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PREVENTION OF WORK-RELATED MUSCULOSKELTAL PROBLEMS AMONG DENTISTS IN PORI DENTAL CARE CENTER

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Purpose of this thesis was to promote wellbeing at work among dentists at Keskushammashoitola in Pori (Pori dental care center) by providing knowledge of ergonomics and effective exercises to prevent and reduce musculoskeletal problems. The aim was to provide an information package, containing knowledge of ergonomics, information of the most common musculoskeletal problems and ways to prevent those.

Furthermore, the purpose of the thesis was to discuss relationship between work-wellbeing and physical workload in dentistry and to determine the factors forming physical workload and musculoskeletal disorders.

Theoretical information studied in this thesis included information about, work-wellbeing, workability and importance of work for one's life. Furthermore, the role of motor learning and motivation were considered in relation to work related physical behaviour. To conclude, ergonomics, work related musculoskeletal disorders and the process of this thesis were discussed. This thesis was written based on available literature, observations and interviews.

CONTENT

1 INTRODUCTION

Employees' wellbeing has been a popular topic over past few years in Finland and elsewhere. It has been discussed significantly as work is closely related to individuals' health. Moreover, lengthening of careers has been current issue in the working life and therefore individual wellbeing and workability has become common interest in both employers and employees. (Website of the Finnish Pension Alliance 2013.)

Dental work is physically and mentally loading. Musculoskeletal problems are common among dentists and one of the main occupational hazards affecting dental personnel. Studies in Finland and elsewhere have shown that 70% to 95% of dentists suffer from musculoskeletal problems. (Roivainen & Hatakka 2007, 28.) High demands of dental work arise from demanding patient interactions, workload, timed schedules and high physical demands. (Hakanen, Bakker & Demerouti 2005, 471.) Furthermore, working on patients' mouth is visually demanding. Fine-tuned and forceful movements and working in awkward postures for long periods of time, set requirements for dentists' musculoskeletal system. (Lindfors, Von Thiele & Lundberg 2006, 192.)

According to a report conducted 2006 by Finnish dental association number of burnouts among dentists have risen. In public sector 53% of dentists were suffering from light to moderate burnouts. In private sector 22% of dentists are suffering from work related stress. In contrast, 53% of dentists experienced positive feelings and had fullfilling state of mind towards their work. (Website of Finnish dental association 2013.) Research suggests that mental stress can create muscle tension similar to caused by physical load. (Lindfors, Von Thiele & Lundberg 2006, 196.)

Ergonomics play an important role in promotion of work well- being and employees' workability. Physical loading in dental work can be diminished by ergonomics, therefore, it is important that dental personnel are provided with adequate information of how to reduce works' physical loading and how to take care of their musculoskeletal health in order to prevent problems and maintain workability.

2 PURPOSE AND AIM OF THE THESIS

Purpose of this thesis is to promote wellbeing at work among dentists at Keskushammahoitola (Dental care center) in Pori by providing knowledge of ergonomics and effective exercises to prevent and reduce musculoskeletal problems. The aim of this thesis is to form an information package, containing knowledge of ergonomics in clinical dentistry, information of the most common musculoskeletal problems among dentists and ways to prevent those.

3 WORK WELLBEING AND WORKABILITY

Work is important for a human as it produces satisfaction, it allows individuals to develop their talents and skills and the result of work is meaningful for the worker. Moreover, it contributes to individual identity and creates social status. Work has an effect on an individual self-esteem as it creates individual feelings of success; I know and I can. By being part of a work organization gives a feeling for the employee of belonging to something and being part of a bigger whole. However, it should be noted work is not one's whole life and that physical and psychological aspects of work can also be predisposing factors for health hazards. In contrast, there is strong evidence that worklessness is harmful for human. It causes poorer general health, psychological distress causing mental health problems and higher medical consumption. (Waddell & Burton 2006, 9.)

3.1 Work wellbeing

Work wellbeing is a broad term which has several definitions. According to Finnish institute of occupational health work wellbeing means that working is enjoyable and fluent in a safe and health enhancing environment which supports individual development in the work community. This definition has been used in several texts. However, the term does not have one generally accepted or scientifically verified definition. (Website of Finnish institute of occupational health 2013, Website of Interna-

tional ergonomic association 2013.) Person who experiences wellbeing is satisfied with his work, is interested in, committed, resilient, competent and efficient. (Website of Finnish institute of occupational health 2013.)

Work wellbeing can also be defined by employees' well-being in relation to productivity of the organization. This definition is called strategic well-being (strateginen hyvinvointi). Employees' wellbeing and organizations' productivity go hand in hand when aiming to strategic wellbeing. (Website of Confederation of Finnish industries 2013.) Otala and Ahonen (2003, 33) suggest that work wellbeing is an individual feeling of wellbeing. Nonetheless, it is also overall wellbeing of entire work organization. Work wellbeing is formed by an individual from physical, social, emotional, environmental and occupational experiences within one's workplace. It is employees as well as employers responsibility (Gould, Ilmarinen, Järvisalo & Koskinen 2006, 17).

Work engagement (työn imu) is in the center stage when talking about work-wellbeing. The term describes the positive enjoyment and enthusiasm towards work. It does not refer to momentary flow, but longer lasting state of mind towards ones' work. In other words, an individual who experiences work engagement goes happily to work in the morning, enjoys the work he does, is proud of what he does and is persistent when facing adversities. Complexity of work engagement and interactions that are involved in it can be seen in figure 1. The figure shows that work engagement and feelings of indisposition (referring to work related fatigue, tiredness or burnout) are placed opposite to one another to show that there is a thin line between those two states. However, it does not mean that if a person who is not experiencing excitement would automatically suffer from depression or who is not satisfied with work would automatically experience anxiety. The figure allows us to consider the complexity of work wellbeing and adverse feelings that are reducing it. Moreover, it gives us an idea how changes in wellbeing can lead the person from one state to another. (Hakanen 2009, 8.)

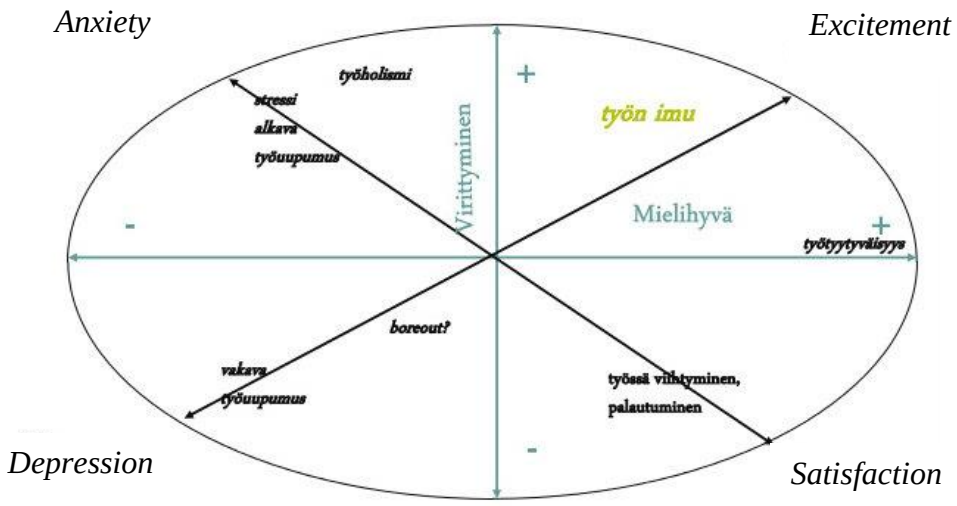

Figure 1. Work wellbeing is multidimensional phenomenon (Hakanen 2009, 8)

Work wellbeing is a continuous process of development to modify the work and workplace so that each employee has a possibility to experience feelings of success and happiness at their workplace. It is a complex process that can be looked at from different perspectives. Work wellbeing is as complex as a human being. Otala & Ahonen (2003, 33) state that human being is an individual, composed from mind, feelings and physical body and he must have balance in every aspect of the body to enjoy wellbeing at work.

3.2 Work ability

The term work ability came along in 1990 in Finland when it was used to describe the aim and a target of occupational health care. The term was born due to ageing population and disability pension politics. The term work ability can be seen from different perspectives. It can be seen from medical point of view when the sickness or one's health is in the center stage when evaluating individual's work ability. In this perspective work ability is evaluated by diagnosing sicknesses and changes in individuals' health. Second way to see work ability is to make use of work ability model, where individual resources are compared to demands of work and the aim is to develop balance between those. In this case work ability is evaluated by measuring

individuals' functional capacity and demands of work. The third way to look at work ability is integrated viewpoint of work ability where the activity is in a center stage and it can be evaluated by analyzing the distractions in the functions and activity. (Martimo, Antti-Poika & Uitti 2010, 162.) Work ability is a balance between individuals' physical and psychological resources and demands of work. In this thesis the concept of workability is defined by using Ilmarinen's multidimensional work ability model. The model suggest that workability has a relationship between the productive potential of a worker, the worker's individual characteristics, the work itself and its' demands, the work environment and the work organization. Dimensions of the term workability can be seen in the house model, figure 2. (Gould, Ilmarinen, Järvisalo & Koskinen 2006, 23.)

The house has 5 floors and a roof. The basement, three floors from the bottom up; health, functional capacity, competences, values and attitudes builds up the individual resources for work. The basement can be made stronger by health enhancing living habits and working environment which supports individuals' health. The stronger this floor is, the better it can take the load from the other floors. (Gould, Ilmarinen, Järvisalo & Koskinen 2006, 22, Ilmarinen & Vainio 2013, 5.) In other words the better the individuals' health and functional capacity, the better it can meet the requirements and demands of working life. Therefore, it is important to promote the employees' wellbeing and provide an environment which supports it. The second floor; competences, which include individuals' knowledge and skills for work, can be strengthened by training programs and providing knowledge which supports an individuals learning at work. To meet the demands and changes of working life, it is necessary to maintain the competences and skills. Ideally, the work offers its' employees' continuously new learning experiences. (Ilmarinen &Vainio 2013, 5.)

