MoU, which was presented to the ISB Executive Council Members at ISB Congress, Natal, Brazil in Aug 2013 in partnership with IITB and Cardiff University, UK. At the ISB Congress in Brazil in 2013, Prof Anthony Van Bogert (ISB President 2011-2013) and Dr Hemmerich convened a workshop to discuss challenges faced by economically developing countries to establish infrastructure for research and training in Biomechanics.

Our proposal was discussed to assess its relevance, feasibility and viability in India. The proposal earned credibility owing to ongoing support from host organization, strong interdisciplinary team of clinicians, Human Movement Scientists and Engineers with complementary skills required for developing clinical biomechanics.

ISB recognized the value of our proposed scientific work and decided to fund us with equipment for basic motion analysis and support travel costs of Prof. Robert Van Deursen. Prof. Van Deursen supported us for installation of the equipment and getting started. A MoU was signed in 2013 between MGMIHS, IITB, Cardiff University, UK, ISB, Vicon, UK and AMTI, USA to structure and foster teamwork.

Mr. Andy Ray (Vicon) and Mr. Gary Blanchard (AMTI) generously donated 8-camera Vicon system and 2 force plates respectively. Mr. Peter Seitz (novel, Germany) donated an in-shoe pressure measurement system. Adele Burdock (Vicon) and François Asseman (AMTI) persevered a highly complex and arduous task for custom clearance and shipment. Local team constituted by Mr. Vivek Nadkarni, Mrs. Tanuja Nadkarni and Mr. Rupesh Pagdhare worked hard to install the equipment under the guidance of Prof. Robert Van Deursen.

With basic equipment, we took our baby steps in Feb 2015. Then a strong national collaborator BETiC came forth and kindly loaned us the remaining equipment in form of 4 Vicon cameras and 1 force plate to complete the required set-up in July 2015 to enable us start full-fledged. In a country where we have a thin line of mega divide between Government and private institutes, it was not common for government institutes to loan equipment to private institutes. Relentless work of Prof. Ravi and his colleague Dr Rupesh Ghyar at BETiC made this possible! The technical process was facilitated by Health Consortium Agreement between MGMIHS and IITB.

After creating the facility, MGMCHMS began its work with a core team of 1 fulltime Physiotherapist training in movement science: Dr Jyoti Chatla (PT) and 1 part-time Physiotherapist training in movement science: Dr Bela Agarwal (PT) supervised by Dr Rajani Mullerpatan with movement science knowledge and skills. Committed collaborators –Prof. Robert Van Deursen, Prof. B. Ravi and Dr .Parag Tandaiya (IITB), supported core team.

Since then, MGM Centre of Human Movement Science has embarked on its mission of integrating human movement science in health care and make movement analysis accessible for people with movement disorders in India. Increased awareness of scope of human movement science in health care and adequate funds for inter-disciplinary research will certainly add momentum to the 'movement' of building human movement science in India.

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MGM INSTITUTE OF HEALTH SCIENCES
(Deemed University u/s 3 of UGC Act, 1956)
Grade 'A' Accredited by NAAC

MGM CENTRE OF HUMAN MOVEMENT SCIENCE

Sector-30, Plot 46, Vashi, Navi Mumbai

MGM SCHOOL OF PHYSIOTHERAPY

Sector-1, Kamothe, Navi Mumbai

VISION

The aim is to generate a task force within the country to undertake research & conduct integrated training for health care professionals & engineers to develop human movement science for health promotion; reduction of rising burden of non-communicable-diseases (NCDs) for e.g. diabetes, arthritis, Parkinson's, cerebral palsy, etc. and design and validate technology for rehabilitation of people with movement disorders

MISSION

The mission is to provide people with robust & comprehensive movement-analysis facilities following injury/disorder at an affordable cost for precise clinical-decision-making.

Faculty

Prof. Rajani Mullerpatan

Dr. R Mullerpatan (BSc PT-1992, MScPT-1995, Mumbai University, PhD -2007, Cardiff University) leads MGM School of Physiotherapy at MGM Institute of Health Sciences, Navi Mumbai (since 2008). After completing her doctoral program at Research Centre for Clinical Kinesiology at Cardiff University, UK (2007), she is currently focused on development of Biomechanics in India to meet local healthcare needs of Indian population. She has collaborated with leading national and international institutions in UK, Canada & Australia to promote training and research in health promotion, clinical biomechanics, clinical rehabilitation and technology design. Her passion and commitment along with a dedicated Team drives activities of clinical service, research and training at MGMCHMS (2008 onwards).

Dr. Bela Agarwal (PT):

Dr. Bela Agarwal's expertise lies in the area of cardiorespiratory and pulmonary. Physiotherapy, the science of exercise physiology and exercise testing. A graduate from Seth.GS Medical College, Mumbai and a post graduate from Lokmanya Tilak Municipal Medical College, Mumbai in 1992, she has been working in the profession for 22 years at acclaimed teaching institutes, hospitals and clinics. She is a Professor at MGM School of Physiotherapy, MGM Institute of Health Sciences, Navi Mumbai since the past 5 years in a part time capacity and is also pursuing doctoral studies at MGMSOP in the area of clinical biomechanics. She has keen interest in studying energy expenditure of movements and relating motion analysis to functional performance and capacity enhancement. (2012 onwards).

Dr. Triveni Shetty (PT):

Dr. Triveni Shetty (PT), graduated from Dr. D.Y Patil College of Physiotherapy under MUHS, completed her Masters in Neurosciences from T.N.M.C, Medical College, Nair Hospital in 2013. She also holds a Diploma in Rehabilitation-Physiotherapy degree from All India Institute of Physical medicine and Rehabilitation. With keen interest in pediatrics and movement analysis of developmental disorders, she is currently working as a Asst. Professor and is an in- house research scholar pursuing her PhD under the guidance of Dr. Rajani Mullerpatan. She is working with MGMCHMS team since its inception and plays a key role in capturing and processing data from VICON motion analysis system. (2015 onwards).

Research Scholar

Senior Research Fellow

Dr. Blessy Thomas (PT): Dr. Blessy Thomas (PT), graduate from MGM College of Physiotherapy, Aurangabad in 2014 and post-graduate from MGM School of Physiotherapy, Navi Mumbai in 2016; worked as a Physiotherapist for 1.5yrs in Multispecialty hospitals. She has keen interest in research and worked as Senior Research Fellow in MGMCHMS (Mar 2019-Mar 2020).

PhD Scholar

Dr. Poonam Desai (PT)

Dr. Poonam Desai (PT) completed Bachelor of Physiotherapy from MGM School of Physiotherapy in 2014 and Master of Physiotherapy in Musculoskeletal Sciences from Sunandan Divatia School of Science, Narsee Monji Institute, Mumbai. She has experience in Neuro-pediatrics and musculoskeletal Physiotherapy. She has completed a diploma in Yoga. With keen interest in Geriatrics she is currently pursuing her PhD under the guidance of Dr. Rajani Mullerpatan. (June 2019 onwards).

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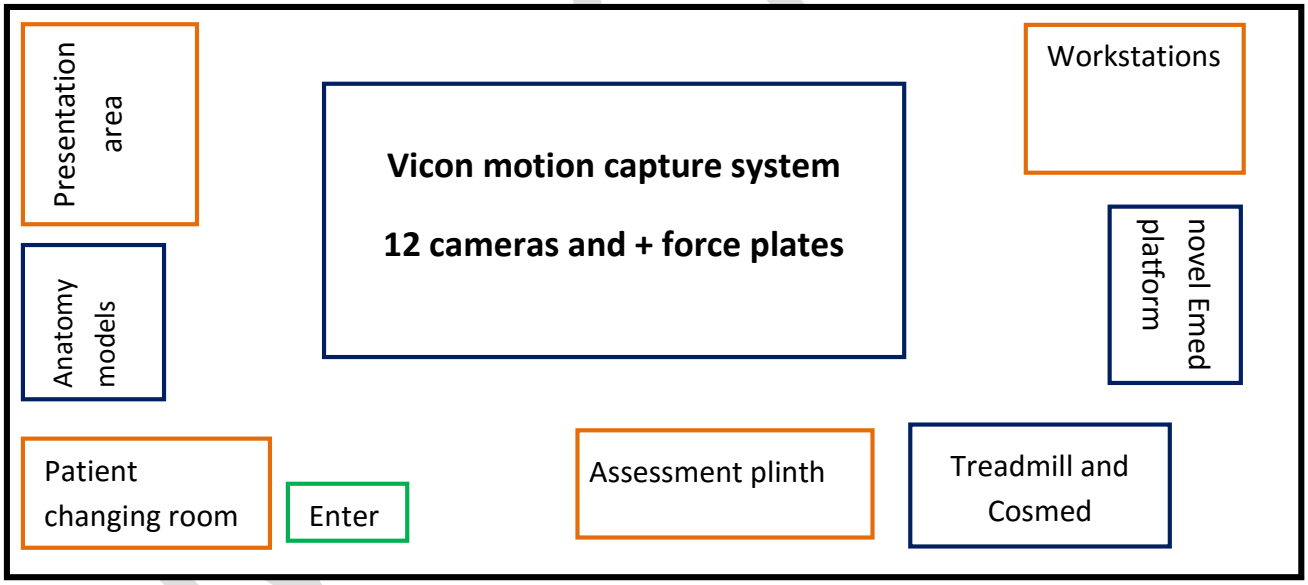
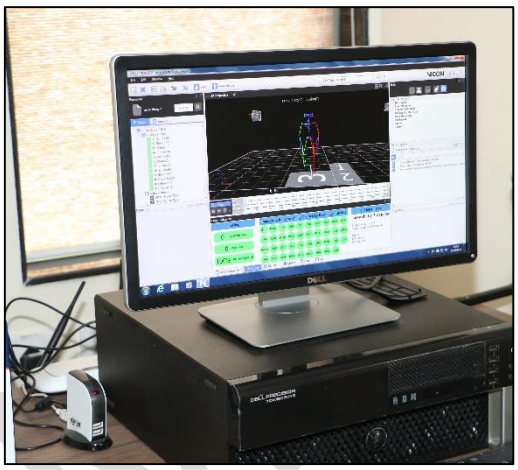
Facilities

MGM CHMS is spread over 2116 sq. feet area, equipped with robust state of art technology for comprehensive evaluation of human motion. MGM CHMS is located on the first floor of MGM super specialty hospital in Vashi, Navi Mumbai. The lab is 92 ft. long x 23 ft. wide x 13 ft. high.



Layout of MGM Centre of Human Movement Science

❖ Vicon motion capture system and AMTI force plates:

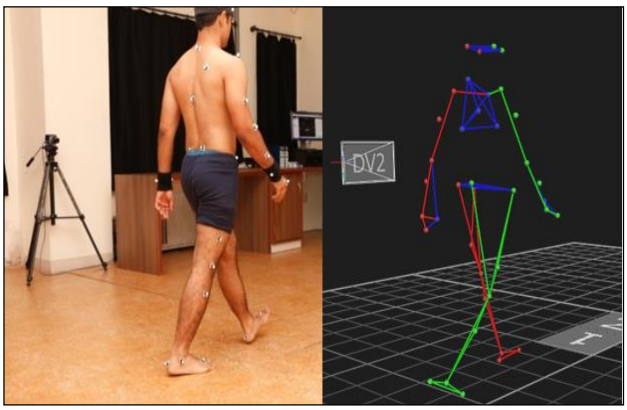


MGM CHMS motion analysis system is a robust gold standard equipment which includes- 12 [Bonita] 240 fps optical cameras (VICON, UK), 2 VGA video camera and three force platforms (AMTI, USA).

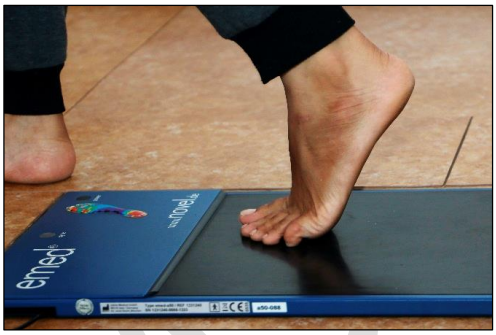
VICON motion analysis system has the potential to offer objective and unbiased gait information that can assist clinical decision-making. In addition, motion analysis can be used to influence decision making for orthopedic surgery and assess post treatment progress. AMTI biomechanics force platforms are designed to measure forces, moments and are sensitive to accelerations. Force plates can be used individually or as a walkway to record multiple footfalls.

VICON along with AMTI force plates is a state of art system for comprehensive motion analysis and allows reliable assessment of kinematics and kinetics of human movement. The system is extensively used in research setting for evaluation of motion in all three planes.

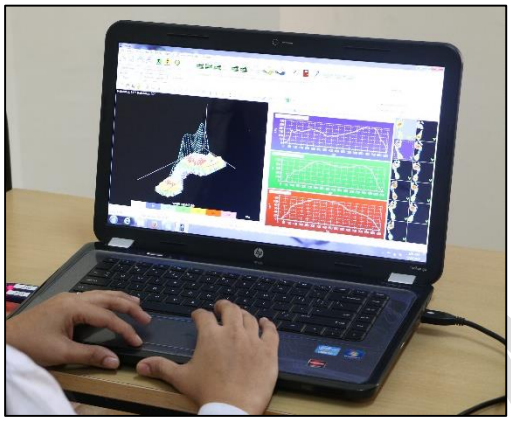
The MGMCHMS is also equipped with Vicon Polygon reporting software. This is an integrated visualization and report editing tool that enables quick and easy creation of a gait report. Polygon analyzes trial data that has been created with Vicon motion capture and processing software. Though the software contains modeled data generated by Vicon biomechanical modeling software (such as Plug-in gait, bodybuilder and OLGA); MGM CHMS has generated custom based template for gait analysis with reference values generated from Indian population, thus providing a better understanding of the deviations pertaining to our population.



