Leonardo® Mechanograph®

Objectives

- Analysis of anaerobic peak power output and maximum voluntary force
- Objective quantification of muscle function
- Motion analysis, power assessment and progress control
- Identification of movement asymmetries
- Documentation of the success of therapy or training
- Easy to use, fast application, high reproducibility of results

Fields of Application

- Research
- Medical
- Physiotherapy
- Sport
- Fitness

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Novotec Medical GmbH

The quality of all Leonardo measurement systems is permanently assured by a TÜV-monitored quality management system acc. to ISO 13485:2003.

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The main objective of Leonardo Mechanography is to provide efficient quantification of functional human movement based on physical parameters. Leonardo Mechanography analyses functional everyday movement patterns because results are highly reproducible across a large age group from children to the elderly. Leonardo Mechanography offers essential advantages for clinical use, allowing the simple quantification of peak force, peak power and left-right differences of movement patterns. It requires no additional complex measurement devices, no time-consuming subject preparation, it is easy to use and results are produced within minutes.

Measurement Method
Human movement can be quantified objectively based on the physical parameters. Leonardo Mechanography measures dynamic ground reaction forces and calculates the centre of mass related physical parameters including acceleration, velocity, energy, power, jumping height and stiffness or flexibility. In addition, asymmetries of the motion pattern can be analyzed directly during a physiological movement since the ground reaction force platform is split into halves. The acquired spatial resolution of the measured forces allows statobilometric analysis, for example, during various types of balance tests.

Leonardo Mechanograph® Series
The Leonardo Mechanograph series includes the standard system Leonardo Mechanograph GRF® which has been used in various international studies to date.

In addition it includes the compact and portable Leonardo Mechanograph GRFT which has been optimised for efficient use in every clinical application.

The Leonardo Mechanograph GW is a modular system which applies various jumps, the chair rising test (well established in the field of geriatrics) and various balance tests. In order to determine the performance of the human body it is essential to utilise motion patterns close to their limits. The built-in assessment function automatically selects the most relevant test per patient and measurement day (counter movement jump, one-legged hopping, chair rising test) and generates a compact report for the most relevant outcome parameters concerning muscular performance.

Power Assessment. Up to now mainly endurance based test types have been established in medicine and sports to characterize the individual muscular performance (e.g. cycle ergometer). Typical endurance power outputs of a human body are in the range of 100 to 300 Watts. Every day functional movements however need much higher peak power output (e.g. getting up from a chair: 1000 Watts, stair climbing: 1500 Watts, counter movement jump: 4000 Watts). This short duration anaerobic peak power is an essential component of mobility and autonomy in every day life. Leonardo Mechanography allows the fast, easy to apply and at the same time highly reproducible measurement of this important parameter of specific functional movements resulting in the highest peak power output: the two-legged jump for maximum height (counter movement jump). The comprehensive reference data set (for 3 to 99 years of age) allows the comparison of individual peak power depending on weight, age and gender. In the case of highly deconditioned individuals who are not able to perform a jumping test the Leonardo Mechanography software offers the chair rising test as an alternative which is well established in the field of geriatrics.

Voluntary Peak Force. Voluntary peak force is another important parameter of mobility. It is essential for the characterisation of the muscle-bone relation. In order to measure this voluntary peak force the subject has to be asked whether he can generate the power with one-legged hopping on the foot sole. When taking into account the lever arms that most muscles in the human body act on, it becomes obvious that a ground reaction force of typically 3.3 times body weight for a healthy individual results in a force of 10 to 15 times body weight on the tibia and the joints above it. These peak forces are essential for the regulation of bone mass and bone strength (Mechanostat). Keeping in mind that simple star class exercise easily exceed 100% of body weight (equivalent to almost 60% of the maximum available peak force of a typical fit individual) the dramatic effects of a loss in voluntary peak force (e.g. by lack of physical activity or pain) become obvious. Therefore the voluntary peak force is another essential component to characterise and quantify muscular function and mobility.

Balance Tests. In the field of geriatrics various balance tests have been established to evaluate coordination, proprioception, fall risk and neuromuscular competence. The Leonardo Mechanography software supports various balance tests (Romberg, Semi-Tandem, Tandem, one-legged stand). The software supports output parameters which are well established in statobilometry and posturography including path length, covered area and frequency analysis.