Fourth floor is a work floor that includes characteristics of work; working environment, work itself, work demands, work community, management and organization. All these aspects are under the roof term, workability. Workability incorporates with the individuals' family, friends and those organizations that provide support for workability for instance occupational health care and occupational health and safety. The most outer layer is the society which forms an infrastructure that composes the macro environment for workability. Workability and work wellbeing are results of

how individual resources meet the demands of work. (Gould, Ilmarinen, Järvisalo & Koskinen 2006, 22.)

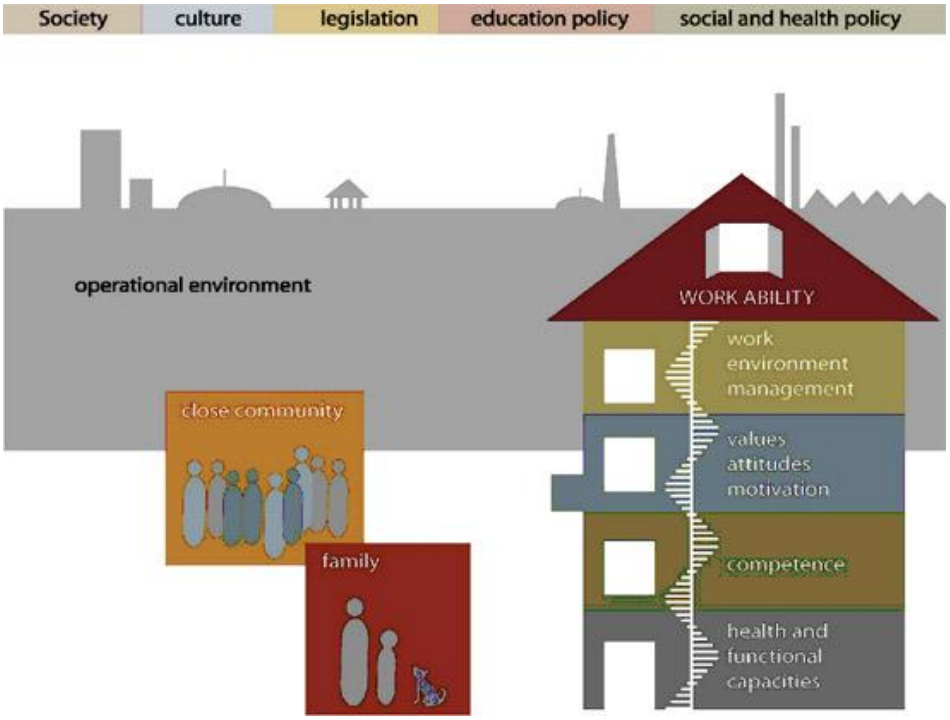

Figure 2. Multidimensional work ability model (Website of Finnish institute of occupational health 2013)

3.3 Changes in work ability

It has been predicted that in 2060 every third person is over 65 years old (Website of Finnish government 2013). The problem is global. However, in Finland the number of elderly is increasing more rapidly than in many other countries. These changes in population will set challenges for the society. Challenges will include need for workforces, pensions and health care system to adapt to these changes and to changing economic situations. (Website of Finnish government 2013.)

There has been considerable amount of discussion about what would be the most beneficial way to carry out the process of lengthening careers. It has been suggested that supporting individuals' work ability so that people are able to stay in work forces for longer period of time could be one option to be considered. Mental health

problems and musculoskeletal disorders have been mentioned to be the biggest threads to individuals' work ability. Occupational health is currently working on those two factors aiming to reduce them. The second option to lengthen the careers is to develop or modify work for ageing individuals and ensure the demands of work are adapted to ones' work ability. (Website of KEVA 2011.)

Individual resources change during the working life, therefore it is important that workability and demands of work are tried to keep in balance continuously. Ageing is one factor that reduces resources for work. However, evaluating the changes in workability is demanding because same time the age may be reducing factor, increasing factor can be for instance the competences that are strengthened as the years worked increase. Therefore, balancing the demands and resources is challenging. This thesis concentrates on the relationship between physical demands of work and employers' wellbeing. As mentioned, workability provides a basis for work wellbeing. Without it an individual is not working and with poor workability it is impossible to enjoy work wellbeing. Therefore, the changes in individuals' workability have a strong relation with work wellbeing. (Ilmarinen & Vainio 2013, 9.)

According to Ilmarinen & Vainio (2013, 6), workability is reduced in 30 % of employers during working life. In contrast, in 10 % of employees' workability increases and in rest, it stays somewhat similar throughout the working life. One cause for reduction of workability is poor ergonomics and inadequate physical activity. Therefore ergonomics and physical activity should be encouraged and promoted among employees, to maintain workability and well-being at work. Employees' health can be improved through health promotion at work places which aims to improve employees' wellbeing and maintain their functional capacity. Physical inactivity together with other health problems is a risk factor for sick leaves and reduced workability. (Fogelholm et al. 2007, 13- 16).

4 MOTOR LEARNING AND MOTIVATION FOR CHANGE

Motives are theoretical terms which are used to explain reasons for human behavior. It has been studied that individuals' operate due to importance they give for their functions. In order to initiate actions, motivation and decision making are needed. In everyday functions one do not need conscious involvement or free will. In contrast, when learning something new, individual needs executive function, meaning that there is a need to develop mechanisms; that one would be able to choose an aim, to initiate function and to make decisions concerning use of operational models. In addition, there has to be mechanism which initiates plans and directs and maintain concentration throughout the process. (Herrala, Kahrola & Sandström 2009, 119.) Inner motivation often arises when an individual finds a conflict between an old and a new operational model. Furthermore, interests towards something new arise often when the need for change is proportioned to individuals' needs, expectations and earlier knowledge. (Kukkonen et al. 2001, 237.)

Often when initiating new actions there is a need to develop new skills. Learning physical skills happens through motor learning. To change work related physical habits or behavior often involves learning new motor tasks. Motor performance and well performed ergonomics have an effect on individual productivity as well as national economy. Work related musculoskeletal disorders produce considerable amount of disability and sick leaves. It has been studied that over million Finns are suffering from chronic musculoskeletal disorder. Approximately every fifth doctor's appointment is due to these problems. Hereditary factors create individual forms and models for moving. However, those can be changed and developed through motor tasks. Motor learning is a lifelong process and it has been studied that motor performance can develop still after hundreds of thousands of practices. (Kauranen 2011, 10.)

Motor learning occurs when individual learns new movement sequences. It has been defined as a set of processes which with practice leads to fairly permanent changes in the capability for producing skilled action. In addition, learning produces permanent changes in one's behavior and it involves learning new strategies for moving.

(Shumway-cook & Woollacott 2001, 27.) Due to motor learning, a human being adapts to demands of an environment as well as communicates and functions within. Motor learning makes permanent changes in neural connections in central nervous system, changing motor performance. Therefore, if an individual learns work related motor tasks wrongly it is more time consuming to change those connections than learn new tasks. However, changing the motor performance is also considered as motor learning. Motor learning experiences can be seen in conscious efforts where individual develop motor performance in particular functions or tasks. Usually an individual has an aim for motor learning. The aim determines the target and the final situation where one is aiming in motor learning. (Kauranen 2011, 291-292.)

When motor skill that is practiced improves, memory trace in central nervous system strengthens. This phenomenon is called consolidation. Motor learning is a chain of events where the first step is seen as an improvement which occur as individual practice. Memory traces are developed. Motor learning includes usually two stages; implicit and explicit stages. Implicit learning occurs unconsciously and explicit occur when individual follows strict advices of how the task is done. Motor learning includes five different phases. First phase is rapid learning phase that happens at the first practice. During the second phase the learning slows down and the performance gets better after practicing the skill several times. Third phase is consolidation phase where performance strengthens whilst individual is resting. A skill becomes automatic during the fourth phase and therefore requires minimal cognition. Individual do not forget the skill. Last phase of learning is retention where the performance occurs without any training after longer period of time. (Herrala, Kahrola & Sandström 2009, 119.)

During this process of motor learning individuals' memory stores an aim, plan for motor action, feedback from performance of how well the task is performed. Performance improves already during the first 15-30 minute practice and continues through next trials. Little by little individual learns to repeat the skill relatively similar way and learns to distinguish relevant matters from irrelevant. (Herrala, Kahrola & Sandström 2009, 119.)

When the skill becomes automatic the individual needs less and less cognitive function and explicit feedback for the performance. At this point individual concentrates on strengthen the skill whilst the performance becomes more and more accurate. This phase takes a relatively long time and even the performance improves it does not mean automatically that individual has learnt the skill. Retention is a sign of that learning has happened. However, it may be still difficult to transfer the skill to another environment if it has not been practiced there. (Herrala, Kahrola & Sandström 2009, 134.)

Motor learning can be result of repeating one simple function which by practice becomes automatic. To learn more demanding motor tasks requires ability to coordinate several joints and control movement patterns. Motor learning may also refer to connections between environment and motor functions, for instance when individual learns to use new work equipment. Neural activity changes always when learning repeated movement sequences or sensory motor links. (Herrala, Kahrola & Sandström 2009, 119.)

Motor learning is tied to environment and situation. Skills that are learnt in particular environment are not automatically transferred to other environments and therefore it is important that new skills that are practiced are trained in the environments where the skill is going to be used. Requirement for motor learning is that it is permanent. Motor learning can be evaluated according to how permanent learning has been achieved by practice. It can be also measured how well the individual has kept the learnt skill after finishing the practice. (Kauranen 2011, 293.)

5 ERGONOMICS

Ergonomics ergon= work and nomos= laws also known as “human factors” and “human factors engineering” is a branch of science which concentrates on developing the interaction between work and human being. It supports individuals work related physical, psychological and social needs. Even though ergonomics can be

looked at from different perspectives the common aim is to develop or modify an environment to meet individuals' needs. Commonly ergonomics are connected to paid labor. (Arakoski, Alaranta, Pohjonen, Salminen & Viikari-Juntura 2009, 41, Website of University of Eastern Finland 2013.)