❖ Novel e-med system for plantar pressure analysis:



E-med® Pedography platform at MGM Centre of Human Movement Science is gold standard system for foot geometry and plantar pressure distribution (Novel e-med, Germany). E-med ® Pedobarography platform (frequency 100Hz, resolution: 4 sensors/cm 2, sensor area: 574x320mm) is an accurate electronic system for recording and evaluating foot geometry and plantar pressure distribution under static and dynamic conditions. It consists of calibrated capacitive sensors that provide robust, objective and reliable information on foot function.



The Emed platform is extensively used for scientific research on foot geometry and pressure distribution. The system provides maximum and average plantar pressure over total foot as well as regional pressure distribution over forefoot, midfoot, hindfoot, hallux and toes. Apart from measurement of foot geometry, important measures such as arch index, hallux angle, coefficient of spreading etc can also be computed which are unavailable from traditional foot print system. Pedobarography measurement has significant applications in footwear design, sports biomechanics to correct altered landing pattern.

❖ Electromyography system:

Delsys Bagnoli EMG System: Delsys Bagnoli EMG DSY-DS-B03 is a 8 channel wire-less device which can be connected to VICON software so that it is helpful in various range of biomechanical research activity such as muscle activity in gait cycle, sports biomechanics.

The ProComp Infiniti: The ProComp Infiniti SA7500 encoder is an eight (8) channel, multi-modality device for real-time computerized biofeedback and data acquisition. It has 8 protected pin sensor inputs with two channels sampled at 2048 s/s and six channels sampled at 256 s/s. The ProComp Infiniti encoder is able to render a wide and comprehensive range of objective physiological signs used in clinical observation and biofeedback. All sensors are completely noninvasive and require little or no preparation for use.

❖ Step Activity Monitor:

The Step Activity Monitor (SAM) by Orthocare Innovations is a highly accurate ankle worn ambulatory activity monitor, the size of a small pager. The StepWatch works with a docking station and software that handles stet-up, downloading, display, analysis, and many other functions. It detects steps for a wide variety of normal and abnormal gait style and cadence ranging from a slow shuffle to a fast run. It has a capacity to monitor and store data for a month.

❖ Trunk Leg Dynamometer:

The Trunk leg dynamometer is an objective instrument for assessing trunk and leg strength. Due to its design, it provides an accurate and safe way to take measurements. A trunk dynamometer measures isometric and concentric strength and muscular endurance of the extensors and flexors of the lumbar and thoracic spine. The oversized body includes a solid base for safety as well as cushion handgrips for comfort. Chain adjusts for height differences or to vary the point of force application. Strength indicator remains at subject's maximum reading until reset. The scale measures to 660 lbs. or 300kg

❖ Vibrothesiometer:

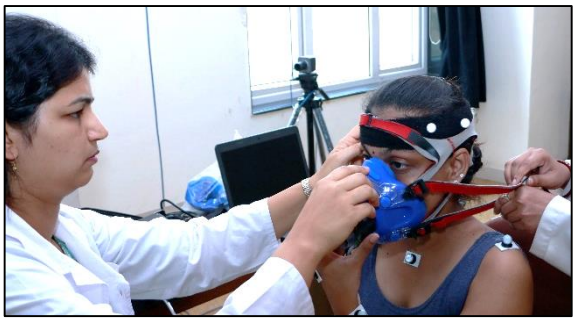
Digital Vibrothesiometer is a robust objective non-invasive tool to detect neuropathy. The vibrometer helps to detect the loss of vibration perception threshold (VPT) accurately. This device is equipped with an electronic tuning fork which has vibration strength that slowly increases till the patient faces the vibration sensation. The digital vibrometer is integrated with a software system that enables storage of data and multiple reports of various patients.

❖ Body Composition Analyser(A202 Tanita):

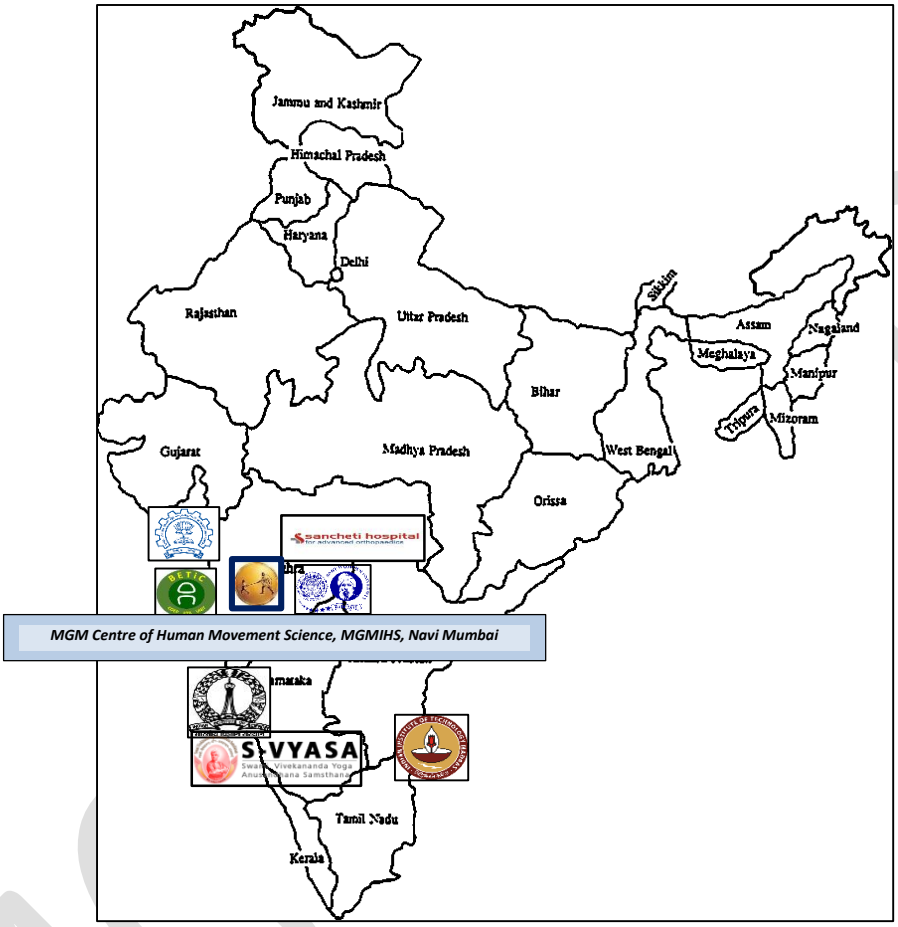
Tanita is the standard and market leader for body composition analyzers. A Tanita body composition monitor provides valuable measurements regarding body fat, skeletal muscle mass and water content. These measurements indicate body fat, muscles metabolism, bone structure and body water. The equipment provides a quick non- invasive method to assess body composition, an important component of physical fitness.

❖ Oxygen Consumption Analyzer (Fitmate Med, COSMED):

Fitmate Med by COSMED, Italy is an electronic device developed for assessing resting metabolism, cardio-respiratory fitness (VO2max) and basic spirometry (FVC, SVC, MVV). It allows personalized weight management programs and exercise prescriptions according to the ACSM's latest recommendations. It is sensitive equipment that provides accurate respiratory gas analysis and real time oxygen consumption. Energy expenditure of activity is computed and comprehensive analysis of cardio-respiratory and metabolic systems allows for monitoring treatment outcomes and prescription of evidence based activity. This non–invasive, indirect measure permits evaluation of sub-maximal and maximal exercise performance. It involves measurements of gas exchange, primarily oxygen uptake i.e. VO_2, minute ventilation, heart rate, respiratory frequency and energy expenditure. VO2 at maximal exercise (peak VO2) is considered the best index of aerobic capacity and cardio-respiratory function. It is a sensitive measure which can be used to understand cardio-respiratory function in health and disease.



National collaborations & Linkages



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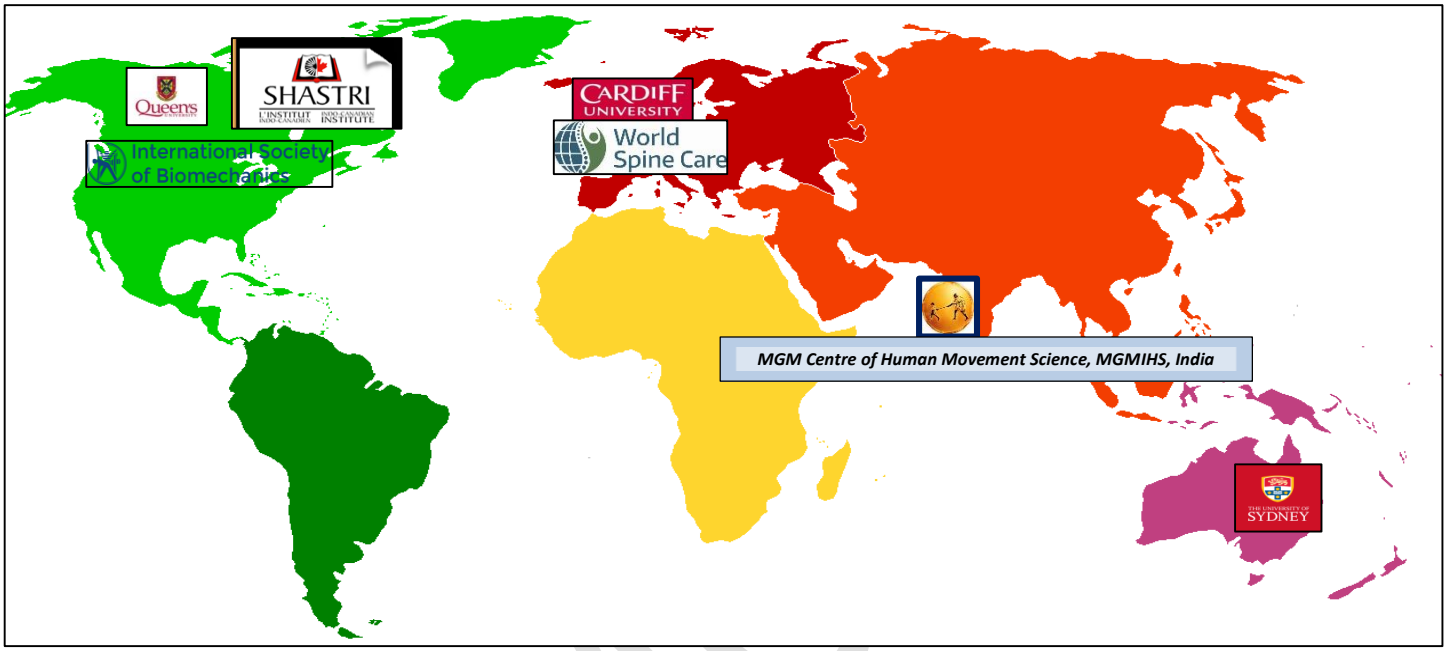
Sancheti Hospital, Pune Dr. Apruv Shimpi(PT), apurv008@gmail.com

SNDT Women's University, Mumbai, Nancy Fernandes, nancy.fernandes@ltnursingsndt.ac.in

International collaborations



Toni Arndt, President, International Society of Biomechanics, toni.arndt@gih.se

Prof. Margareta Nordin, World Spine Care, Europe-dmn2@nyu.edu

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Knowledge Dissemination

In past 5 years, the Centre gained recognition for its work in training clinicians and engineers across various states of India in clinical biomechanics and commonly adopted applications of biomechanics such as human gait. Guided tours to higher secondary school and junior college students and short-term demonstrations are regularly conducted to spread awareness and disseminate knowledge of biomechanics within Maharashtra and outside, among clinicians, students and faculty members of health care and engineering.

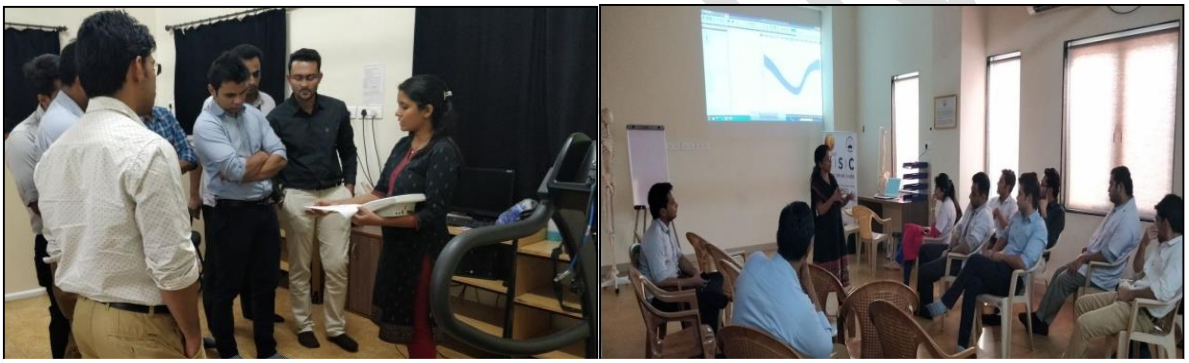
The Centre has trained several clinicians and engineers in clinical biomechanics across Maharashtra, Gujarat, Karnataka, Kerala & Delhi through 11 training courses. Participants reported an excellent feedback on knowledge base and awareness of applications of biomechanics in clinical evaluation and rehabilitation; research and technology design. Additionally, over 1200 students from Physiotherapy (including BPT & MPT), Prosthetics & Orthotics(BPO) and MS(Orthopedics) benefitted from biomechanics training.