Examples of Applications

Geriatrics. International studies have shown that muscle power is an essential parameter to determine fall risk and fracture risk. In the geriatric field the chair rising test has been established, which can be analysed in detail when performed on the Leonardo Mechanograph. Instead of simply measuring the time per iteration, the Leonardo Mechanography software can also analyse force peaks, power peak and left-right differences for each repetition of the test. Since the chair rising test lacks significance for fit individuals the Leonardo Mechanography software also offers jumping tests. The counter movement jump for maximum height generates the highest peak power output of all functional movements and therefore is ideal to characterise muscular performance. Comprehensive reference data makes this individual performance and the efficiency of the movement comparable between individuals.

Paediatrics. Muscle performance is an essential component of mobility and autonomy for everyday life. Especially in the field of chronic diseases Leonardo Mechanography is especially ideal to quantify the physical status and to document each individual’s therapy success.

Orthopaedics & Physiotherapy. In the fields of orthopaedics and physiotherapy it becomes increasingly important to evaluate and to document the success of therapy. Apart from the objective quantification of physiologic movement patterns the Leonardo Mechanograph also allows the quantification of left-right differences of the locomotion apparatus. This offers an essential advantage because a more-symmetric movement pattern is typically an obvious measure for physiotherapy success.

Clinical Studies. Leonardo Mechanography is the ideal tool to quantify muscular function based on locomotor movements. The software includes reference data from age 1 to 99 to make results of different studies comparable in terms of muscular function. Many international studies already use this approach for objective and reproducible analysis of intervention results and to allow easy comparison to other studies. Leonardo Mechanograph’s detailed analysis allows to pin-point the physical aspect of movement the selected intervention is focused on. An additional benefit offers the combination of Leonardo Mechanography and pQCT (peripheral quantitative computer tomography) in order to assess the functional muscle-bone unit (Mechanostat). The research version of the software includes an additional statistics module allowing the easy application of statistical analysis on sub groups and easy export of the resulting data.

Fitness & Sports. The fast and easy to apply measurement method of Leonardo Mechanography allows the efficient use of muscular performance assessment without time consuming subject preparation. A single test can be performed in 1 minute, a standard assessment in 5 minutes. In addition the symmetry of motion can be detected and quantified and motion patterns can be optimised according to the measured force curves. The Leonardo Mechanograph is an ideal tool for efficient training control and the documentation of training success.

Your Benefits

Measurement of anaerobic peak power. Leonardo Mechanography is the ideal tool to extend established performance tests. These devices like the bicycle ergometer measure the aerobic performance (endurance power). Leonardo Mechanography measures the anaerobic peak power which is imperative for functional movements like chair rising or lunging to avoid a fall.

Conclusive functional principle. Since Leonardo Mechanography is based on functional everyday movements it can be applied to a wide age and performance ability range. From children to the elderly, from obese to elite athletes - i.e. a new dimension in objective and comparable analysis of muscular function.

Detailed analysis results. Leonardo Mechanography allows the quantification of anaerobic peak power, voluntary maximum force and asymmetries of the locomotor system during physiological movements. A variation of balance tests can also be performed due to the Leonardo Mechanograph’s spatially resolved data acquisition. Detailed analysis of the chair rising test is possible when using the optional, easily mounted bench.

Efficient and fast analysis of muscle function. Leonardo Mechanography measurement procedures are time efficient, easy to instruct and measurement results are highly reproducible. No special subject preparation is required which makes Leonardo Mechanography easy to integrate into the daily workflow. A single measurement takes only a minute - a standard assessment takes only five minutes.

Wide range of application. Leonardo Mechanography can be used in research, clinical applications, physiotherapy, in fitness as well as in elite athletes.

Easily comparable results. Leonardo Mechanography includes comprehensive reference data ranging from 3 to 99 years of age. Due to the wide age and performance ability range that can be analysed using the same methodology Leonardo Mechanography is the ideal tool to compare many different fields of applications. Leonardo Mechanography is the ideal method of quantifying muscle function in clinical use, sports, fitness and research.

Monitoring rehabilitation progress. Leonardo Mechanography’s simple and quick application. Its comprehensive assessment of muscular function and ability to quantify asymmetries make it the ideal tool to monitor therapy and training effects after muscle or tendon related injuries. It allows the accurate documentation of the individual’s therapy success and monitoring of muscle function.