Ergonomics is a broad term containing physical, cognitive and environmental aspects. Study of physical ergonomics focuses on physiological and biomechanical effects of work on human being, covering topics such as working postures, workstations, work related safety and health, materials handled and work related musculoskeletal disorders. Cognitive ergonomics support a relationship between individual and different systems at work place which employees operate with. It concerns individual's cognitive processes and one's ability to process information, for instance technological solutions used at work. The third branch of ergonomics, the organizational branch concerns organizational processes, structures and policies at workplace. This includes communication within the workplace, working hours, work processes and co-operation within operators. (Website of International ergonomic association 2013.)

Work-related physical loading can be managed by ergonomical arrangements. Working environment can be organized so that it supports individual's health and optimizes one's work performance. Environment, furniture, lighting, temperature and surrounding noises can either support or disable individual's performance at work. Unsupportive working environment has an effect on employees' health. It may cause reduction in satisfaction, inefficiency, mistakes, dysfunction, health hazards and accidents. In contrast, in optimal working environment individual's performance is optimized. Aim of the ergonomics is to bring human being and technology together and produce optimal performance, quality, minimal distraction and ensure one's safety, wellbeing and development at work. (Launis, Lehtelä & Enäjärvi 2011, 19.) The aim of ergonomics is to provide a working environment that is suitable for every individual. Ideally ergonomics provide an optimal working environment for employees, the amount of errors is decreased, individual develops at his work, is more productive and work has factors that support individuals' health (Arakoski, Alaranta, Pohjonen, Salminen & Viikari-Juntura 2009, 41.)

Ideal work station is suitable for every individual working in it. It is safe and it supports operator's health. Work postures are balanced and operator can freely change the posture whilst working. In the ideal workstation individuals' size is taken into account and short as well as tall individuals are able to work in environment which supports the individual's health. Work station should be planned so that the individual is able to access the information and equipment needed for work with reasonable effort. Organization of the work environment is important factor determining physical work load. (Launis, Lehtelä & Enäjärvi 2011, 21.)

In Finland organization of ergonomics at work places are regulated by law. Regulations concerning ergonomics can be found from occupational safety act. (Act on the occupational safety 23.8.2002/738 section 2.) The aim of the act is to improve working environment and working circumstances to ensure employees' workability and prevent occupational diseases and other physical and psychological health hazards. The clause 24§ includes the regulations of ergonomics. It states that the workstation and working equipment must be chosen and measured considering the employee and ergonomics. Equipment for use must be adjustable so that employee is able to carry out his work without predisposing for adverse loading or other health hazards. It is employers' responsibility to make sure employee has adequate space for working and possibility to change the working position, to make use of assistive tools to decrease physical load if needed, to ensure all lifting that are unfavorable for health are organized the safest possible way and repetition of tasks is minimized. (Website of Finlex 2013.)

Occupational health care has also been regulated by law in Finland. The act of Occupational health service regulates employers' responsibility for organizing occupational health care for the employees. (Act on the occupational health service 21.12.2001/1383 section 2.) The aim of the law is to prevent work related diseases and accidents to occur, to promote health and safety and employees work ability and functional capacity during different phases of their career as well as to promote good function of working environment. (Website of Finlex 2013.)

5.1 Ergonomics in clinical dentistry

Dentists own experiences as well as recent studies indicate that dental work is physically loading and therefore promoting ergonomics among dental personnel is important. Study conducted in the Netherlands concerning the effects of ergonomics in dental work, showed that promotion of ergonomic interventions is effective as 90% of dentists who took part in the study carried out the interventions given by professionals partly and 53% of participants carried out the interventions fully or nearly fully. As a result of the intervention 72% of participants reported that their worst musculoskeletal problem had either disappeared or reduced considerably during the intervention. (Droeze & Jonsson 2005, 216.)

Ergonomic interventions in dental work require changes in the working environment. However, motivating the individual to carry out interventions is equally important. (Roivainen & Hatakka 2007, 29.) Studies have shown that there is a relationship between musculoskeletal disorders and work performance. The most effective way to reduce musculoskeletal disorders seems to be interventions that concern the worker as well as the ergonomic factors within the workplace. Designed ergonomic interventions can be used to reduce health risks. Effective ergonomic intervention should be targeted to identify the risk factors that have an effect on individual's health. Identification must always be followed by an action to resolve the risks. Occupational characteristics in dentistry predisposing for musculoskeletal disorders are "cervical flexion and rotation, excessive use of small muscles, repetitive precision demanding tasks, tight grips, fixed working positions, often raised arms, limited movements and long term static load on muscles" (Droeze & Jonsson 2005, 212.)

5.1.1 Sitting at work

Sitting position provides stable working position for many occupations. (Launis, Lehtelä & Enäjärvi 2011, 174.) However, sitting has been studied to be significant health hazard predisposing individuals for many health risks. Finnish adults spend 80% of their time sitting. Sedentary lifestyle increases risk of having age related disorders and decreases productivity of work. Ministry of social affairs and health states

that everyday physical activity throughout the day must be increased and the time spend in sitting decreased. In addition, the role of physical activity in everyday life must be emphasized and strengthen among Finnish population. (Website of Ministry of social affairs and health 2013.)

In sitting, spine should be nearly in the same position than in standing. Spine has four natural spinal curves as seen in figure 3; cervical lordosis, thoracic kyphosis, lumbar lordosis and sacral kyphosis. This particular s-shape allows spinal movements to occur. Cervical and lumbar fragments are the most mobile and therefore also often the most problematic. Furthermore, lumbar spine is the most loaded part of the spine as it carries the biggest amount of weight. Changes in one vertebral curve have an effect on the three others. When each vertebra is resting on top of one another they require minimal function from active structures (muscles and ligaments) to maintain erect position. (Valachi & Valachi 2003, 1604-160, Website of Suomen selkäliitto 2009.)

Figure 3.Spinal curves (Putz & Pabst 2009, 262.)

Common problem in dentistry occur when seated without back support. Poor sitting posture and unsupported back allow lumbar spine to flatten. Vertebras are no longer resting on top of each other and the posture is causing tension to surrounding soft tissues; muscles and ligaments causing pressure changes in intervertebral disk. As a result the pressure on the disks is no longer divided equally. Consequently, there is more loading on the anterior portion of the disk. In long term, this may cause nucleus pulposus to migrate posteriorly towards spinal cord causing disk herniation. (See figure 4) (Valachi & Valachi 2003, 1605.) Herniated disk may cause compression of sciatic nerve causing radicular symptoms to lower limb. To maintain lumbar spine

lordosis in sitting without back support requires good function of vertebral muscles supporting vertebral column. When lumbar lordosis disappears and pelvis tilts backwards as seen in figure 4, distribution of load on intervertebral disks is disturbed. (Launis, Lehtelä & Enäjärvi 2011, 175.)

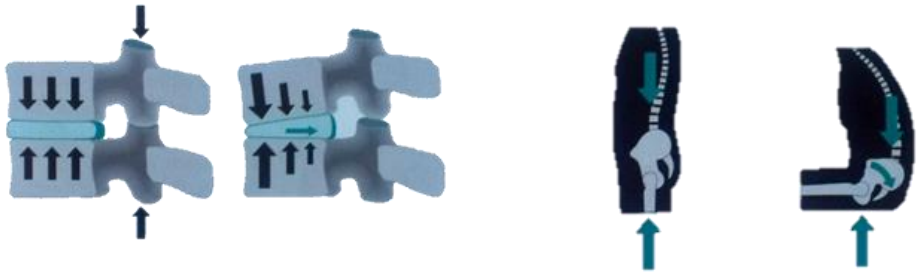

Figure.4. Loading on intervertebral disks (Launis 2011, 175)

As important as it is to maintain lumbar lordosis, it is important to maintain neutral position of cervical spine. Common problem among dentists is to develop forwarded head posture as the work is visually demanding. High visual demands force the operator to increase neck flexion and head is pushed forward. Due to this posture, dentist may develop tension neck syndrome as the muscles are over stressed by trying to maintain neutral position of cervical spine. This syndrome cause head ache and may lead to other problems in shoulder girdle function. Furthermore, disk herniation may also occur in cervical spine due to uneven load distribution. It is important that dentists strengthen neck flexors as well as stretch and relaxes over loaded occipital muscles. Forwarded head posture may also predispose individual to further shoulder girdle problems such as impingement syndrome. (Valachi & Valachi 2003, 1605.)

Stationary sitting may cause problems in back, neck and shoulder area as well as it can have an effect on function of stomach and blood circulation of lower limbs. When in sitting and leaning forward also respiratory function may be reduced and restricted. (Launis, Lehtelä & Enäjärvi 2011, 174.) In addition, poor posture is a risk factor for developing muscle imbalance which may then cause pain and limitations in movements. Limitations in range of motions then easily lead to tightness and weaknesses in the other body regions. Therefore, the posture and balanced musculoskeletal system are in the center in prevention of musculoskeletal problems. Passive struc-

tures (bony structures) are individual and cannot be changed; however every individual is able to improve the muscle function, strength and endurance. Strengthening musculoskeletal system takes time and achieved results needs to be maintained to preserve decent muscle function and effects of training. (Website of Suomen selkäliitto 2009.)

Work stool and its adjustments play an important role in prevention of musculoskeletal problems. Dentists commonly use saddle type of stool or regular chair with back rest. The basic idea of chair adjustments is that physiological sitting posture is achieved. Physiological sitting posture is achieved by increasing hip-trunk angle over 90 degrees having the feet resting on the floor. If operator is using normal chair lumbar spine should be supported against a back rest which based on the studies can help to maintain neutral position of lumbar spine and reduce risk for low back pain. In the saddle type stool the hip-trunk angle increases all the way up to 130 degrees which helps to maintain neutral position of the spine. (Roivainen & Hatakka 2007, 28) In improving body postures, the individual becomes more aware of his own body. Ideal sitting posture can be trained by sitting on iscial tuberositys also known as "sitting bones". In order to improve sitting posture, individual has to become aware of his own body. This can be achieved by carrying out different body awareness exercises. (Launis, Lehtelä & Enäjärvi 2011, 176.)