Curricular training

IV BPT students being trained on 3D gait analysis for healthy and patient population

Designing protocol for data capture with Physiotherapy Master Scholars

Master Scholars and Interns practicing 2 D analysis of movement.



Demonstration of 3D motion capture system to MS Ortho residents (II & III year), MGM Medical College, MGM IHS, Navi Mumbai

CME for Physiotherapy Master Scholars on Musculoskeletal modelling by Prof. Marcus Pandey, Chair of Mechanical & Biomedical Eng., University of Sydney

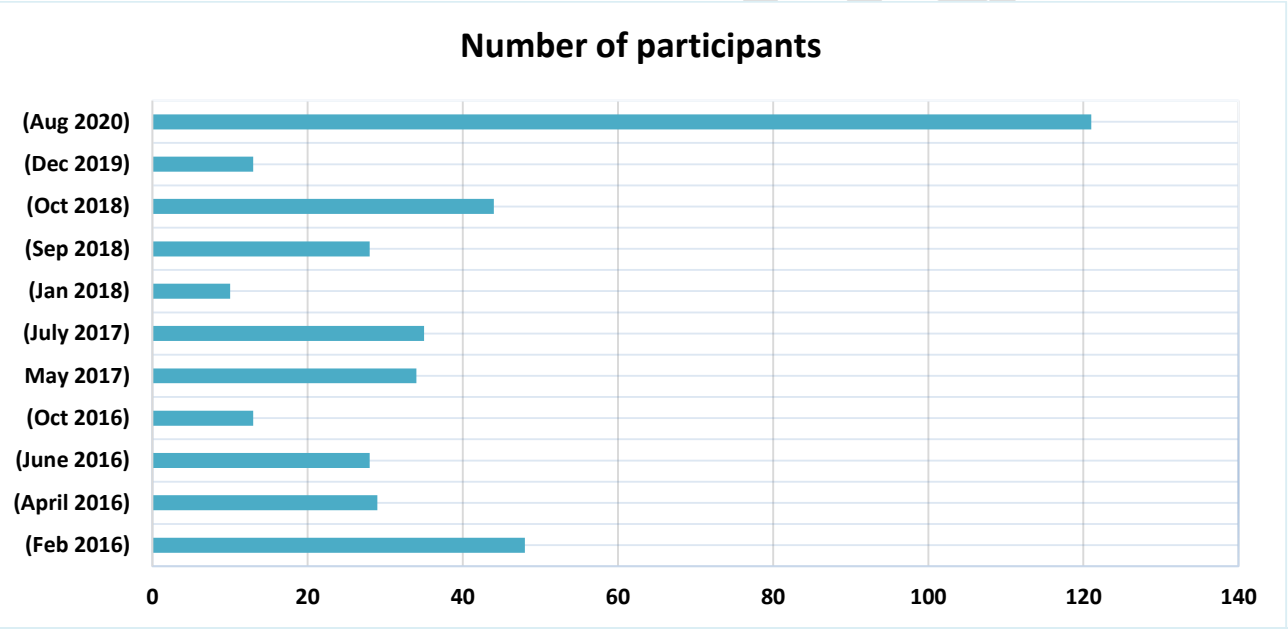
Workshop on strength and conditioning for Physiotherapy Master Scholars by Mr. Shailesh Shetty (Trainer)and Dr. Ruchita Tendolkar (Sports Physiotherapist)

Workshops

In the last 5 years, MGM CHMS conducted 11 training programs to train students, faculty members and clinicians from engineering and healthcare fields.

- **Three workshops in 'Course in Clinical biomechanics'**
  (Feb & April 2016, May 2017)

- **Eight workshops in 'Basics of Gait Analysis (2D/3D)'**
  (June 2016, Oct 2016, July 2017, January 2018, September 2018, Oct 2018, December 2019, Aug 2020)



Graph presents number of participants in the workshops conducted at MGMCHMS from 2016-2020

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Workshop in Clinical Biomechanics

Workshop in Clinical Biomechanics in April 2016

Workshop in Clinical Biomechanics in April 2016 & May 2017

Advanced Workshop in Clinical Biomechanics in May 2017

Basics of 2D & 3D Gait Analysis

Basic 3D Gait Analysis workshop in Feb 2016

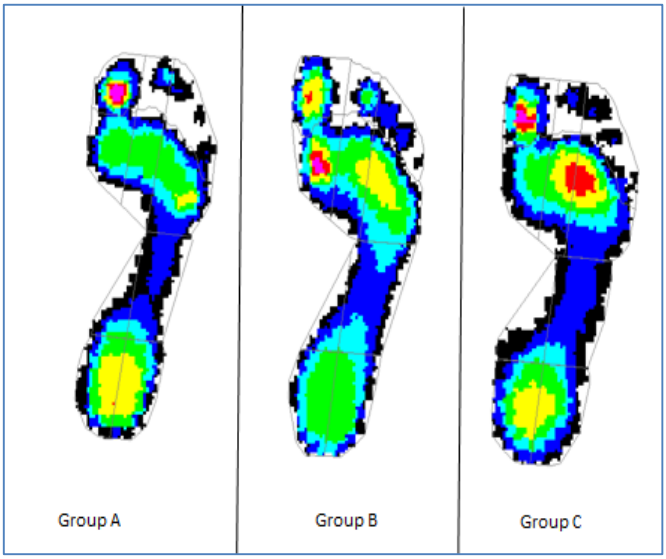
Basic 3D Gait Analysis workshop in October 2016

Basic 3D gait analysis workshop conducted in collaboration with Private Practitioners Group Mumbai and Bombay branch of IAP in July 2017 (seated left to right: Dr. Roshan Vania, Dr. D H Dastoor, Dr. Asha Chitnis, Dr. Deepak Kachalia)

Research

The Centre conducts research in 4 major thrust areas: i) biomechanical exploration of traditional ground level activities and its scientific application; ii) biomechanical exploration of Yoga (Suryanamaskar) and its scientific application in healthcare; iii) biomechanical exploration of traditional sports and its scientific application in healthcare and iv) biomechanical exploration of traditional dance form (Bharatanatyam) and its scientific application in healthcare. Research activities in these areas have yielded 17 original scientific papers in peer reviewed Scopus/PubMed indexed journals. Complete research output is compiled into a chapter titled 'Biomechanics of Indigenous Postures' in the Textbook of Basic Biomechanics of the Musculoskeletal System, 5ed, Publ: Wolters Kluwer which is due for publication in Jan 2021.

Fundamental and applied research was conducted to study over 3000 healthy volunteers to generate normative reference values for Indian population (of all age groups ranging from pediatric to geriatric), which are copyrighted, have huge potential for application in future research and design of healthcare solutions including therapy and tool kits for rehabilitation, sports, education and daily personal care. Three patents are filed for design of technology pertinent to rehabilitation. In past 5 years, MHMCHMS has evaluated 308 participants for various research activity and its clinical implementation in the area of cerebral palsy, women's health, diabetes mellitus, spine pain, lower limb amputations, dancer's health as well as development of indigenous medical assistive devices through various intramural, extramural and collaborative funded research projects.



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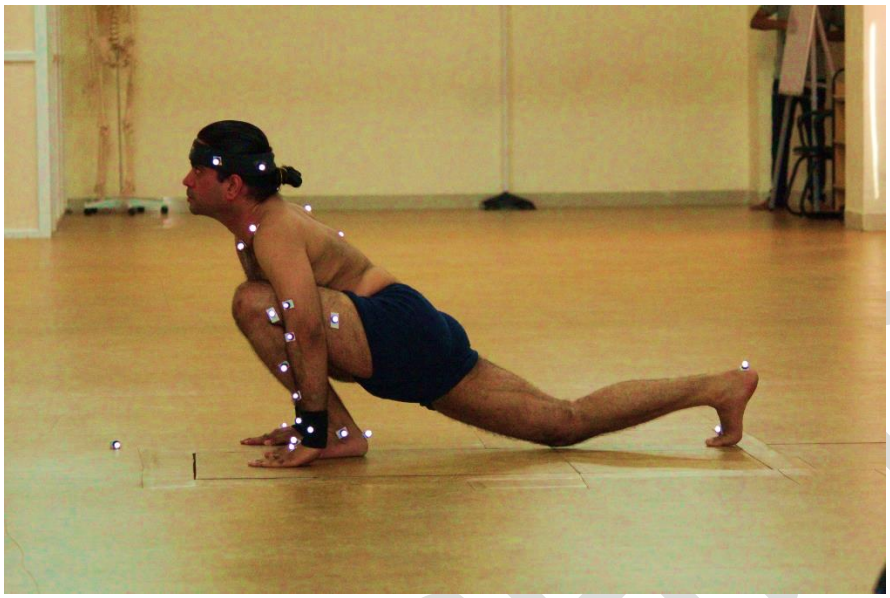


Research Thrust Area

Biomechanical Exploration of Yogasana and its Scientific Application

MGM Centre of Human Movement Science has undertaken much needed robust biomechanical exploration of Yogasana, which is necessary for its safe prescription in health promotion and prevention, and management of neuro-musculo-skeletal disorders. Research studies are largely funded intramural by MGM Institute of Health Sciences, Navi Mumbai. The highlights of research findings include- kinematics, kinetics, postural control and muscle control during Suryanamaskar and its application in management of low back pain. Additionally, influence of Yoga intervention on cricket bowling performance, balance performance of people with diabetic neuropathy and shoulder function in people with frozen shoulder presenting with diabetes mellitus was studied.

Thoppukaranam was studied to explore its physical and neuro-psychological benefits in University students. Brief summary of research work completed in this thrust area is presented in this section.

❖ Effect of Yoga on Bowling Performance and Physical Fitness in Cricket Bowlers

Sumedh Vaidya, Bela Agarwal

Cricket, as a sport, derives its thrill from the battle between bat and ball. Limited information is available on factors that contribute to proficient fast bowling performance. Yoga has a distinct emphasis on physical postures(asanas),respiration techniques (pranayama), deep relaxation that cultivate awareness and improve attention. A total 30 non- elite cricketers aged 13-25 years were recruited for a 12week Yoga intervention program. A 12-week intervention of Yoga demonstrated significant improvement in bowling speed (p = <o.oo1), accuracy (p = <o.oo1). upper limb strength (p = <o.oo1), lower limb strength, power and flexibility (p = <o.oo1), back muscles strength (p = <o.oo1), and cardiovascular endurance (p = <o.oo1). Bowling speed and accuracy was marginally better in Yoga intervention group compared to control group. Speed improved by 6.52% in the Yoga group, whereas Control group demonstrated improvement of 5.18%. The bowling accuracy improved in the Yoga group by 35.4% while control group demonstrated an improvement of 31.29%.

Bowlers being tested for bowling accuracy

Research Thrust Area

Biomechanical exploration of Traditional dance forms

India is the land of origin of various magnificent forms of classical and folk dances. Dance as a graceful form of movement has huge potential to maintain and enhance balance, co-ordination, muscle strength, gait and daily activity. Yet negligible scientific information is available to understand potential of Indian classical dance forms in healthcare application. Therefore, MGM Centre of Human Movement Science has undertaken biomechanical exploration of traditional Indian dance forms to unfold its potential as a therapeutic device for health promotion and rehabilitation of movement disorders among children and adults and serve as a conduit for cultural heritage restoration. Secondly, survey findings reporting musculoskeletal injuries among dancers in India prompted research in this thrust area. Preliminary work conducted to explore biomechanical demands of the most commonly performed Indian classical dance form i.e. Bharatanatyam, is presented in this section.

Research Thrust Area

Exploration of traditional sports for healthcare application

Sports Science has evolved in the last century to understand mind and body demands to play a sport, address health problems of sports people and its application in health promotion. However, a few sports have received the glamour and attention in competition and science. Whereas traditional sports remain neglected. Hence at MGM Centre of Human Movement Science, attempts are made to explore biomechanical and cardio-pulmonary demands of traditional sports such as skipping, Mallakhamb, Kabaddi etc. to expand boundaries of existing sports science field with emerging knowledge. It is foreseen that scientific exploration of traditional sports will not only add to the knowledge of sports science but also revive and popularize them among children and adults of generations to follow.

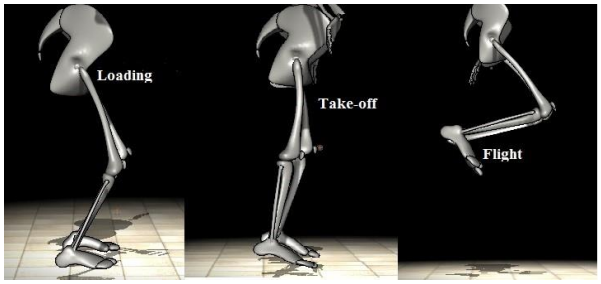
❖ Effect of Plyometric training on explosive power, agility, balance and aerobic performance of young adult male Kabaddi players

Richa Dharod, Triveni Shetty, Ruturaj Shete, Rajani Mullerpatan

Kabaddi is a team contact sport demanding higher level of endurance, explosive power, strength, agility, reaction time, spatial awareness and speed. Present study hypothesized that plyometric training integrated with conventional Kabaddi training would sports specific fitness among male Kabaddi players. Sixty-one sub-elite Kabaddi players (18-35 years) were allotted to plyometric training group (n=31) and control group(n=30). Kabaddi players trained with plyometric exercises demonstrated significant improvement in physical fitness components of explosive power ($p< 0.05$), lower extremity flexibility ($p= 0.00$), skeletal muscle mass ($p= 0.00$), balance ($p< 0.05$) agility ($p= 0.00$) and aerobic capacity ($p= 0.00$) compared to conventional training group. This improvement is speculated to cast a positive impact on raiding and defense performance of Kabaddi players. Hence, it is recommended that plyometric training could be integrated along with conventional training regime to enhance sports performance of Kabaddi player.

❖ Lower extremity joint loading during Bounce rope skip in comparison to run and walk

Rajani Mullerpatan, Triveni Shetty, Yuvraj Singh, Bela Agarwal



Bounce rope-skip holds immense scope for physical activity in space and time constrained urban setting, wherein compliance to commonly performed weight-bearing, aerobic activities like walking and running is a challenge. Thus, present study aimed to explore kinematics and lower-extremity joint loading during rope-skipping compared to walking and running. Following ethical approval, 3D motion analysis of bounce rope-skip, walk and run was captured from 22 healthy female participants aged 18-25yr. In one bounce rope-skip cycle, hip motion ranged between 13.4^{o}-35.3^{o}flexion; knee between13.6^{o}-67.9^{o} flexion and ankle between 34.5^{o}dorsiflexion to-13.4^{0}plantarflexion. In coronal plane, peak hip and knee adductor moment during rope-skip were lower compared to run and higher than walk ($p<0.001$). Bounce rope- skip caused low loading on hip, knee and ankle joints compared to run ; supporting its prescription as hip and knee joint-protective exercise for health promotion in young adults.

❖ Level of Sports Participation and Performance among People with Spinal Cord Injury (published)

Oshin Amberkar, Bela Agarwal, Yuvraj Singh, Ruturaj Shete & Rajani Mullerpatan

Sports participation in people with spinal cord injury leads to enhanced functional capacity, increased muscle strength, greater flexibility, and increased optimism. It is important to encourage people with spinal cord injury to participate in sports and understand facilitators of and barriers to it. Sports participation in people with physical disabilities including spinal cord injury is lower compared with people without them. Sports participation among the physically disabled in high-income countries like the United States and the Netherlands is 44% and 37%, respectively, whereas among people with spinal cord injury in Australia and Switzerland it is 44.6% and 59.8%, respectively. Limited information is available on sports participation of people with spinal cord injury in low- to middle-income countries. The present study aimed to explore sports participation among adults with spinal cord injury in Mumbai, India. Following ethical approval, 102 subjects (mean age 40.41 years; 88 males and 14 females) with spinal cord injury from four paraplegic rehabilitation center were interviewed. Sports participation was 60% in people with spinal cord injury (n = 61/102). Strong family support, financial security, and institutional support in the form of motivation and training facilities were the top facilitators. Barriers faced during participation in sports were difficulty in reaching the sports ground, lack of disabled-friendly toilets, and accommodation. Reasons for not participating in sports were lack of self-motivation, poor fitness level, and low confidence attributed to disability.

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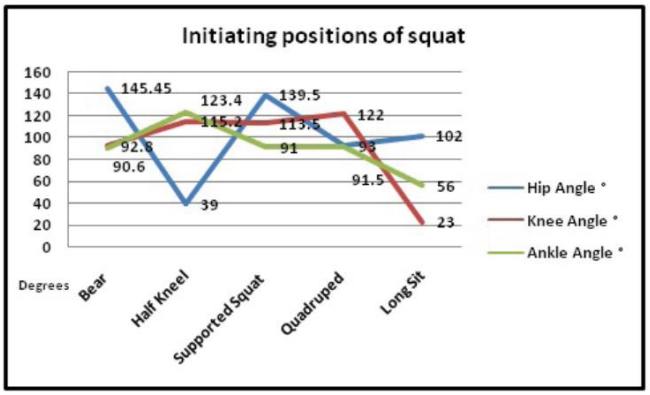
Research Thrust Area

Exploration of traditional ground level activities for healthcare application

Changing lifestyle has brought about a phenomenal reduction in physical activity profiles of people, globally. Deleterious effects of sedentary lifestyle such as decrease in joint mobility, low muscle strength and loss of function, are gaining attention. The World Health Organization recommends 150 min/week of regular engagement in moderate-vigorous physical activity. Various researchers have demonstrated benefits of accumulating activity in any form to meet this net total score. Although, people now recognize the need for engaging in exercises to improve cardiorespiratory fitness, activities of daily living that contributed to non-exercise activity thermogenesis (NEAT) are becoming extinct. People have given up high flexion activities such as squatting, sitting down cross leg on the floor and kneeling. Ability to sit down on the floor and get up without support is now recognized as a prognostic marker predicting longevity. Hence, we are exploring the influence of regular engagement in ground-level activities on muscle activation, joint mobility, postural control and participation and health related quality of life among healthy people and patients with knee osteoarthritis.

❖ Development of the Deep Squat Milestone in Typically Developing Children (*manuscript published*)

Rajani Mullerpatan, Meera Thanawala, Bela Agarwal & Sailakshmi Ganesan



Deep squat is a functional activity recruiting multiple muscle groups in a single manoeuvre with huge potential value in paediatric rehabilitation following neuro-musculoskeletal dysfunction. Current study was designed to explore development of the deep squat milestone, patterns of movement adopted for attainment, and lower-limb joint motion during deep squat in typically developing children. Following ethical approval and parental consent, data were recorded from 12 normally developing children, aged 6–13 months, using video cameras in the natural environment of each child every consecutive month. Hip, knee, and ankle joint angles were computed using Silicon Coach software. Descent of squat was attained first, followed by ascent from squat one month later. The average age at which typically developing children initiated supported/ unsupported descent to deep squat was 11 months; supported ascent from squat was initiated at 12 months. Ascent from deep squat to upright posture was broadly noted from three initiating postures: bear followed by half kneeling and then supported squat. Timing of ascent from squat was observed to be one month after reported attainment of pull-to-stand reported at 11 months.

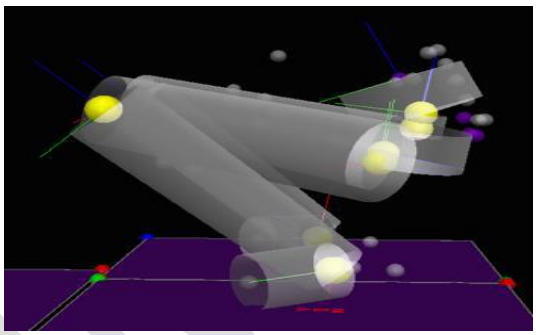
❖ Birthing experience of women who have undergone normal deliver in a selected community of India. (*manuscript published*)

Nancy Fernandes Pereira, Shobha Gaikwad, Andrea Hemmerich, Rajani P Mullerpatan and Bela Agarwal

A study was conducted on "Birthing experience of women who have undergone normal deliver in a selected community of India". The purpose of the study was to provide support & comfortable position to women during birthing process. A qualitative research approach was used to analyze the interview & content analysis was done. Finding of the study revealed that work experience of ANM (Auxiliary Nurse Midwifes) & ASHA workers, was important because with increase in number of cases they felt skillful & confident. In terms of facilities for delivery it was identified that there was no special arrangement of rooms available, they had to conduct delivery single handedly, and the position for delivery commonly used was the traditional position supine position with legs flexed & drawn towards the abdomen. Findings related to the mother evolved over their experience because all the mothers wanted a pleasant experience of delivery. The study concluded that squatting position which is adopted in daily activities of life among Indians which increased the pelvic dimension is not used during child birth.

❖ **Influence of pelvic segment definition using landmarks palpated in a high flexion posture on joint angles and moments (*published*)**

Andrea Hemmerich, Rajani Mullerpatan, Tara Diesbourg, Bela Agarwal, Emily Geens, Triveni Shetty, Geneviève Dumas



Several studies have demonstrated presence of motion artifact during high impact activities such as running, however the quantum of motion artefact during high flexion activities remains unquantified. We compared joint angles at the hip and lumbo-sacral joint using palpated and digitized anatomical markers in squat posture to angles measured using routine 3D motion capture technique where markers are placed in standing posture. We observed that hip flexion angles were lower whereas lumbo-sacral angles were higher for palpated pelvis model compared to skin marker model which may be due to a caudal shift of the PSIS marker during squat. Moments were not influenced by marker models which may be due to relatively consistent position of center of mass and inertial properties of the pelvis.

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Research Thrust Area

Clinical Rehabilitation

Biomechanical exploration of impairments of children and adults with neuro-musculoskeletal conditions such as cerebral palsy, Parkinson's disease, lower extremity amputation, knee osteoarthritis, sports injuries, dance injuries, etc. has unraveled exclusive clinical features of Indian patient population at various stages of involvement and socio-cultural specific needs for clinical rehabilitation.

❖ Gait Deviation Index of Children with Cerebral Palsy with Severe Gait Impairment (published)

Triveni Shetty, Rajani Mullerpatan, Ashok Johari

The gait deviation index (GDI) is a comprehensive tool derived from three dimensional gait analysis providing averaged kinematic data from the pelvis, hip, knee, ankle, and foot. Lack of information on the GDI of children with severe gait impairment characterized by high crouch angle (> 20°) motivated our group to explore GDI at different levels of the gross motor function classification system (GMFCS). Forty-seven ambulatory children (5–18 years) with cerebral palsy (CP) (28 males; 19 females) with a mean crouch angle 20.15° were compared with 45 normally developing healthy children. The GDI of children with CP was 25% lower than that of age-matched healthy children and 13%–27% lower than that of children with less severe crouch angle (2.2°–18.9°) at similar functional levels reported in the literature. Significant linear decline was observed in GDI across GMFCS I (70), GMFCS II (65.42), and GMFCS III (44.6). Out of nine kinematic variables computed to calculate GDI, minimum knee flexion in stance was three times greater (6.9°) among children at GMFCS I and two times greater (16.1° and 37.39°, respectively) among children at GMFCS II and III compared with children at similar GMFCS levels reported in the literature.

❖ Lower Extremity Muscle Strength and Endurance in Ambulatory Children with Cerebral Palsy (published)

Triveni Shetty, Sailaxmi Ganesan, Rajani Mullerpatan

Muscle weakness in children with cerebral palsy (CP) results in inability to produce isolated maximum voluntary muscle contraction from individual muscles results in stereotypical movements, consequently, early fatigue during ambulation causing further deterioration in muscle endurance. Limited information on lower extremity muscle strength and muscle endurance based on functional tests drove the present study with a purpose to inform clinician variation in lower extremity muscle strength and endurance in children with CP. Thirty children with CP (15 males, 15 females, GMFCS level I–II) and 30 age-matched healthy children were evaluated for muscle strength and endurance using functional tests such as 30-second chair stand test, step-up test, timed up and go test, timed floor to stand test, 30-meter walk test, calf-raise test, and 14 stair climb test. Performance of children with CP was 54–73% lower on all tests compared to healthy children. In conclusion, markedly lower strength and endurance of all major lower extremity muscle groups, namely, hip flexors, hip extensors, hip abductors, knee extensors, and ankle plantar flexors, reiterates a strong need for objective functional evaluation and targeted training to improve ambulatory performance in children with CP. Gender and GMFCS level did not influence strength-endurance evaluation.

❖ Evaluation of Daily Walking Activity in Patients with Parkinson Disease (published)

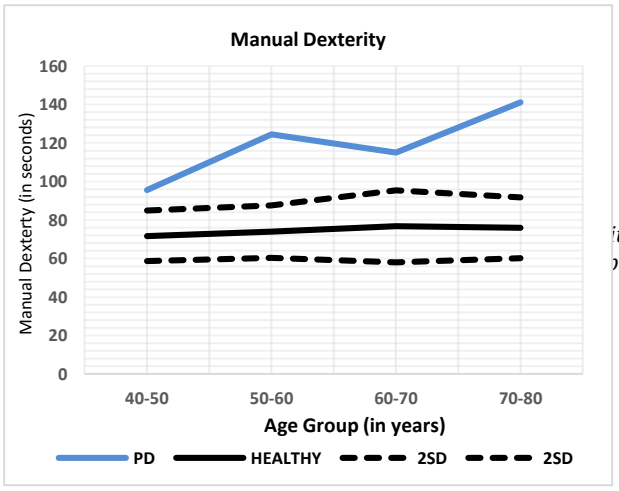
Akanksha Pisal, Bela Agarwal, Rajani Mullerpatan

Parkinson disease limits walking, and little is known about the performance of walking and factors that influence the quantum of walking in active, city-dwelling patients with mild to moderate Parkinson disease in an environment characterized by extended family support but limited access to public spaces. An exploratory study was performed to evaluate daily walking performance and the influence of an intrinsic factor—namely, balance during standing—and the extrinsic factors habitual physical activity and health-related quality of life in people with Parkinson disease. Daily walking activity was recorded with a step activity monitor for 8 consecutive days in 15 patients with Parkinson disease (Hoehn and Yahr scale score, 1–3). Patients with Parkinson disease demonstrated 17% lower engagement in long-duration activity and a 47% lower score on the physical activity domain of the World Health Organization Quality of Life BREF instrument. A moderate positive correlation was observed between balance during tandem stance and mean number of daily steps.