Patient documentation takes considerable amount of time from dentists' working hours and therefore it is important that the work station is suitable for the operating individual. Same rules mentioned above apply on the sitting posture while working on computer. Operator should be seated comfortably using as much back rest as possible unless the saddle type of stool is used. Feet should be resting flat on the floor and the thighs must not be compressed against the seat avoiding pressure. Key board should be placed so that the user can rest the forearms and hands on a table or on armrests. Screen is recommended to be placed below operators' horizontal eye level. (Website of Finnish institute of occupational health 2013.)

5.1.2 Placing of work equipment

One way to reduce dentists musculoskeletal loading is to place work equipment correctly. Work equipment should be used so that they are easy to reach without forceful movements with minimal effort. Dental instruments are recommended to be placed so that they are within dentists' field of vision, no more than 30 degrees away from the midline to both sides right and left symmetrically. This allows operator to pick up the instruments without turning the head or rotating the back. To avoid unnecessary arm movements reach for equipment should not be more than 30- 40 cm. (Oene, Joseph & Zijlstra-Shaw 2006, 5.)

Kipeitä paikkoja- Guide for dental personnel suggests placing equipment so that proper sitting position can be maintained whilst working. Equipment should be placed as near as possible to the hand that they are used with and so that they can be picked up using the grip that they will be used with. Instrument tray is best placed next to the patients left ear if the dentist is working together with dental nurse. Drill is placed above patients' chest area. Dental vacuum (tehoimu) is best placed on 12-1 a'clock. (Murtomaa et al. 2002, 3.) Pedal for adjusting patient chair height should be placed so that the operator can maintain neutral back position while adjusting it. (Roivainen & Hatakka 2007, 31.)

Strenuous use of force, repetitive movements and extreme variations from neutral joint alignment are risk factors for upper limb disorders and injuries. (Launis, Lehtelä & Enäjärvi 2011, 195.) Dental instrument handling requires fine-tuned, forceful and repetitive movements. This is a risk factor for developing finger- related and other upper limb related symptoms which have been studied to be common among dentists and dental hygienists. However, dental hygienists seem to present more upper extremity disorders than dentists due to work containing considerable amount of dental scaling and root planing. (Nevala, Sormunen, Remes & Suomalainen 2013, 5.)

Carpal tunnel syndrome is common among dental personnel caused by repetitive and forceful pinching and non-neutral wrist position. Most strained fingers are index and middle finger as they are the most often used in precise grips. Instrument design and material have been studied to have a relation with upper limb and finger symptoms

as well as those have an effect on perceived satisfaction and productivity at work. Recently conducted Finnish study, stated that thick silicon instruments (12-14 mm diameter) were found to be the most user-friendly and caused the lowest amount of musculoskeletal strain. Moreover, work productivity was highest using thick silicon instruments. (Nevala, Sormunen, Remes & Suomalainen 2013, 5.)

Finger arthrosis and carpal tunnel syndrome are more common among dentists than other population and it is a common reason for disability among dentists. Also repetitive and monotonous tasks have an effect on developing arthrosis. Most commonly dentists present symptoms in DIP- joints. (Website of Finnish work environment fund 2005.) To decrease load from the upper limb and from the hand it is important that dentists have adequate breaks throughout the day and they carry out some relaxing and stretching exercises involving hand and forearm. (Taimela et al. 2002, 275.)

5.1.3 Patient positioning

Patients are often positioned horizontally whilst treated by dentist. Horizontal patient positioning allows dentists to perform physiological sitting posture. (ISO/TC 106/SC 6 N 411,19.) When patient chair is lowered adequately it reduces upper limb strain. Too high patient chair require operator to raise shoulders which increases the load for upper extremities, neck and shoulder area. It has been studied that already 30 degree abduction in shoulder joint cause considerable load on the neck and shoulder region. Hatakka and Roivainen (2007, 29) states that according to earlier studies concerning dental work, dentists work one third of their working hours shoulder joints in 30 degree abduction.

Typical risk factor for dentists is cervical spine flexion as they work 82% of their working hours cervical spine in 30 degree flexion. Only maximum 20 degree flexion in cervical spine is accepted as absolute maximum. The risk for neck pain increases if 70% of working hours are performed cervical spine in 20 degree flexion. Neck flexion can be avoided by having about arm length between the patient and the dentists. Typically neck flexion occurs if the dentist is sitting too close to the patient. Neck flexion may be increased also by high visual demands. Suitable distance be-

tween dentist and patient is around 35- 45 cm. (Roivainen & Hatakka 2007, 29.) Study concerning neck pain caused by neck flexion, rotation and sitting at work suggested that individuals who spend 95% of their working time in sitting have higher incidence of cervical spine pain. Moreover, the same study stated that there is a relation between neck flexion and neck pain. (Ariens et al. 2001,205.)

Patient chair is recommended to be lowered so that it reaches dentist's thighs. In addition, the neck support is adjusted depending on if the dentist is treating patient's mandibular or maxillaris. If the patient can not lie down for medical reason dentist work in standing position. Static working postures can be reduced by changing the position as much as possible. (Murtomaa et al. 2002, 3.) Positioning patient on the correct level is important as Valachi & Valachi mention that most common mistake is to position patient too high. This causes static muscle work due to raised shoulders and abducted arms. (Valachi & Valachi 2003, 1608).

5.2 Breaks throughout the working hours

Static work requires adequate recovery. There are no specific recommendations for break times and those should be always planned according to tasks. However, common recommendation is that 5-10 minute breaks should be kept every hour. Employees' whose work requires high concentration and precision should have breaks every half an hour. Short breaks that last for few seconds which include some relaxing exercises or movements are recommended for tasks that require high concentration. (Launis, Lehtelä & Enäjärvi 2011, 71.)

It has been studied that musculoskeletal problems can be prevented by taking frequent breaks and carrying out stretching during working hours. Valachi & Valachi states that there is a relation between the hours worked and the incidence of musculoskeletal problems. Dentists seem to lose flexibility to the opposite side that they are postured during the working day. Frequent stretching and breaks have an effect on muscles' blood circulation, reduction of synovial fluid production and formation of trigger points. Moreover, breaks help to maintain normal range of motions, to in-

crease the nutrient flow to the disks and helps individual to identify tightness in his body structures. (Valachi & Valachi 2003, 1608.)

Muscle strengthening exercises are important because problems in dentistry commonly arise from fatigued muscles with stabilizing functions. Due to muscle fatigue, poor postures occur which predisposes the operator to musculoskeletal problems. It is important for dentists to exercise muscles which have stabilizing function in the trunk and in the shoulder girdle to maintain good posture. Stabilizing muscles that need to be strengthened include for instance transversus abdominis and multifidus muscles. Muscles stabilizing shoulder girdle are also important involving middle and lower part of trapezius, rhomboids, serratus anterior as well as muscles of rotator cuff. (Valachi & Valachi 2003, 1604-1612.)

Adequate breaks and physical exercise are recommended for dentists to prevent musculoskeletal problems. Short breaks along the day reduce discomfort in the musculoskeletal and nervous system. Maintaining good general health and carrying out exercises for problematic body regions seems to have strong role in reducing musculoskeletal problems. (Kierklo, Kobus, Jaworska & Botulinski 2011, 79-84.)

6 WORK RELATED MUSCULOSKELETAL PROBLEMS AND WELLBEING

World health organization WHO, defines musculoskeletal disorders as follows; "Work related musculoskeletal disorders refers to health problems of the locomotor apparatus, i. e. of muscles, tendons, the skeleton, cartilage, ligaments and nerves." According to WHO musculoskeletal problems become work related when they are aggravated by work or the circumstances of its performance. Although, problems of these kind are supposed to be caused or worsened by work, often individuals' free time activities may also be involved. (Website of World health organization 2013.)

Ergonomics and organization of work are key components in preventing work related musculoskeletal problems. Moreover, positive working environment and reasonable

workload promotes individual's wellbeing at work. Musculoskeletal problems are one of the most common reasons for sick leaves in Finland and they cause considerable amount of disability, especially in ageing individuals. Work related musculoskeletal disorders are produced by difficult, repetitive or static working positions and high physical demands. Inadequate recovery from work may also be predisposing factor for musculoskeletal problems and disability. Even tough, musculoskeletal problems would not cause disability and sick leaves they cause a decrease in one's functional capacity, workability and wellbeing, (Website of Finnish institute of occupational health 2013) which has an effect on individuals' quality of life. Together with other studies the study conducted in Sweden indicated that dentists with musculoskeletal problems reported significantly lower satisfaction at work, more work related anxiety and reduced general health than dentists without such problems. (Lindfors, Von Thiele & Lundberg 2006, 192-197.)

Musculoskeletal problems are common among many occupations. Physically heavy work, difficult working postures, handling heavy loads, repetitive tasks, use of forces and sitting at work increase the risk of developing musculoskeletal problems. (Kauppinen et al. 2013, 129.) In addition, those problems may be caused by flexion and rotation direction postures, lifting heavy objects, repetitive, static and strength demanding tasks. Individual factors include; ageing, sex, smoking, obesity, problems in sleeping, physical inactivity, poor physical capacity and genes. Environmental factors e. g. heat increases works physical demand and therefore predisposes for musculoskeletal problems. Psychosocial factors, including too high work load and demands, inadequate feedback, poor co-operation and general problems at workplace increase incidence in musculoskeletal problems. (Website of Finnish institute of occupational health 2013.)

Work related musculoskeletal disorders occur when mechanical workload is higher than individuals' musculoskeletal systems' load bearing capacity. Work load is composed from physical and psychological demands, work equipment used and organization of work. Physical demands come from muscle work, use of force and working postures. These factors form physical loading causing musculoskeletal problems and changes in individuals' health. Musculoskeletal problems can be reduced and prevented by planning work processes and tasks that require less muscle work, tasks that

are less repetitive, re-organizing the work environment, make use of ergonomically suitable equipment and materials and making sure that individuals have adequate breaks throughout the working day. (Arakoski, Alaranta, Pohjolainen, Salminen, & Viikari-Juntura 2009, 41-46.)