❖ A Study of Fine and Manual Hand Dexterity among People with Parkinson's Disease (published)

Tosha Shah, Mamta Shetty, Meruna Bose, Rajani Mullerpatan

Dexterity evaluation is pivotal in assessment of hand function during rehabilitation of people with Parkinson's disease. Scarce information on hand dexterity in Parkinson's disease (PD) using standard tools, prompted present study, aimed to evaluate fine and manual hand dexterity using Minnesota Manual Dexterity Test (MMDT) and Nine Hole Peg Test(NHPT). A purposive sample of 54 people with PD and convenient sample of 54 healthy age and gender matched adults were studied using standard protocol. Average value of manual dexterity in people with PD was116.8sec and of fine dexterity was 39.5sec (left hand) and 36sec (right hand). No significant difference was noted in fine dexterity between right and left hand. The study revealed moderate positive correlation(r=0.63;p=0.00) between manual dexterity and motor function on MDSUPDRS. Low positive correlation (r=0.44; p=0.001) was found between fine dexterity and motor function on MDSUPDRS.



❖ Comparison of effects of Yoga intervention and balance exercises on standing balance in people with diabetic peripheral neuropathy

Jinny Kanjirathingal, Rajani Mullerpatan, Girish Nehete, Nagaratna Rao

Diabetic peripheral neuropathy (DPN)is known to cause impaired balance and eventually increase risk of fall. Yogasanas, hold potential for training balance control. Therefore, the current study aimed to evaluate the effect of structured Yogasana intervention on static and dynamic balance performance among people with diabetic neuropathy. Thirty- five people with diabetic peripheral neuropathy aged 42-70 years were recruited, to Yogasana intervention group following ethical approval. Balance performance and lower extremity strength demonstrated improvement among Yogasana intervention group ($p \leq 0.05$) post 12-week intervention. Post hoc comparison revealed that Yogasana intervention was marginally more effective to improve static and dynamic balance performance compared to conventional balance exercises in all variables of standing balance performance($p \leq 0.025$).

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Research Publications

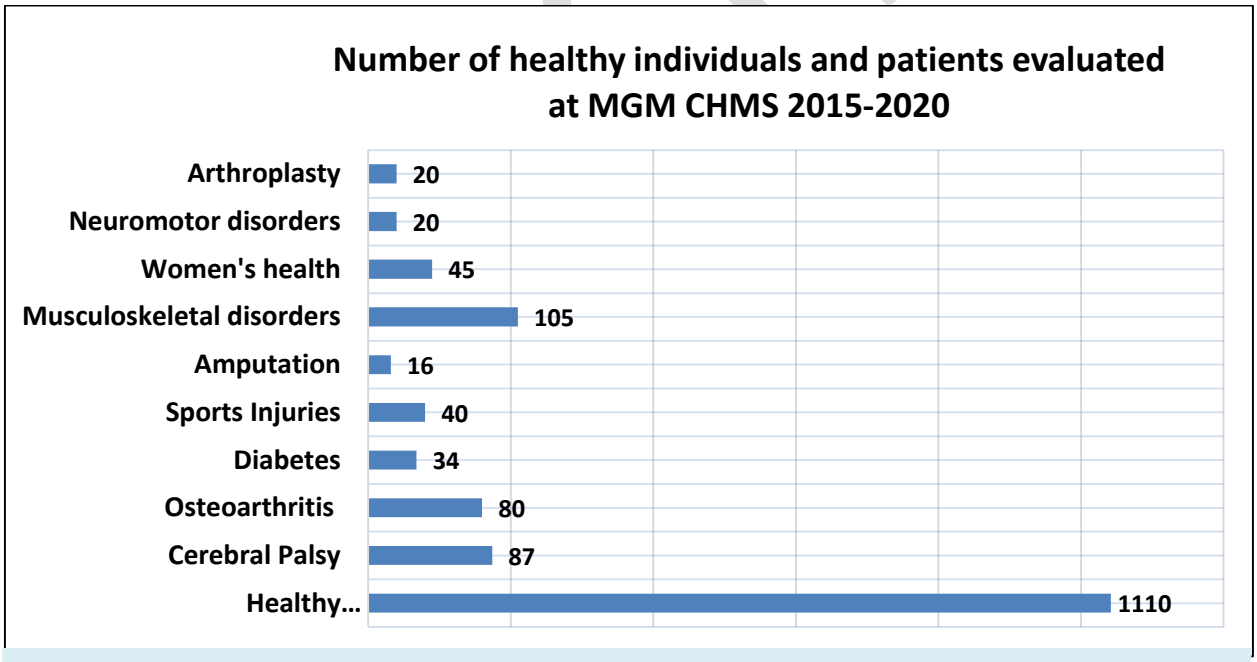
Sr. No	Title	Authors	Journal	Year	Database Indexing
	Exploration of Yoga				
1.	Exploration of muscle activity using surface electromyography while performing Suryanamaskar	Rajani Mullerpatan, Bela Agarwal, Triveni Shetty	International Journal of Yoga	2020	PubMed
2.	Kinematics of Suryanamaskar using three-dimensional motion capture	Rajani Mullerpatan, Bela Agarwal, Triveni Shetty, Girish Nehete, S.N. Omkar	International Journal of Yoga	2019	PubMed
	Dance Biomechanics				
3.	Evaluation of Standing Balance Performance in Indian Classical Dancers	Juhi Bharnuke, Rajani Mullerpatan	Journal of Dance, Medicine and Science	2020	PubMed
4.	Gait Kinematics in Bharatanatyam dancers with and without low back pain	Rajani Mullerpatan, Juhi Bharnuke, Claire Hiller	Critical Reviews™ in Physical and Rehabilitation, Medicine	2019	Scopus
5.	Survey of Musculoskeletal Disorders among Indian dancers in Mumbai and Mangalore	Shruti Nair, Shruti Kotian, Rajani Mullerpatan	Journal of Dance, Medicine and Science	2018	PubMed
	Clinical Rehabilitation Cerebral Palsy				
6.	Review of lower extremity function following SEMLS in children with cerebral palsy	Rajani Mullerpatan, Triveni Shetty, Sailakshmi Ganesan, Ashok Johari	Critical Reviews™ in Physical and Rehabilitation Medicine	2019	Scopus
7.	Exploration of Gait Deviation Index in children with cerebral palsy with severe gait impairment	Triveni Shetty, Ashok Johari, Sailakshmi Ganesan, Rajani Mullerpatan	Critical Reviews™ in Physical and Rehabilitation, Medicine	2019	Scopus
8.	Exploration of sports participation in children with mild intellectual disability	Priyanka Iyer, Triveni Shetty, Sailakshmi Ganesan, Shruti Nair, Nagmani Rao, Rajani Mullerpatan	Critical Reviews™ in Physical and Rehabilitation, Medicine	2019	Scopus

Research Publications

Sr. No	Title	Authors	Journal	Year	Database Indexing
		Amputation/Disability			
9.	Review of Contextual Factors Influencing Function Following Lower Extremity Amputation in Low to Middle Income Countries	Rajani Mullerpatan, Megha Sonkhia, Blessy Thomas, Swagatika Mishra, Abhishek Gupta, Bela Agarwal	Critical Reviews™ in Physical and Rehabilitation Medicine	2019	Scopus
		Women's Health			
10.	Birthing experience of women who have undergone normal delivery in selected community of India	Nancy Fernandes, Shobha Gaikwad, Andrea Hemmerich, Rajani Mullerpatan, Bela Agarwal	International Journal of Innovative, Knowledge Concepts	2018	EBSCO, Index Copernicus
		Parkinson Disease			
11.	Evaluation of Daily Walking Activity in Patients with Parkinson Disease	Akanksha Pisal, Bela Agarwal, Rajani Mullerpatan	Critical Reviews™ in Physical and Rehabilitation, Medicine	2019	Scopus
12.	A Study of Fine and Manual Hand Dexterity among People with Parkinson's Disease	Tosha Shah, Mamta Shetty, Meruna Bose, Rajani Mullerpatan	Critical Reviews™ in Physical and Rehabilitation, Medicine	2019	Scopus
		Sports			
13.	Level of Sports Participation and Performance among People with Spinal Cord Injury	Oshin Amberkar, Bela Agarwal, Ruturaj Shete, Yuvraj Singh, Rajanu Mullerpatan	Critical Reviews™ in Physical and Rehabilitation, Medicine	2019	Scopus
		Ground level Activity: Squat			
14.	Influence of Varying Squat Exposure on Knee Pain and Function among People with Knee Osteoarthritis	Bela Agarwal, Manisha Advani, Robert Van Deursen, Rajani Mullerpatan	Critical Reviews™ in Physical and Rehabilitation, Medicine	2019	Scopus
15.	Influence of habitual deep squatting on kinematics of lower extremity, pelvis and trunk	Bela Agarwal, Robert Van Deursen, Rajani Mullerpatan	International Journal of Health and Rehabilitation Science	2018	Index Copernicus
16.	Comparison of Muscle Activity and Energy Cost between Various Bodyweight Squat Positions	Shreya S. Sahasrabudhe, MPT, Bela M. Agarwal, Rajani P. Mullerpatan,	Clinical Kinesiology	2017	Scopus
17.	Development of the Deep Squat Milestone in Typically Developing Children	Rajani Mullerpatan, Meera Thanawala, Bela Agarwal, Sailakshmi Ganesan	Critical Reviews™ in Physical and Rehabilitation, Medicine	2019	Scopus

Our efforts continue to explore-i) the value of squat, a traditionally practiced Indian movement for maintenance of lower extremity muscle strength, joint motion, mobility and walking capacity among people with knee osteoarthritis; ii) in order to help children with cerebral palsy undergoing single event multiple level surgery, a tool is being developed for home based monitoring of function; iii) biomechanics and energy cost of two modifications of traditional Suryanamaskar for application in elderly people (a collaborative project with Sancheti College of Physiotherapy, Pune).

Nearly 500 patients (traumatic sports/dance or mechanical injury or disorders such as cerebral palsy, stroke, Parkinson 's disease, amputations, diabetic foot complications, osteoarthritis, joint replacement) have benefitted from robust evaluation for gait analysis (at one-third of prevailing cost), balance assessment and foot geometry and pressure at markedly subsidized cost. Quantified objective reports helped surgeons, physiotherapists and prosthetics and orthoticians to plan targeted surgical interventions and therapy to optimize function after trauma/disorder.



Graphs presents number of patients and healthy participants evaluated at MGM CHMS 2015-2020

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Feedback

Students & Research Scholars

Dr. Triveni Shetty (PT), PhD Scholar (2016-Present)

"It's a great pleasure to be associated with MGM Centre of Human Movement Science, MGM School. Being a PhD student, I have been exposed to a lot of opportunities which were otherwise far from reach. The knowledge base has improved substantially under the guidance of Dr. Rajani Mullerpatan"

Dr. Jinny Paul (PT), MPT Scholar (2016-18)

"I have got the opportunity to carry out my masters' project and avail the benefits of the facilities exclusively available for the patients and myself at MGM Centre of Human Movement Sciences under the guidance of expert team."

Mr. Ajinkya S. Patil (External Project Student, Mechanical Engineering, IIT Bombay)

"I was introduced to MGM Centre of Human Movement Science through IIT-B Professor Dr. Parag Tandaiya. I worked on a project of "Experimental Biomechanics of human squatting". I had valuable guidance from Dr. Rajani Mullerpatan, Dr. Bela Agarwal, Dr. Robert Van Deursen& Dr. Andrea Hemmerich. Lab was well equipped with every resource required for research in biomechanics. All the professors working in the lab were very helpful and fun to work with. Awareness among engineers about biomechanics will promote projects in unconventional required fields of healthcare."

Mr. Giridhar Sharma (PhD Student (Ext.), IIT-Bombay and Scientific Officer-F, BARC)

"I have used the MGM CHMS lab for Gait Data Capture in 2016, this data is found to be very useful for my research on 'Foot Ground Interaction'. The lab has maintained high standard of accuracy in captured data. I am very thankful to MGM CHMS for helping me in providing data that was very much essential for my research work. Such facilities are first step to venture into field of biomechanics. The insight provided by the trajectories of the markers and ground-reaction-forces are important to fully understand any biomechanical system. Very good facility. I have been to CMC Vellore also, this is better and useful"

Feedback

Clinicians' who referred patients to MGM CHMS

Dr. Ashok N Johari, Pediatric Orthopedician (World President, International Society of Orthoepdics and Traumatology)

In the past, results in cerebral palsy were reported subjectively as excellent, good, fair and bad based on physical examination and a belief that all muscles are tight, often forgetting the aspect on weakness. Interventions were geared to make a child straight, without real consideration of the long- term outcomes of these muscle lengthening procedures. An example of this is the indiscriminate hamstring surgeries done even today, often under the guise of scar less procedures or percutaneous methods. They make the child straight in the short- term, but with questionable long term outcomes. Hamstrings contribute to 50% of total hip extensor power and are crucial for hip extension. They are probably the cause of the problem at the knees only in 1/3rd of the cases, yet often bear the brunt of inept clinical decision making. Motion labs aid in clinical decision making process and assessing outcomes objectively and can be used to learn, teach and report research findings. This is where MGM Centre for motion analysis plays a pivotal and indispensable role. The real strength of any motion lab is its core team. Dr Rajani and her team are extremely knowledgeable in every aspect of gait and the facility itself is world-class. We must work to give every child with cerebral palsy a chance of living to the best of their potential. A facility of this sort helps the clinician to consider numerous factors and dose the interventions appropriately. A decision is by far more important than an incision in children with cerebral palsy!