Work and its loading are always individual and vary between people as free time activities and life outside of work has an effect on individual and how well one can manage the work load. Biomechanical factors are believed to be important issues causing most of the musculoskeletal problems people suffer from. Disorders and injuries are caused by mechanical overload of the biological structures (Website of World health organization 2013.) When work requires more from musculoskeletal system than it can handle or movements are repeated too much, tissue damage occurs. Static working posture can cause fatigue which causes changes in tissue metabolism. This can be harmful even tough clear tissue damage has not occurred. The human body has to deal with considerable amount of forces coming from outside to move and maintain postures. Physical work load can be evaluated by using biomechanical analysis at the workplace. (Arakoski, Alaranta, Pohjolainen, Salminen, & Viikari-Juntura 2009, 46.)

High intensity forces and torques acting on and inside of the body cause overload to body tissues. Duration that the individual is exposed to musculoskeletal disorder or injury is an important factor in development of problems. Duration is determined by number of repetitions e.g. per day as well as by the total exposure time for instance hours per day or days per month. Short term exposure to loading may cause acute health problems. In contrast, long term loading may cause acute problems to become chronic. (Website of World health organization 2013.)

As already noted, dental work has high requirements for musculoskeletal system. For instance forward bended working postures cause back problems. Neck and shoulder area is loaded by neck flexion, rotations and by lifted arms. Upper limbs are loaded by wrist movements that happen away from neutral joint alignment, repetitive tasks and the task that require compressive force. Working away from neutral joint alignment may also cause problems in long term as well as repetitive tasks and tasks that

require maintaining difficult postures. (Arakoski, Alaranta, Pohjolainen, Salminen, & Viikari-Juntura 2009, 46.)

Posture of the operator is a great risk for musculoskeletal problems. Moreover, long term sitting is studied to increase risk for musculoskeletal disorders as well as risk of cardio- avascular disease and diabetes. Muscle inactivity cause musculoskeletal problems which quite often can be seen in poor sitting postures. Postural muscles need an activation to maintain their function. If the muscle activation in some body parts is lacking it will develop deconditioning and eventually leads to functional and structural deficits. Muscles that are inactive are not able to stabilize passive structures which causes overloading of joints, movement abnormalities and incoordination associated with pain. (Website of World health organization 2013.)

As noted, demanding work postures increase risk for musculoskeletal problems. Forward bended and rotated back posture as well as long periods of working arms lifted cause neck and shoulder problems. (Kauppinen et al. 2013, 145.) Especially muscles of trunk with stabilizing functions are important in maintaining healthy postures and reducing risk to obtain poor postures for working. Good body control and awareness of own body is essential for maintaining healthy postures. (Fogelholm et al. 2007, 63.)

Muscle work can be either dynamic or static. In dynamic muscle work muscle lengthens and shortens, contracts and relaxes. During the relaxation the muscle receives new blood which brings oxygen and nutrients to it. In static muscle work the muscle is contracting for longer period of time which lowers down the blood circulation and prevents the muscle getting oxygen and nutrients. Reduced blood flow occurs due to compressed blood vessels as the muscle contracts. Consequently, the products of metabolism accumulate in the muscle causing fatigue. Static muscle work cause muscle fatigue three to six times faster, than dynamic muscle work. Therefore, the static muscle work should be avoided and reduced as well as possible. Muscles that are fatigued from static muscle activity are best recovered by light dynamic activity which improves blood circulation in tensed muscles. Moreover, exercises throughout the working day may reduce discomfort caused by static work.

Therefore, it is important that employees' have adequate breaks throughout the working day. (Aulanko, Huovinen, Kiikka & Lehtinen 2010, 33.)

Even musculoskeletal problems will not cause the operator to go on a sick leave they reduce ones' wellbeing and workability causing pain and discomfort at work. Musculoskeletal systems and works relation is multi-dimensional for the reason that loading is necessary for human body to maintain healthy but loading at work is traditionally considered detrimental. Individuals' load bearing capacity depends on body structure, size, sex and age. Optimal loading for individual is loading that enhances individuals' health. (Martimo, Antti-Poika & Uitti 2010, 87.)

Three factors determine physical loading; amount, duration and repetition. Work can be organized in relation to these three factors so that the health risks are minimized. Musculoskeletal problems can be prevented by ergonomics, minimizing all the possible health hazards at work, organizing early medical treatment for possible disorders, improving individuals' overall health through physical exercise, making adaptations at work for individuals' suffering from musculoskeletal problems and by affecting individual attitudes towards work and promoting the individual to take responsibility in the process. (Martimo, Antti-Poika & Uitti 2010, 91-96.)

Examples of possible ways to reduce and prevent musculoskeletal problems at work are for instance to make changes in work tops and their dimensions, to change the target the individual works with and to make use of equipment that are designed in the best possible way to maintain neutral joint positions and minimize compressive forces and reduce repetitions. All musculoskeletal problems can be affected by reducing repetitive and monotonous tasks, minimizing health hazards and removing uncomfortable equipment. (Martimo, Antti-Poika & Uitti 2010, 91-96.)

Physical activity may be reducing factor in musculoskeletal problems or it may help to maintain current functional capacity. General idea is that if the general health and functional capacity is good the musculoskeletal system can handle more stress and also the problems are experienced differently than if sedentary. To achieve benefits of exercising the body systems must be loaded more than they are used to. Body systems that are exercised get use to the certain level and therefore it is important that

the exercises are progressive as the body system adapts itself. (Taimela et al. 2002, 295.)

Exercises for musculoskeletal health are specific and carefully targeted and the benefit of exercising is only seen in the structures that are involved in training. Muscle strengthening exercises should be carried out minimum three times a week and training has to be progressive. Also coordination and motor control are important factors in musculoskeletal systems health. In the neck and shoulder girdle it is important to exercise neck and shoulder girdle muscles together with motor control and coordination exercises. To maintain back health it is important to exercise muscles which have stabilizing functions in abdomen, back and pelvic girdle. (Taimela et al. 2002, 295.)

Musculoskeletal problems are common among dentists and one of the main occupational hazards affecting dental personnel. Studies in Finland and elsewhere have shown that 70% to 95% of dentists suffer from musculoskeletal problems. (Roivainen & Hatakka 2007, 28.) Study conducted in Malaysia showed that 93% of dental students stated musculoskeletal problems. Musculoskeletal problems were significantly higher among female students. Most common problematic body regions were neck (82%) and low back (64%). Musculoskeletal problems may contribute to sick leaves, reduced productivity and work wellbeing. The length of the career seems to have a relation to musculoskeletal problems. Some studies suggest that the dentists who have been working longer have learnt to adjust their work posture and therefore report less such problems. (Khan & Yee Chew 2013, 118.) In contrast, the study conducted in the Netherlands suggested that musculoskeletal problems occur after few years of working and they are not yet apparent among younger dental workers. (Droeze & Jonsson 2005, 218.) Australian study stated that the most common musculoskeletal problems among dentists in Queensland were neck (64%), shoulder (61%) and lower back (53%) problems. (Leggat & Smith 2006, 324.)

Dental work cause considerable strain for the upper limbs and fingers. Dentists are in risk of developing carpal tunnel syndrome as their work involves pinching and non-neutral wrist alignment. When performing tasks requiring precision movements dentists use especially their thumb and their middle finger. As many other studies, the

study conducted in Finland concerning musculoskeletal problems among teachers and dentists stated that musculoskeletal problems are common and that the most common and the most permanent problem was neck pain as 74% of participants reported. 66% of participants' reported low back pain, 63% of shoulder pain and 44% reported pain in the hand and wrist area. The study also stated that reduction of work-related stress and maintaining healthy weight are important factors having an effect on musculoskeletal symptoms. Ergonomics, instrument development and changing the tasks should be paid attention to so that musculoskeletal problems could be avoided. (Website of Finnish work environment fund 2013.)

7 THESIS PROCESS

Thesis process can be seen in table 1. The process started in March 2013 when I had a conversation with dental students about their ergonomics and musculoskeletal problems they had experienced during their studies. The idea of the topic grew slowly and I started to contemplate possible clients for my thesis work. In April 2013 I contacted Pori dental care center and agreed on the topic of the thesis. Writing process started in May.

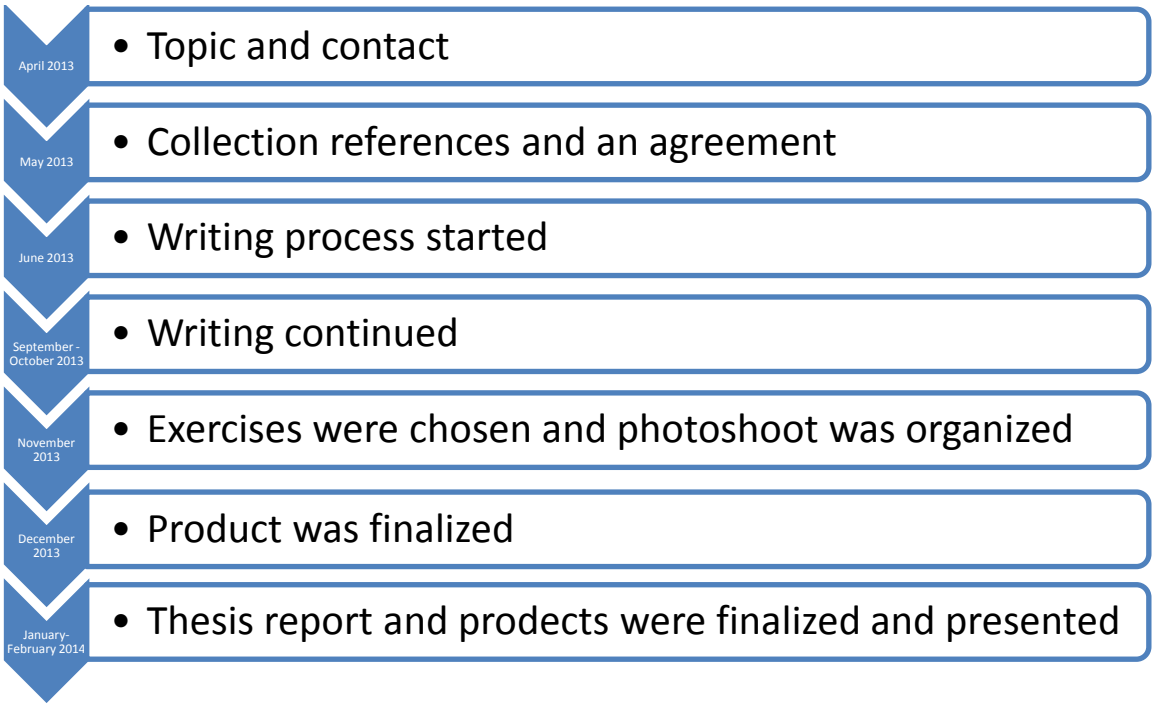

Figure 3. Thesis process

Writing process commenced by finding relevant references for the theory to back up the information used in the thesis products. The theory was gathered from literature, articles and from electronic sources. In September 2013 I agreed to carry out observations and interviews (Appendix 1) in Dental care center in Pori. Thesis product was created using the theory from this thesis report. Information package was formed during November and finalized during December 2013. Final product of this thesis is an information package and a poster for Pori dental care center. The information package and the poster are aimed to increase knowledge of ergonomics and how to prevent musculoskeletal problems.