"One of the best gait laboratories in the country; very affordable, great colleagues; very useful for clinical and research purpose".

Dr. Tushar Agarwal (Visiting Pediatric Orthopedic Surgeon at MGMIHS, Bombay Hospital and AASTHA)

"A good gait analysis facility at MGM CHMS, can provide scientifically based and technically precise information about run cycle. This helps in identifying the biomechanical abnormalities during running that can lead to injuries and inefficiencies in the future and also help in rehabilitation of injuries. Run analysis not only helps identifying correct shoes for a runner but also helps in planning a proper flexibility, strength and conditioning regimen."

Dr. Pravin Gaikwad, Comrades 90k Ultramarathon Runner, Pediatric Physician.

Feedback

Industries

Mast. Kunj Dedhia, a X standard student from Dhirubhai Ambani International School, Mumbai.

"Throughout the research and development phase of this device, MGMCHMS has helped me in the testing phases. Testing involved, finding a correlation between the sensor values and values generated through Kinovea. The input received from Dr. Rajani Mullerpatan and Dr. Yuvraj Singh has helped me make my device scientifically accurate and valid. I have finally produced a state of the art ergonomically designed device for cyclists to prevent low back pain."

Mr. Aneesh Karma & team - MASC KAFO

"We are really thankful to MGM CHMS for adding valuable information through gait analysis for our two patient and providing objective results on our MASC KAFO. The support has given a positive assurance and confidence in presenting our results at the national platform. We look forward for continual support in future for our project"

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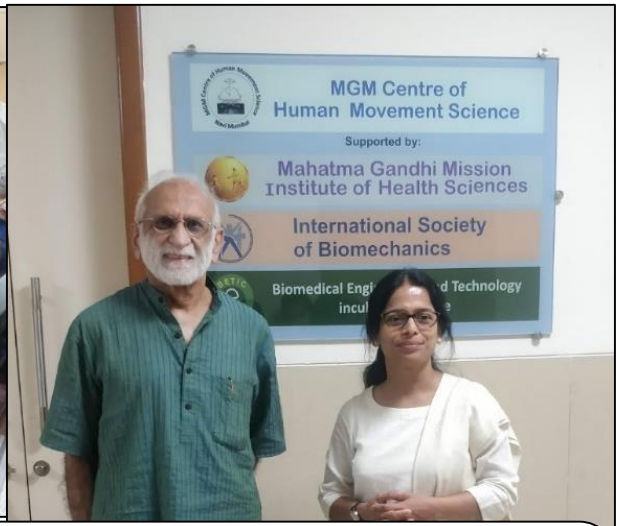
Eminent Visitors

L-R: Dr.R Mullerpatan,Dr. S. D Dalvi (Hon'ble VC, MGMIHS, Prof Ravi B, BETic, IITB, Dr. Anil Kakodkar, Director, RGSTC, Govt of India)

"Very happy to see the newly set up facility, look forward to a major thrust in interdisciplinary work, All the best !"
- Dr. Anil Kakodkar, Director, RGSTC

L-R: Dr. Prabhat Ranjan, Executive Director, TIFAC, Prof Ravi B, BETic, IITB Dr Asim Tiwari, R Mullerpatan,

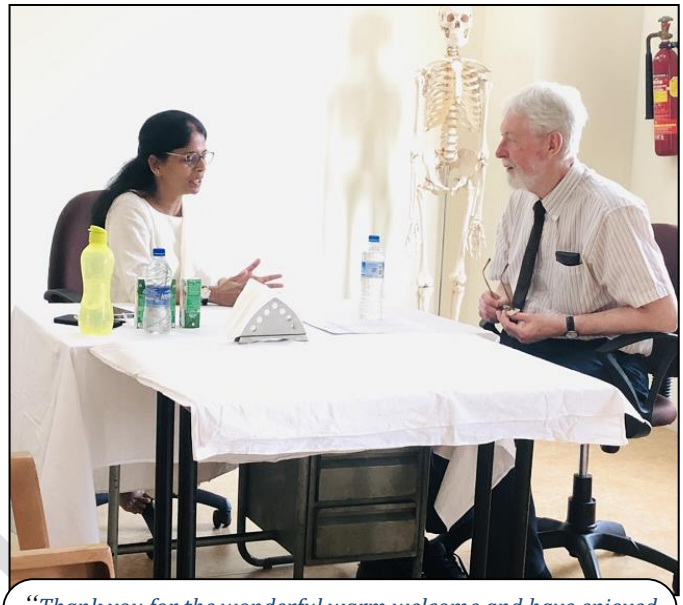


Dr Rajani Mullerpatan with Prof. Manohar Panjabi, Professor Emeritus, Dept. of Orthopedics and Rehabilitation and Mechanical Engineering, Yale University- Spine Biomechanics, Boston, MA, USA

"It was exciting for me to learn about research being done by young people. I wish you good luck with all your projects. You are planting seeds for future spine biomechanics in India."
- **Prof Manohar Panjabi**

L-R: Prof. Robert van Deursen, Dr. Raman Yadav, Dr. Vipla Puri, Dr. R Mullerpatan, .

"It has been a wonderful experience to be a part of building up of great facility so that clinical biomechanics can take off in Mumbai and hopefully as a result of this, India can become a leader in research specific to the culture and customs of the country. I look forward to a continued collaboration on this very worthy project"
- Prof Robert van Deursen, Cardiff University, UK



''Thank you for the wonderful warm welcome and have enjoyed the facility and research. Thank you"

-Prof John Reid

L-R: Dr. R. Mullerpatan, Prof. Genevieve Dumas, Professor, Dept of Mechanical Eng., Queens University, Dr. Andrea Hemmerich, Queens University.

"Wonderful lab! thank you for showing us a way. Good luck with your projects"
-Dr. Andrea Hemmerich

Eminent Visitors

L-R: Bela Agrawal, Prof. Margareta Nordin, Vice President of the World Spine Care

''Excellent visit , congratulations to the laboratory in biomechanics in India!"
- Prof. Margareta Nordin

L-R: T Shetty, Dr. R Mullerpatan, B Agarwal, Dr. Khadaga Gurung, President of Nepal Physiotherapy Association

''Thank you Dr. Rajani. It's a great innovation. Thank you so much!"
-Dr. Khadaga Gurung (PT)

L-R :, Dr. R Mullerpatan, Dr. Claire Hiller, Senior Lecturer, University of Sydney

"Great set up. All the best for ground breaking research"
-Dr. Claire Hiller

L-R: Dr. Scott Haldeman, President of World Spine care, Dr. Kim Reid, T. Shetty, Prof Manohar Panjabi, Dr. R Mullerpatan

Dr. D H Dastoor, Senior Physiotherapist, Ex-HOD, Seth G S Medical College and KEM Hospital inaugurating 3D Gait analysis workshop with Dr Rajani Mullerpatan on 1st July 2017 at MGM CHMS

L-R: Dr. R Mullerpatan, Padmashri Dr. Kanak Rele, Founder- Director, Nalanda Dance & Research Centre, Dr Bela Agarwal (PT)

L-R: Giridhar Sharma, Prof Anirban Guha, ME dept. IIT B, Dr. K. Kurien Issac, Prof., IIST, Dr. R Mullerpatan

"Excellent facility. Congrats. Hope to collaborate"-

- **K Kurien Issac**

L-R: Dr. R Mullerpatan, T Shetty, Dr. S Sujata, Prof, IITM, Prof. Marcus Pandy, Chair of Mechanical & Biomedical Eng., University of Sydney.

Thank you for allowing me to visit your world class facility. It was an honor to be here and meet with all of you"

-**Prof. Marcus Pandy**

Dr. Roshan Vania (PT), HOD Neurophysiotherapy Dept, Bombay Hospital Session with final year BPT students

"

Review and Summary

Past, present and future activities of MGM Centre of Human Movement Science in four domains namely- training, research, patient care and technology design and validation were reviewed in a meeting on 5th Oct 2020, which was witnessed by collaborators from pertinent disciplines of health and engineering from across various states of India. Keen and active participation of researchers, academicians and clinicians from government and self-funded higher academic health and engineering institutes generated constructive feedback to plan a roadmap for future initiatives synched with national health priorities and global healthcare needs.

All collaborators from health and engineering institutes and invitees from state and central government funding agencies unanimously applauded the progress of MGM Centre of Human Movement Science in all four domains of training, research, patient care and technology design and validation in last 5 years. The interdisciplinary ecosystem created at MGMCHMS from collaborations between government and self-funded higher academic health and engineering institutes at national and international level emerged as an exclusive hallmark feature of the Centre.

Maximal utilization of facilities at the Centre to offer training in human movement science to students and research scholars of Masters and PhD programs in health and engineering disciplines across the country was appreciated. Original scientific contribution made by the Centre to build knowledge base in form of a Chapter on biomechanics of indigenous movements to a fundamental Textbook of Basic Biomechanics was highly commended. Opportunities were identified to introduce these credit based training modules to students from various health and engineering institutes who will benefit from the new Education Policy 2020.

Participants also praised attempts of the Centre to provide high- end investigation technology at most subsidized rates to patients with movement disorders to assist clinicians to plan targeted interventions for effective treatment.

Scientific exploration of Indian traditional movements adopted in daily life, Yoga, sports and classical dance forms to promote human movement as a therapeutic device; received special attention because it also serves as a conduit for restoration of heritage. Robust biomechanical exploration of Yoga in the land of origin of Yoga was commended.

Researchers acknowledged access to the state of art gold standard technology facilities available at MGMCHMS necessary for design and validation of innovative devices in the field of rehabilitation; because robust validation added value to the devices which were awarded by BIRAC, (Department of Science and Technology).

The immense value of contribution of work conducted at MGMCHMS to the wider perspective of health promotion and technology design and validation was echoed. Based on valuable, critical suggestions offered by visionaries in health and engineering, the Centre has planned future initiatives.

Prof. Shashank D Dalvi, Vice- Chancellor

"On the occasion of 5 years completion and celebration of MGM Centre of Human Movement Sciences under MGM School of Physiotherapy with MGMIHS, Navi Mumbai, the Chief Guest for function, Dr. Anil Kakodkar Sir (Chairman of Rajiv Gandhi Science & Technology Foundation), Honorable Chancellor-Dr. Kamalkishore Kadam Sir (President of MGM Trust), Dr. P.M. Jadav Sir (Vice Chairman), Dr. Nitin Kadam Sir (Pro.Vice Chancellor), Dr. Sudhir Kadam Sir (Former Vice Chancellor) in who's regimen, MGM Centre of Human Movement Science has be initiated. All the dignitaries and the interested persons or stakeholders who has jointly helped for this particular Centre and are present on this occasion, I would like to mention their names too. Dr. Sanjay Mishra, Dr. Rajiv Parashar, Dr. Geeta Lathkar, Dr. Subodh Tiwari, Dr. Chandarpuri, Dr. T.M. Shrinivasan (Former Pro-Vice Chancellor), Savita Ram Madam (Director of Research, MGMIHS), Vanita Shenoy Madam (Dean of Dental College)-members of MGM Institute of Health Sciences, Dr. Rajani Mullerpatan (Professor-Director, MGM School of Physiotherapy), Dr. Bela Agarwal, Dr. Triveni Shetty, Dr. Juhi, Dr. Rinkal Khanna and all the MGMIHS participants.

I am very happy on this particular occasion. Journey what you have shown Dr. Rajani Madam, in past 5 years we have worked a lot. But again, I would say that, what you have mentioned about the slow walking, there is a more need of showcasing of our MGM Centre of Human Movement Science, with respect to maximum use for the clinical services as number of patients are not aware about the Centre. You have performed very good activities in the field of research such as training, more than 11 workshops and technical validation. Thus, the Centre is working in the direction of all the four objectives that were planned.

I am also very happy that in the Post-Covid area the Physiotherapy Department is particularly playing role in rehabilitation of the patients by implementing Pulmonary exercises to restore the breathing capacity. As this Centre has been in collaboration with BETiC-IIT-Bombay, all the high-tech equipment's are available here, maximum utilization of this Centre should happen.

I am very happy to see all the stakeholders at this occasion. I wish all the success and best wishes on this occasion to this Centre. In the future, this Centre will earn more and more laurels. As you have already mentioned in the book, a chapter regarding the information about this particular Centre, that is appearing in the Bible of the Biomechanics field. Biomechanics being a new area which is unexplored, it will provide more advantage for research, clinical services and technical validation.

Thank you for inviting me on this occasion and Best wishes. Thank you everyone."