8 DISCUSSION

Discussion of changing working life and its' demands as well as my own interest in occupational physiotherapy gave me an idea to carry out the thesis in this area. Dentistry is a demanding occupation physically and mentally and therefore I desired to study the physical demand of the occupation more thoroughly. This thesis was carried out in order to create information package for Pori dental care center to provide knowledge of ergonomics as well as most common causes of musculoskeletal problems and deliver ideas how to prevent those.

Dentistry has been studied considerably and there was a plenty of material available for the thesis work. The topic was narrowed to physical work load in dentistry as mental load is another significant loading factor and could be studied separately. However, those two factors cannot be studied in complete isolation as both factors have an effect on each other. There are also several other factors that have an effect on dental work load which were not studied in detail in this thesis, for instance co-operation or pair work together with dental nurse, timed schedules and patient interactions and their demands. Moreover, there are also areas concerning ergonomics that were not covered in this thesis; such as lighting, handling of certain materials, risk of getting infections and use of protective devices or clothing.

Articles and guidebooks have been written concerning ergonomics in clinical dentistry, however there is not much information available of effectiveness and types of interventions aimed to prevent musculoskeletal problems among dentists and how those have been implemented. Only one European study reviewed for this thesis had concentrated on the effectiveness of ergonomic interventions among clinical dentists. Study had been carried out in the Netherlands and it suggested that 72% of dentists, who carried out the intervention, reported their worst musculoskeletal problem had either disappeared or considerably reduced. Due to this study it could be deducted that ergonomic interventions targeted to dentists are needed and that those, if well implemented, are effective ways to reduce musculoskeletal problems.

Several studies stated that overall physical activity level during working hours among Finnish population must be aimed to increase. It has been studied lately that recreational physical activity is not giving the same benefits as the overall increase in physical activity throughout the day for those who spent most of their working hours in sitting. In conclusion, overall time spent in sitting among those who work seated must be aimed to be decreased. This trend was also seen in new guidelines of Ministry of social affairs and health as they noted that time spent in sitting must be decreased among Finnish population. Due to this fact it can be stated that among dentists, who mainly work in sitting, it is important that interventions that are developed to increase work- ability and wellbeing are targeted to increase the overall activity during working hours.

Interviews and observations as part of this thesis process widened and strengthened my knowledge gathered from the literature. Moreover, through the observations, I gained better understanding of what are the critical aspects of dental work that forms physical loading. Furthermore, I developed several ideas for the thesis products. Interviewees were requested to evaluate the physical workload on a scale from 1-10, 1 indicating no load at all and 10 the worst possible loading caused by work they could imagine. Three out of three evaluated the physical work load as number 8. The most loading tasks were mentioned to be complicated tooth removals or treatments that go over 30 minutes. In addition, the patient position was mentioned to be problematic sometimes due to patients' medical problems or other requirements.

The most loading factors in dentistry are the static and complicated work postures and long treatments that go on over 30 minutes. All three dentists had suffered from musculoskeletal problems in the neck and shoulder area and upper limbs. Also headache was mentioned to be a problem due to muscle tension in the neck area. All three dentists mentioned that they had adequate knowledge of ergonomics. However, they found it difficult to take the knowledge into practice. In addition, all three stated that the best way to reduce and prevent musculoskeletal problems is regular exercise. Two out of three mentioned gym exercising to be the most effective in their opinion. Interviewers mentioned that breaks in exercising can be felt in the musculoskeletal system as pain and discomfort appear if there had not been time to exercise.

Observations were carried out using videotaping. Videos were then further analysed by using ergonomic assessment tool; RULA rapid upper limb assessment (Appendix 2). RULA assessment tool was chosen as I was familiar with it, which I believe increased the reliability of the analysis. Rapid upper limb assessment is a survey tool which can be used to evaluate ergonomics in workplaces where work related upper limb disorders are reported. It pays particular attention to neck, trunk and upper limb but can be used to assess biomechanical and postural loading of the whole body. RULA is often used as a part of broader ergonomic study. RULA scores from observations indicated that further investigations and changes were needed in all three participants' ergonomics. Biggest risk factors were neck flexion and the position of the upper limbs.

The dentists stated that they considered their knowledge of ergonomics fairly good but the problem seem to be how to follow those guidelines at work. Due to this finding I came up with an idea for a poster that can be placed on the dentist's desk or wall to remind to have adequate breaks and to carry out simple exercises throughout the working day. This was done in order to decrease the time spent in sitting and to increase the overall physical activity during working hours. Several studies suggested that short "micro" breaks are effective ways to reduce musculoskeletal loading. Therefore, I believe dentists need to be encouraged and reminded to carry out short and simple exercises throughout the working hours. I also believe that posters or even computer programs which activate dentists to take adequate breaks are easy way to reduce dental work's physical loading. Moreover, mini breaks and exercises during work days are inexpensive way to reduce musculoskeletal loading. Exercises must not be too complicated and they should not demand considerable effort or time from employees.

The problem seems not to be the lack of knowledge but the lack of reminding. Therefore, in ergonomic interventions it is crucial to consider the factors affecting individuals' motivation. Hence, how to motivate individuals and how the interventions are implemented are important aspects of ergonomic education among dentists.

To increase the quality of the thesis products the information package and the poster could have been piloted in a group of dentists or even in a group of dental students,

which would have given ideas for further development and possible changes needed in the information package. It would have also been beneficial to carry out a survey before starting the thesis process, for instance using questionnaire to find out the level of knowledge of ergonomics or dentist's own opinion what they think they would benefit from the most or if they had had experiences of ergonomic interventions during their careers and which aspects they consider the most important. I also believe that I could have benefited from analyzing the target group of the thesis more thoroughly to understand better their needs and particularly the needs in Pori dental care center. In addition, a survey or higher number of interviews would have strengthened and widened my knowledge of the needs of the target group. However, there was a limited time frame and resources for the process which forced to narrow the topic and follow the timetable

A follow up survey could be carried out following the implementation to find out the effectiveness of the information package in Pori dental care center and to find out how the dentists took it as a part of their work and do they think that it has had an effect on their awareness of ergonomics and if they have increased their amount of exercise outside of work and during their working hours.

The information package and the poster could be also used in university clinics where dental students practice their skills. They would already that time learn correct ergonomics and what they should take into consideration to prevent musculoskeletal problems. As noted in the fourth chapter of this thesis the process of changing neural connections that has been set whilst learning are significantly harder to change than to develop new skills and connections. Therefore learning proper ergonomics and adjustments for work equipment should start in the early phase of one's career rather than when problems start to appear. However, those can be improved in the later phase too and it is never too late to learn new ways of functioning. Presence of musculoskeletal problems among professionals and students or newly qualified dentists was discussed in several articles. However, the statements were conflicting. Some references suggested that musculoskeletal problems occur after few years of work and some stated that students have not yet developed their own ways to cope with loading and therefore experience more musculoskeletal problems. Therefore, adequate knowledge of ergonomics is needed among both, professionals and students.

This thesis gave me an opportunity to deepen my knowledge in the field of ergonomics, work wellbeing, workability and work-related musculoskeletal disorders. As a future physiotherapist I understand the importance of work for one's life as well as what are the health enhancing effects of work. In contrast, I developed understanding of adverse health effects of work for one's life. Moreover, I deepened my knowledge on how to evaluate ergonomics, works physical loading and what kind of interventions and materials can be used to promote work-wellbeing. The thesis process gave me an opportunity to create something completely new which in a way was a challenge but also gave me a freedom to make independent decisions concerning the products of the thesis.

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http://www.ttk.fi/tyoelaman_kehittaminen/tyoterveyshuolto_tyohyvinvoinnin_tukena

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APPENDIX 1

HAASTATTELU

1. Millaisena koet hammaslääkärin työn fyysisen kuormituksen?

   0_____10

2. Onko työstä aiheutunut Sinulle tuki- ja liikuntaelimistön ongelmia?

3. Jos niin millaisia? työn aiheuttamaa kipua, lihaskireyttä tai päänsärkyä?

   Niska-hartia seudussa?

   Selän alueella?

   Alaraajoissa?

   Yläraajoissa?

   Muualla? missä?