Dr. Sabita Ram, Research Director, MGM Institute of Health Sciences, Navi Mumbai

"It a privilege to congratulate the MGM Centre of Human Movement Science (MGMCHMS) on completing 5 years of dedicated service in training students, research, clinical service, technology design and validation. The Centre is unique and considered as one of the Centres to be reckoned nationally as a Centre of Excellence in Human Movement Science for their contribution to healthcare. The Centre has encouraged research and a number of organisations have approached the Centre for validation of their ingeniously designed. The faculty has documented research and have published research papers in high impact journals which speak of their zest to disseminate findings among other researchers. The Team works on collaborative studies with mechanical Engineers of IIT Bombay, Queen's University, Canada; Human movement scientists from Cardiff University, UK and Canadian Indo-Shastri Foundation. They have spread their wings not only nationally but internationally. I am sure the Team of Physiotherapy with the enthusiastic Captain, Dr. Rajani Mullerpatan will take the Centre to newer heights .I wish them all the best for their future endeavours"

Dr. Raman Yadav, Technical Director, MGM Innovation Incubation Centre

"On this occasion I would like to congratulate Dr. Rajani Mullerpatan and her team for their endeavor for the progress of this Centre. I heard number of things during the meeting today. One thing I would like to mention, all though you have started the Centre as Interdisciplinary Centre, you are providing good space for the Scientist, Clinicians as well as the other members to work together along with the Engineers. What I know about your Centre is that you are exploring the potential of the Biomechanics. But being a Scientist of the new phase of Biomechanics, I would like to suggest few things:

1.In this Centre, if Biomechanics can be extended for the Molecular explanation or Biochemical explanation of the Biomechanics which will be the new phase in the Global Scenario. Although we have a collaboration with you for one of the projects where you are working on the Biomechanics and our team is working on the Biochemical explanation of that movement.

2. One Transcultural Research in the Human Movement Science. If you see the strategy in our Country, European Country or Western region is totally different. So, what type of this scientific things can be explained and we can benefit out of it needs to be explored.

3. Another important area to be highlighted is Rural Area: In Rural area, there are different types of skills that can be recorded and classified at the efficiency level. That efficiency level can then be translated into the technology in the future.

Example: Climbing in the South India. Number of Biomechanics can be explored particularly in the Rural areas. Dr. Rajani Mullerpatan is already doing things such as training, education, research and validating the technology at MGM Centre of Human Movement Sciences. MGMIHS is always open for new domains in Research and Innovation which in turn attracts Researchers and Innovators of high caliber. Hence, we have a good scope. Thank you, I wish success to you and your team in the future."

Dr. Geeta Lathkar, Director, MGM College of Engineering, Nanded

"Honorable Chief Guest, Dr. Anil Kakodkar Sir (Chairman of Rajiv Gandhi Science & Technology Foundation), Honorable Chancellor- Dr. Kamalkishor Kadam Sir (President of MGM Trust), Honorable Vice Chancellor-Dr. Shashank Dalvi Sir, all the dignitaries, members of MGMIHS and participants, I am very happy to be a part of this meeting. Engineering and Medical fields can work together in this journey. I read about Biomechanics, the first credit of work in Biomechanics goes to Aristotle because he studied the movement analogy of animals with machines followed by Leonardo da Vinci who studied anatomy in correlation with mechanical movements and many more. Biomechanics existed since ancient times such as in Archery.

I happen to recollect a recent incidence. During NCC parades, we insist that a cadet should be standing with a 45-degree angle between the feet. I found that in this foot position, body can be maintained in standing posture for longest duration. A dear friend of mine performs testing of vehicles and does consultation for car manufacturers. He also studies impact of collision of cars with other stable objects or objects in motion by setting the mannequins with sensors in the vehicles to monitor the probable injuries.

In a television documentary, forces generated by the jaws of wild animals during clutching were studied. I observed an improved Posture, Gait and Attitude in one of my students who has joined Navy, may be due to Defense force training. Biomechanics is involved right from our movements in day to day activities, Yoga, Dance, Sports and so on. Study of Biomechanics play an important role to enhance our performance, prevent injuries or for rehabilitation. As far as Engineers are concerned Mechanical Engineers play an important role in improving the materials used in composites or to study the mechanics for improving the performance.

An exoskeleton was designed for mathadi workers to reduce fatigue during repetitive work. It has reported to reduce fatigue by 25%. Mechanical Engineers, Physicist, Chemists, Biologists, Electronic Engineers (can contribute to Signal sense system), Computer Engineers (can contribute to stimulation part) all can contribute to a collaborated study with Biomechanics study team. Study can also be taken to fluid dynamics.

With this collaboration, the Engineering students will be able to work towards the interest of the society and comfort of the mankind which is the need of the time. Engineering and Medical college co-exist in MGMIHS, hence a stronger association between the two fields can be carried with interdisciplinary opportunities for carrying out the research in concurrence with new education policies. I look forward for a strong and longer association. Thank you."

Dr. M. C. Mishra
Former Director-All India Institute of Medical Sciences

"At the very first outset, I would like to congratulate Dr. Rajani Mullerpatan on 5 years completion of MGM Centre of Human Movement Sciences. I visited the Centre 3 years ago, progress there on has been immense, very significant and very encouraging for me. It definitely depicts and conveys your passion towards this specialty and what relief it can bring to the users after your interventions. You are saying that with your interventions Knee Replacement can be delayed by 10 years, I would rather say in some of them Knee Replacement may not be even needed after your intervention which should be our exact goal when we are dealing with such mechanisms and non-operative interventions by investigating motion science in these patients.

So, I have no doubt that you are doing excellent and outstanding work in India which is unparallel work, I haven't seen it anywhere with this passion. I am now in Sharada University in Greater Noida; I am going to ask people who are working in this area to get in touch with you and get some inspiration from you to establish something similar here. Keep going with this passion and keep raising your bar. Soon there will be no boundaries to it.

What I would look forward in future would be modern prosthesis for upper limbs and lower limbs (as we seen in developed countries) at an affordable cost because India is still limited in fine, light and affordable prosthesis needed for amputees. It is a huge area which still needs to be worked upon. There are few charitable Institutes working on it such as one in Rajasthan named Mahavir Sansthan. They are doing a wonderful job by providing this prosthesis, similarly there is an Artificial Limb Centre in Pune for armed forces. Particularly for individuals who cannot afford expensive prosthesis, it serves as a limiting factor for them. If you can depute someone with interest in this area that would be remarkable and is much needed in our country. Low-income groups suffer the most. I discussed with you when I visited the Centre that disability adjusted life year lose due to injuries exceeds more than Heart Diseases and Cancer according to WHO data. Injury may keep occurring in the future. There is a drop noticed in the accident rate in this pandemic but after the lockdown it has come back to original numbers.

Thank you for inviting me. I could know what you have accomplished so beautifully and effectively. My request to you is to continue with this passion and raise your bars. Develop certain groups amongst your team and choose those who can take up the different areas in this field. What you are doing is a humongous work. I hope to get more insights of your work in future. Thank you to MGMIHS for exposing me to this field at your Centre. I look forward for more information from you in this area. I request you to share the link of this meeting with me so that I can forward it to the Dean of Paramedical Sciences here and ask him to get in touch with you. Thank You. "

Professor Robert van Deursen
Cardiff University

MGM Centre of Human Movement Science after 5 years

The MGM Centre of Human Movement Science is a movement analysis laboratory that started only 5 years ago. One floor in the newly constructed hospital in Vashi, Navi Mumbai was adapted for this purpose. Immediately after building work and equipment installation was completed, the team started with an ambitious programme of research, development, education, and clinical service.

The Centre is unique in many ways but one of its main strengths is the close collaboration between physiotherapy researchers and biomechanical engineers. Together they deliver research and innovations that are essential for patients in need of rehabilitation. The combination of fundamental and applied science is an important strategy to ensure progress can be made in this clinical specialty. A lot remains to be achieved to optimize diagnosis and treatment for the benefit of patients. The Centre is well placed to deliver on this agenda at a local, national, and international level.

Students passing through the Centre benefit from this state-of-the-art facility and from the creativity and dedication with which this team is operating. This provides future clinical practitioners, researchers, and designers with a fantastic role model.

I was honored to attend the inauguration ceremony. The Centre has been tirelessly on the move from the word go. The next 5 years will build on the outstanding achievements to date. It will be truly rewarding to witness that the MGM Centre of Human Movement Science becomes a Centre of excellence in the near future. Congratulations to the team on their wonderful progress and success.

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MGM Centre of Human Movement Science,
Annual Meeting: Monday, 5th October 2020
Past, Present and Future

Time: 9.00 a.m. – 1.30 p.m. **Mode:** Online Zoom platform **Attendees: 35**


Zoom Meeting
Recording...
Rajani Mullerpatan
Mr.Nitin
T. M. Srinivasan
Kamalkishor Kadam
Dr Sabita Ram
Shashank Dalvi
MGM CHMS
MGM CHMS
Mahesh Mishra
Girish Nehete
Dr Raman Yadav
Anil Kakodkar
Rita Khadkikar
Arun Sapre
Pro-Vice Chancel...
raju parasher
Prashant Mullerp...
Ramesh Lekurwale
Sujatha Srinivasan
Ravi Bhalamudi
Sai Baba M
Vrushali Panhale
Rohan Kothurkar
Chander Puri
Director MGMCEN
1/2
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❖ **Meeting Agenda**

MGM Centre of Human Movement Science

MGM School of Physiotherapy,
MGM Institute of Health Sciences, Navi Mumbai

Annual Meeting: 5th October 2020

Past, Present & Future of MGM Centre of Human Movement Science

Meeting link: https://zoom.us/j/8992680728

Tentative Agenda

Time	Activity	Speakers
10.00 a.m.	Opening Remarks	**Shri. Kamalkishore N Kadam**, Chancellor, MGM Institute of Health Sciences, Navi Mumbai
10.10 a.m.	Opening Remarks	**Prof. Shashank Dalvi**, Vice-Chancellor, MGM Institute of Health Sciences, Navi Mumbai
10.20 a.m.	MGM Centre of Human Movement Science – 5 Year Journey	**Dr. Rajani Mullerpatan**, Director, MGM School of Physiotherapy, Navi Mumbai
10.30 a.m.	Recent Progress: Patient Care, Training, Research & Validation of Technology	**Dr. Triveni Shetty** (PT), **Dr. Juhi Bharnuke** (PT), MGM CHMS, Navi Mumbai
10.40 a.m.	Future Initiatives & Updates (Society of Biomechanics in India)	**Dr. Bela Agarwal**, MGM School of Physiotherapy, Navi Mumbai
10.50 a.m.	Roadmap to establish National COE in Human Movement Science & National Centre for validation of Movement pertinent Technology	**Invitees** (DST, Society of Indian Physiotherapists (SIP), MUHS Physiotherapy, AYUSH, NIAS Bangalore, SVYASA Bangalore, AMITY Noida) **& Partners** (IISc Bangalore, IIT-Madras, IIT-Guwahati, KJ Somaiya College of Engineering, Kaivalyadhama Yoga Institute)
11.20 a.m.	Association with BETIC: Past, Present and Future	**Prof. B. Ravi**, Founder, BETIC, Mechanical Engineering, IIT-Bombay
11.30 a.m.	Potential Collaborations with Internal and External Stakeholders	**Prof. Geeta Lathkar**, Director, MGM College of Engineering, Nanded
11.40 a.m.	Concluding Remarks	**Dr. Anil Kakodakar**, Chairman, Rajiv Gandhi Science & Technology Commission
12.00 noon	Vote of Thanks	**Dr. Rajani Mullerpatan**, Director, MGM School of Physiotherapy, Navi Mumbai

Meeting Participants

MGM IHS Board, MGM CHMS Collaborators, MGM CHMS Team & Invitees

Virtual Room will be open from 9.30 a.m. | Meeting will start at 10.00 a.m.

Please call Dr. Juhi B (PT) at +91- 8169497069 in case of any difficulty. Thank you

Host: Dr. Rajani Mullerpatan, MGM Centre of Human Movement Science, MGM Institute of Health Sciences Navi Mumbai

- **Graced the occasion**

Chairman

1. Dr. Anil Kakodkar, Chairman, Rajiv Gandhi Science and Technology Commission, Mumbai

Dignitaries

2. Shri. Kamalkishore Kadam, Chancellor, MGM Institute of Health Sciences, Navi Mumbai
3. Prof. Shashank Dalvi, Vice Chancellor, MGM Institute of Health Sciences, Navi Mumbai
4. Dr. Nitin Kadam, Pro Vice Chancellor, MGM Institute of Health Sciences, Navi Mumbai
5. Dr. Sabita Ram, Research Director, MGM Institute of Health Sciences, Navi Mumbai
6. Dr. Chander Puri, Former ProVC Research, MGM Institute of Health Sciences, Navi Mumbai
7. Dr. Raman Yadav, Director, MGM Innovation Cell, MGM IHS, Navi Mumbai
8. Dr. Sanjay Mishra, Department of Science and Technology(DST), Government of India
9. Dr. Sai Baba M, National Institute of Advanced Studies (NIAS), Bangalore
10. Dr. Mahesh Mishra, Former Director, All India Institute of Medical Sciences, New Delhi
11. Dr. Rita Khadkikar, Internal Quality Assurance Cell head, MGM Institute of Health Sciences
12. Dr. Arun Sapre, Rajiv Gandhi Science and Technology Commission
13. Dr. Raju Parasher, President, Society of Indian Physiotherapists (SIP)
14. Dr. T.M Srinivasan, Swami Vivekananda Yoga Anusandhana Samsthana, Banglore
15. Dr. Geeta Lathkar, Director, MGM College of Engineering, Nanded
16. Dr. Prashant Mullerpatan, S L Raheja Hospital and Research Centre, Mumbai
17. Dr. Sona S, Sancheti College of Physiotherapy, Pune
18. Dr. Rinki Gupta, AMITY University, Noida

Collaborators

19. Prof. Ravi Bhallamudi, PI/Founder, BETiC, IIT-Bombay
20. Dr. Subodh Tiwari, Director, Kaivalyadhama Yoga Institute, Lonavala
21. Dr. Ashok Johari, World President, International Society of Orthoepdics and Traumatology
22. Dr. Ramesh Lekurwale, K J Somaiya College of Engineering, Mumbai
23. Mr. Girish Nehete, Yoga Practitioner
24. Shastri Indo-Canadian Institute, New Delhi
25. Dr. S.N. Omkar, IISc Banglore,
26. Dr. Kanagaraj, IIT-Guwahati, Assam
27. Dr. Sujatha Srinivasan, IIT-Madras
28. Dr. Rohan, IIT-Guwahati, Assam

Faculty & Students

29. Dr. Vanitha Shenoy, Dean, MGM Dental College, Navi Mumbai
30. Dr. Srivalli Shrikanth, MGM Dental College, Navi Mumbai
31. Dr. Vrushali Panhale, Principal, MGM College of Physiotherapy
32. Dr. Mansee Thakur, Director, MGM School of Biomedical Sciences, Navi Mumbai
33. Dr. Triveni Shetty (PT), Core Team, MGM Centre of Human Movement Science
34. Dr. Juhi Bharnuke (PT), Core Team, MGM Centre of Human Movement Science
35. Dr. Poonam Desai (PT), PhD Scholar, MGM CHMS, MGM School of Physiotherapy, Navi Mumbai.

Future Initiatives

MGM Centre of Human Movement Science has planned future initiatives in training, research, patient care and technology design and validation based on its experience in last 5 years.

Training: In an attempt to bridge the gap in integrated biomechanics knowledge of health and engineering graduates, the Centre plans to scale its existing efforts nationwide; to offer a credit choice based module on Clinical Biomechanics to graduates and research scholars in a blended mode environment, which is in tune with the objectives of new Education Policy 2020. The Team at MGMCHMS is compiling a Textbook of Biomechanics of Indigenous Movements; which will serve as a resource material to inform this science to students, researchers, clinicians and engineers working in provision of healthcare and design of pertinent technology. A Yogasana evidence based brochure is in the making for easy reference of clinicians, Yoga practitioners and grass root level healthcare workers to execute evidence based Yoga practice.

Research: Covid 19 pandemic has awakened us to notice our negligible investment in public health. In order to strengthen our efforts to adopt movement as a therapeutic device for health promotion and reduction of burden of non-communicable diseases and delay disability caused by movement disorders, we have planned to scale the collaborative interdisciplinary research model. Successful outcome of interdisciplinary research model engaging health and engineering research scholars of Masters and PhD programs has motivated us to plan larger number of interdisciplinary research projects to achieve the goal of applied translational research to enhance function of people with movement disorders and reduce disability.

Patient-care: Lack of e-evaluation tools for early detection, measurement, function monitoring and rehabilitation based on appropriate clinical algorithms prompted the Team at MGMCHMS to develop mobile-based technology to promote movement as a therapeutic device for people with musculo-skeletal, neurological & cardio-respiratory disorders, amputation, etc.

Technology design and validation: e-Hackathons in rehabilitation technology are in the planning for designing innovative technology for enhancement of movement performance and reduction of disability caused by movement disorders. The Centre has planned to reach out to various Innovation Centres across India to inform them of availability of robust, gold-standard technology available for validation of technology pertinent to rehabilitation.

Enthused response from dynamic researchers in the field of human movement science has initiated the activity of forming a vibrant National Society of Biomechanics/Human Movement Science for development of this science in India and represent internationally as an affiliate Society of International Society of Biomechanics.

Team, MGM Centre of Human Movement Science

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Acknowledgements

The dream of MGM Centre of Human Movement Science (MGMCHMS) was conceived and nurtured by several visionaries to develop Human Movement Science in India for academic and societal benefit. The Centre will remain grateful to each one of them for its existence and growth.

MGM Institute of Health Sciences(MGMIHS) took a strong initiative to develop Human Movement Science in India and established MGMCHMS in October 2015 with generous support from International Society of Biomechanics and BETiC IITB. Chairman of MGM Trust & Chancellor, MGMIHS, Shri Kamalkishore Kadam and previous and present members of MGMIHS, particularly-Former Chancellor Prof. K.G.Narayan Khedkar and Former Vice Chancellor Dr. Sudhir Kadam, Vice-Chancellor, Prof. Shashank Dalvi, Former Vice Chancellor Prof. R.D. Bapat, Pro Vice-Chancellor Dr. Nitin Kadam, Former Pro Vice Chancellor Lt. Gen Dr. S.K. Kaul, Former Pro Vice Chancellor Research Dr. Chander Puri, believed in integrating biomechanics in healthcare and supported this dream. The Registrar of MGMIHS, Dr. Rajesh Goel, Research Director, Dr. Sabita Ram and Medical Superintendent of MGM Hospital Kamothe, Lt. Gen Dr. K.L. Salgotra has always helped enthusiastically in execution of various activities.

Dr. Anil Kakodkar inaugurated the Centre in recognition of the need for developing biomechanics in India to address unmet needs in healthcare. The Team looks up to his commitment to guide and support the mission of MGMCHMS. Prof. B. Ravi, Founder & PI, Biomedical Engineering and Technology Innovation Centre (BETIC) has been a rock pillar, since the inception of MGMCHMS and continues to be unassumingly supportive and our guiding lighthouse!

The Team is grateful to International Society of Biomechanics(ISB) who helped this initiative with massive support for equipment and expertise for planning and installation of the motion capture system. Former members: President, Prof. Anthony Van Bagert, President, Prof. John Challis, Affiliate Societies Officer, Dr. Andrea Hemmerich and Dr. Bart Koopman from ISB played exclusive roles in creating this facility. Prof. Robert van Duersen, ISB Member supported the Centre immensely, right from planning and installation of equipment and continues to participate in the research activities from Cardiff University, UK. We express our deep gratitude to Mr. Andy Ray, Vicon, UK; Mr. Gary Blanchard, AMTI, USA and Mr. Peter Seitz, novel, Germany for their generous equipment donations to get MGMCHMS started with necessary equipment.

MGMCHMS is thankful to its collaborators, particularly, Dr. Rupesh Ghyar, BETiC and Prof. Abhishek Gupta from IIT Bombay; Dr. S.N.Omkar, Indian Institute of Science Bangalore; Dr. Sujatha Srinivasan, IIT Madras and Dr. Kanagraj, IIT Guwhati for engineering expertise.

We are thankful to expert clinicians who utilize this facility for robust objective investigation of movement disorders particularly Dr. Ashok Johari, Director, The Enable International Centre for Paediatric Musculoskeletal Care, Dr. Tushar Agarwal, Pediatric Orthopedic Surgeon along with Dr. Roshan Vania (PT), Head of Dept, Neurophysiotherapy, Bombay Hospital and Dr. Rahul Kadam, Dr. Bhushan Patil and Dr.Atul Bhaskar, Orthopedic Surgeons.

The Centre continues to strive for excellence with untiring, utmost efforts of its dedicated Team, which includes core members- Dr. Bela Agarwal (PT), Dr. Triveni Shetty (PT) and Dr.Juhi Bharnuke (PT). We will remember Dr. Jyoti Chatla (PT), who supported the Centre in the beginning and are grateful to all our research associates (Dr. Bindiya Sharma (PT), Dr. Megha Solanki (PT) and Dr. Blessy Thomas (PT)), PhD scholars, MPT Scholars, Faculty members, Interns and students of MGM School of Physiotherapy and PhD and M.Tech Scholars of IIT Bombay.

The Team thanks all our friends, well-wishers and family members who have immensely supported us always.

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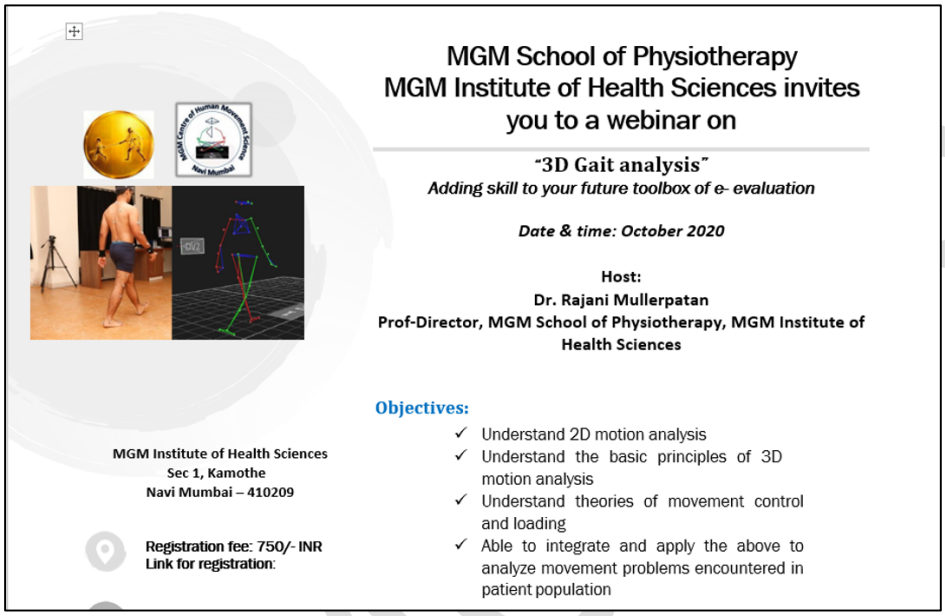
Notes

Courses Offered:

3D Gait Analysis – Adding skill to your future toolbox of e-evaluation



Clinical Biomechanics

Course Title:	Clinical Biomechanics and Human Movement Analysis
Course Description	Value Added Course **Mode**: Online/Blended
Course Duration	4 weeks
Credits	8
Hours	24 Theory + 16 Practical = 40 hours 6+4 hours/week = 10 hours/week 6+2 =8 credits
Course Instructors	Dr Rajani Mullerpatan, Dr Bela Agarwal (PT), Dr Triveni Shetty (PT) and Dr Juhi Bharnuke (PT), MGM School of Physiotherapy, MGM Institute of Health Sciences, Navi Mumbai
Beneficiaries	Bachelor of Physiotherapy, Master of Physiotherapy, BTech and MTech students
Course Objectives	Understanding normal and pathological joint motion, gait and biomechanical determinants of motion Methods of motion capture and analysis Gain skills in 2D motion capture

04-12-2020 MGM Centre of Human Movement Science, MGM SOP, MGMIHS, NM

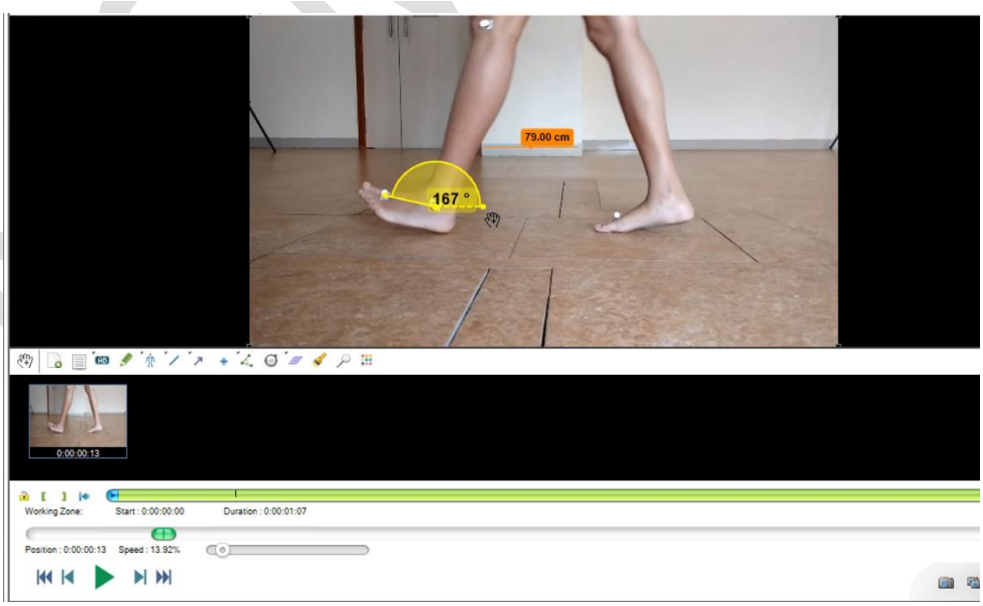
Other courses offered:

Detection, Awareness and Management of Cerebral Palsy

Value Added Course

Title	**Detection , Awareness and Management of Cerebral Palsy**
Department	MGM School of Physiotherapy , MGM IHS , Navi Mumbai
Venue	MGM School Of Physiotherapy , Navi Mumbai
Course objectives	1. Understand normal development. 2. Identify high risk babies / babies at risk of development of cerebral palsy (based on etiologies) 3. Identify the red flags for diagnosis of cerebral palsy (based on developmental sign and symptoms) 4. Understand Cerebral palsy, level of function, severity & needs of children with cerebral palsy. 5. Understand whom to refer / referral framework for children with cerebral palsy

One-day Virtual Training Webinar on 2D analysis of Motion



How to reach us:

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