4. Jos, niin kuinka usein vaivoja esiintyy?

   Kerran viikossa

   Kerran kuukaudessa

   Kerran puolessa vuodessa

   Kerran vuodessa

6. Oletko joutunut olemaan poissa työstä tuki- ja liikuntaelimistön ongelmien vuoksi?

7. Miten huomioit työn fyysisen kuormituksen omassa työskentelyssäsi? Miten huolehdit ergonomiasta?

8. Miten huolehdit fyysisestä kunnostasi?

9. Millaisena koet oman tietämyksen työergonomiasta?

10. Mistä haluaisit mahdollisesti tietää lisää?

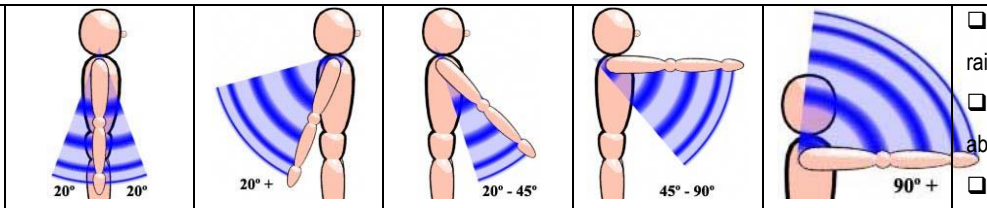
APPENDIX 2

9 RAPID UPPER LIMB ASSESSMENT

Client:	Date/time:	Assessor:

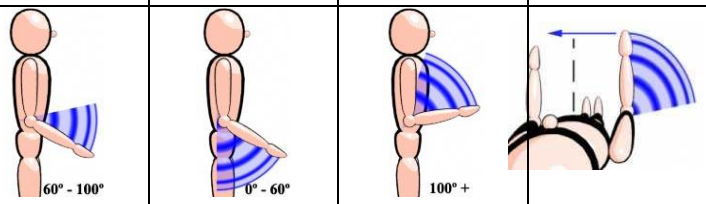
Right Side:

Right Upper Arm



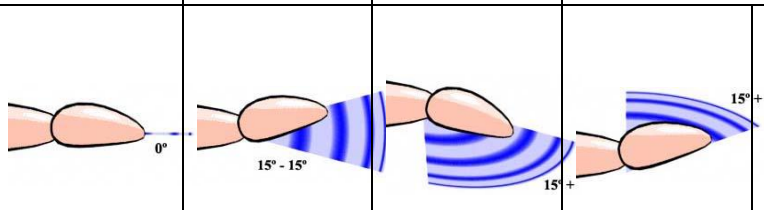
- ❑ Shoulder is raised
- ❑ Upper arm is abducted
- ❑ Leaning or supporting the weight of the arm

Right Lower Arm



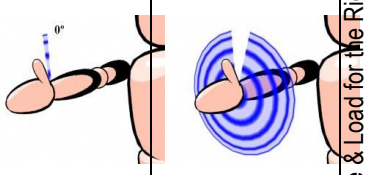
- ❑ Working across the mid-line of the body or out to the side

Right Wrist



- ❑ Wrist is bent away from midline

Right Wrist Twist



Force & Load for the Right hand side

SELECT ONLY ONE OF THESE:

❑ No resistance ❑ less than 2kg intermittent load or force

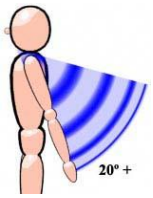
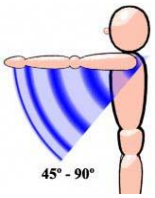
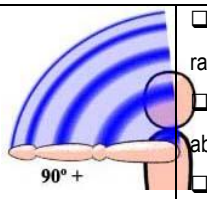
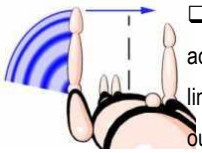
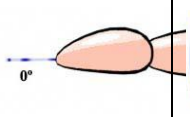
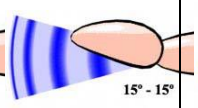
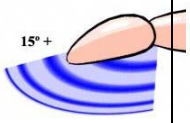
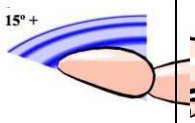
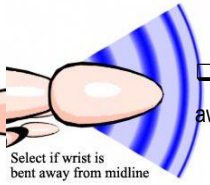
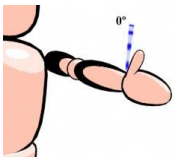
❑ 2–10kg intermittent load or force

❑ 2–10kg static load ❑ 2-10kg repeated loads or forces ❑ 10kg or more intermittent load or force

❑ 10kg static load ❑ 10kg repeated loads or forces ❑ Shock or forces with rapid build-up

Muscle Use	❑ Posture is mainly static, e.g. held for longer than 1 minute or repeated more than 4 times per minute

Left Side:

Left Upper Arm						❑ Shoulder is raised ❑ Upper arm is abducted ❑ Leaning or supporting the
Left Lower Arm				 ❑ Working across the mid-line of the body or out to the side		
Left Wrist						❑ Wrist is bent away from midline
Left Wrist Twist			Force & Load for the Right hand side	**SELECT ONLY ONE OF THESE:** ❑ No resistance ❑ less than 2kg intermittent load or force ❑ 2–10kg intermittent load or force ❑ 2–10kg static load ❑ 2-10kg repeated loads or forces ❑ 10kg or more intermittent load or force ❑ 10kg static load ❑ 10kg repeated loads or forces ❑ Shock or forces		
Muscle Use		❑ Posture is mainly static, e.g. held for longer than 1 minute or repeated more than 4 times per minute				

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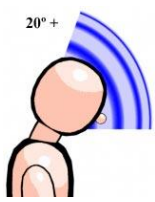
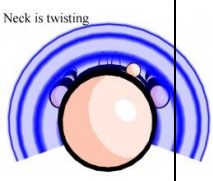
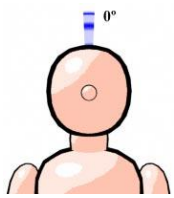
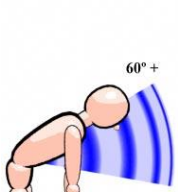
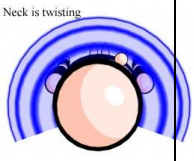
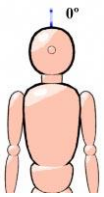
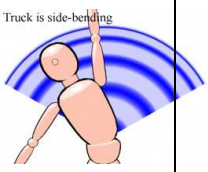
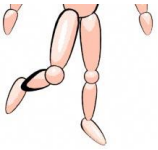
Neck					
Neck Twist					

Neck Side-bend					
Trunk					
Trunk Twist					
Trunk Side-bend					
Legs		Legs and feet are well supported and in an evenly balanced posture.		Legs and feet are NOT evenly balanced and supported.	
Force & Load for the neck, trunk and legs	**SELECT ONLY ONE OF THESE:** ❑ No resistance ❑ less than 2kg intermittent load or force ❑ 2–10kg intermittent load or force ❑ 2–10kg static load ❑ 2-10kg repeated loads or forces ❑ 10kg or more intermittent load or force ❑ 10kg static load ❑ 10kg repeated loads or forces ❑ Shock or forces with rapid build-up				
Muscle Use	❑ Posture is mainly static, e.g. held for longer than 1 minute or repeated more than 4 times per minute				

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For further information on methodology, please refer to our on-line guidance at **www.rula.co.uk** or refer to: McAtamney, L and Corlett, E.N. Reducing the risks of work related upper limb disorders - A guide and methods. Published by: Institute for Occupational Ergonomics, University of Nottingham, Nottingham NG7 2RD, UK. (1992). Tel: +44 (0)115 9514005 for details.

*McAtamney, L. and Corlett, E.N. "RULA -: A survey method for investigation of work-related upper limb disorders. Applied Ergonomics 1993, 24(2), 91-99

HAMMASLÄÄKÄRIN TYÖN ERGONOMIAA

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Sisältö

- Työn kuormitus
- Työn tauottaminen
- Ergonominen istuma- asento
- Työvälineiden sijoittelu
- Potilaan asettelu
- Työn tauotus
- Harjoitteet

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Työn kuormitus

Hammaslääkärin työn fyysinen kuormitus koostuu muun muassa työn aiheuttamasta staattisesta lihaskuormituksesta. Yleisimpiä tuki- ja liikuntaelimistön ongelmia ovat niska-hartia-yläraaja ja alaselän alueen ongelmat. Tuki- ja liikuntaelimistön ongelmien ennaltaehkäisyyn ja hoitoon voidaan käyttää ergonomian ja kohdennetun harjoittelun keinoja.

Staattinen lihasjännitys heikentää lihaksen aineenvaihduntaa, aiheuttaa lihasten kipeytymistä ja väsymistä. Se uuvuttaa lihaksen kuusi kertaa nopeammin kuin dynaaminen lihastyö. Staattisen lihastyön aiheuttamaa kuormitusta voidaan vähentää työaikana työn tauottamisella ja taukojumpalla.

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Tauota työtäsi

Työn tauotuksella on vähentävä vaikutus tuki- ja liikuntaelimistön ongelmiin. Taukojen tarkoituksena on lihasten aineenvaihdunnan palauttaminen. On myös todettu, että lyhyet tauot monta kertaa päivässä ennaltaehkäisevät tuki- ja liikuntaelin ongelmia. Tutkimusten mukaan useammin työtään tauottaville hammaslääkäreillä on vähemmän tuki- ja liikuntaelin ongelmia.

- ✓ **Nouse päivän aikana useasti seisomaan ja kävele mahdollisimman paljon**
- ✓ **Tarkkaile työasentoasi**
- ✓ **Rentouta ja ravistele käsiäsi usein**
- ✓ **Vie ajoittain olkapäitä taakse ja purista lapaluut yhteen**

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Ergonominen istuma-asento

Työskenneltäessä istuen hyvän ryhdin säilyttäminen on tärkeää. Hammaslääkäreillä usein selkäongelmia tuottaa työskenneltäessä lanneselän luonnollisen notkon katoaminen, jolloin istumisen tuottama kuormitus ei kohdistu selkärangan rakenteisiin tasapuolisesti. Pitkään jatkunut epäsuotuisa asento kuormittaa välilevyjä aiheuttaen muutoksia niiden rakenteessa ja toiminnassa.

Huono ryhti johtaa usein lihasepätasapainon muodostumiseen, josta saattaa aiheutua kipuja sekä liikkeiden rajoittumista. Lihasepätasapainolla tarkoitetaan lihasten aktiivisuustasojen muuttumista, osa lihaksista laiskistuu ja osa ylikuormittuu. Tämä johtaa passiivisten rakenteiden ylikuormittumiseen aiheuttaen tuki- ja liikuntaelin ongelmia.

- ✓ **Eteenpäin kallistuessa, kiinnitä huomiota siihen, että liike tulee lonkista ei selästä**
- ✓ **Istuttaessa säädä tuolin istuinkulma siten, että lantion ja reisien välinen kulma on noin 130 astetta**
- ✓ **Pidä jalat tukevasti maassa**
- ✓ **Säilytä lanneselässä luonnollinen notko**

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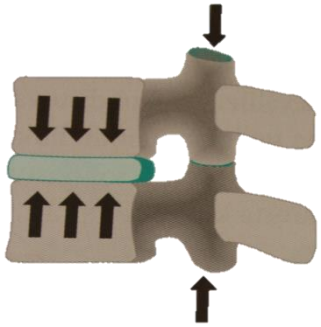
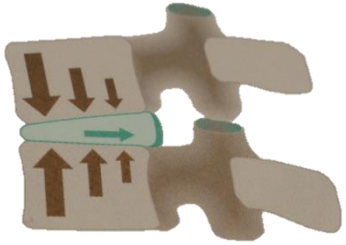
Ergonominen istuma-asento

- ✓ Hyvässä istuma-asennossa välilevyyn kohdistuva kuormitus tapahtuu tasaisesti. (kuva 1)
- ✓ Lanneselän luonnollisen notkon katoaminen aiheuttaa kuormituksen kohdistumisen välilevyn etureunaan, jolloin vaarana on välilevyn pullistuminen taaksepäin. (Kuva 2)



Kuva 1. *(Launis & Lehtelä 2001)*



Kuva 2. *(Launis & Lehtelä 2011)*

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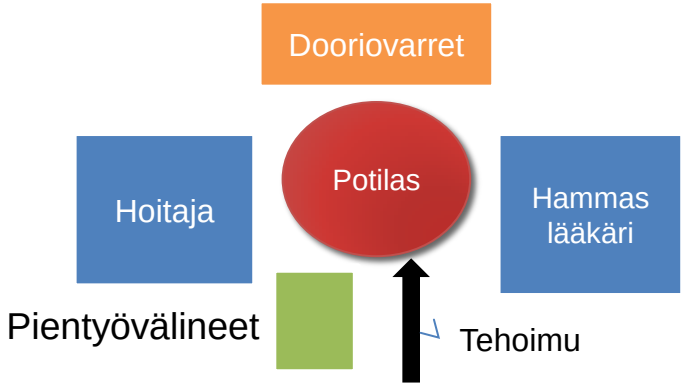
Työvälineiden sijoittelu

Sijoita työvälineet mahdollisimman lähelle niitä käyttävää kättä.

Tärkeää työvälineiden sijoittelussa on huomioida myös niiden sijoittaminen niin, että hyvä istuma-asento voidaan säilyttää koko hoitotapahtuman ajan. Työvälineeseen tulisi aina tarttua sillä otteella, jolla niitä käytetään. Jos työskennellään nelikätisesti, instrumenttitarjotin sijoitetaan potilaan vasemman korvan viereen. Porakojetelineelle hyvä paikka on potilaan rinnan yläpuolella. Tehoimu sijoitetaan kello 12-13 kohdalle ja pienlaitteet kello 12 kohdalle. (1)

“Työskenneltäessä vältä olkavarsien kohoasentoja”

Ergonomia suositus nelikätiseen työskentelyyn:



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Potilaan asettelu

- ✓ Laske potilas riittävän alas
- ✓ Säädä niskatuki ala- ja yläleuka työskentelyä varten

Kuva 1. Alaleukatyöskentely

Kuva 2. Yläleukatyöskentely

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Hammaslääkärin lihaskuntoharjoittelu

Hammaslääkärin työn kannalta tärkeää on pitää huolta hyvästä lihaskunnosta. Hankalat ja staattiset työasennot vaativat tukea erityisesti keskivartalon asentoa ylläpitäviltä lihaksilta. Myös yläselän ja käsivarren lihasten hyvä rasituskestävyys estää työstä aiheutuvia tuki- ja liikuntaelimistön ongelmia. Lihaskuntoharjoittelun tulee olla säännöllistä, vähintään 3 kertaa viikossa tapahtuvaa harjoittelua.

Tärkeää on oman asennon huomioiminen työpäivän aikana ja tietoisuus omasta kehosta. Työasentojen huomioiminen ja työn tauottaminen vähentävät tuki- ja liikuntaelimistön ongelmia. Työpäivän aikana lihasten aktivointi ja venyttely on tärkeää. Lihaskunnon lisäksi on tärkeää harjoittaa hengitys- ja verenkiertoelimistöä kuormittavaa liikuntaa.

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Löydä hyvä ryhti

Oman kehon tunteminen ja hallinta vaatii harjoittelua. Joskus pitkään jatkunut lihaskireys ja jännitys aiheuttaa oman kehon asennon muuttumista niin, että sitä ei huomaa. On hyvä palauttaa mieleen millainen on oman kehon hyvä perusasento. (3)

- ✓ Seiso selkä seinää vasten, kantapäät hieman irti seinästä.
- ✓ Vedä napaa kevyesti sisään samalla hengittäen normaalisti.
- ✓ Paina leuka kevyesti alaspäin, jolloin yläniska venyy ja kaulan etuosa aktivoituu.
- ✓ Pidä hartiat rentoina.
- ✓ Hyvässä asennossa seinän ja lanneselän väliin jää kämmenen suuruinen tila.
- ✓ Tarkkaile myös jalkojesi ja lantion asentoa, sillä ne vaikuttavat koko vartalosi asentoon.

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Keskivartalon hallintaharjoitteet (6)

”Vahvuutta keskivartaloon ja asentoa ylläpitäviin lihaksiin”

- ✓ Aloita harjoitus kyynärnojasta polvet koukussa. Vedä napaa sisään ja nosta lantio ylös alustasta. Voit vaikeuttaa liikettä nostamalla toisen jalan ilmaan. Säilytä vartalon suoralinjaus koko harjoituksen ajan

© Elina Kuopio Kuvat: Annamari Merta

”Hoover”

Aloita kyynärvarsinojasta niin, että olkavarsi on kohtisuorassa lattiaa kohden. Vedä napa kevyesti sisään. Nouse päkiöiden varaan. Pysy asennossa muutama sekunti. Voit helpottaa harjoitusta pitämällä polvet alustassa. Pidä niska vartalon suuntaisesti koko harjoituksen ajan.

Lannerangan asennon hallinta

Asetu konttausasentoon, reidet 90 asteen kulmassa lattiaan nähden. Etsi selän luonnollinen asento ja nosta keppi lannenotkon kohdalle. Vedä napaa kevyesti sisään ja nosta vuorotellen jalkaa ja käsivartta rauhallisesti lähes vaakatasoon. Pyri hallitsemaan lantion asento niin hyvin, ettei keppi liiku selkäsi päällä. Voit helpottaa harjoitusta nostamalla ainoastaan jalkojasi vuorotellen.

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Niska- ja hartiaseudun vahvistavat ja venyttävät harjoitteet

- ✓ Hammaslääkärin työn kannalta yläselän lihaskunto on tärkeää, jotta se olisi riittävän vahva asennon ylläpitämiseen ja kestämään työn rasitusta.

1. Lavan hallintaharjoite

Istu tuolilla kuminauhan päällä. Harjoitus on hyvä tehdä peilin edessä. Tuo kuminauha edestä ristiin ja nosta kyynärpäät vartalon eteen niin, että pikkusormet osoittavat peiliin päin. Lähde nostamaan kuminauhaa käsillä hieman ylös ja alas. Tarkkaile kyynärpäitäsi, jotta ne eivät lähde aukeamaan sivuille.

2. Yläselän vahvistavaharjoite

Asetu käyntiasentoon ja aseta kuminauha tukevasti jalan alle. Kierrä kuminauhaa käden ympärille ja aloita liike etummaisen polven vierestä. Kierrä ylävartaloa ja vedä hartiaa taakse vieden kuminauha kiinni vyötäröön. Ajattele kuin yrittäisit viedä lapaluun kohti selkärankaan.

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Niska- ja hartiaseudun vahvistavat ja venyttävät harjoitteet

<u>Eteen työntö kuminauhalla</u>

Aloita laittamalla kuminauha selän taakse. Lähde työntämään kuminauhaa eteenpäin. Yritä tuoda lapaluita mahdollisimman paljon eteen ja tuo kädet lähelle rintaa ja aloita työntö uudelleen.

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Niska- ja hartiaseudun vahvistavat ja venyttävät harjoitteet
(7)

<u>1. & 2. Niskan ja kaulan venytys</u>

1. Venytä niskan lihaksia viemällä korvaa kohti olkapäätä. Pidä venytys muutaman sekunnin ajan.

2. Venytä kaulan etuosan lihaksia aloittamalla kuin edellä. Vie korvaa kohti olkapäätä ja vie katse yläviistoon. Tuo vastakkainen käsi solisluun päälle. Tunnet venytyksen kaulan etuosassa.

<u>3. Rintalihaksen venytys</u>

Aloita laittamalla käsivarsi seinää vasten, niin että kyynärpäähän muodostuu noin 90 asteen kulma. Käännä ylävartaloa seinästä poispäin. Tunne venytys rintalihaksessa.

<u>4. Niskarusetin venytys</u>

Ota ote leuastasi niin, että peukalo on leuan alla ja etusormi leuan edessä. Paina etusormella kevyesti leukaa alaspäin pitäen pää paikallaan, niin kuin tekisit pienen nyökkäysliikkeen. Venytyksen tulisi tuntua aivan niskan yläosassa.

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Vahvista ja venytä kyynärvartta (7)

1. & 2. Kyynärvartta vahvistavat harjoitteet

1. ja 2. Istu tukevasti tuolilla. Aseta kuminauha jalkasi alle. Ota ote kuminauhasta niin, että kämmenselkä on ylöspäin ja ojenna rannetta ylöspäin itseäsi kohti. Harjoitus vahvistaa kyynärvarren yläpuolta. Tee harjoitus hallitusti ja rauhallisesti. Käännä sitten käden kämmen puoli ylöspäin ja ota ote kuminauhasta. Koukista rannetta itseäsi kohti. Tunnet harjoituksen käsivarren alapuolella.

3. Hauislihas harjoitus

Laita kuminauha jalkojesi alle ja tuo se edessä ristiin. Koukista kyynärvarsia vuorotellen.

4. Kyynärvarren venytys

Tuo kädet edessä ristiin venytettävä käsi alimmaisena. Vedä toisella kädellä venytettävän käden rannetta koukkuun. Venytys tuntuu kyynärvarren lihaksissa.

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