Improving ergonomy in pipetting prevents work-related upper limb disorders

Liquid handling plays a key role in many laboratory analyses. Of the various instruments employed in the laboratory, none is more routinely used nowadays than the pipettor. Basically all experiments in biological sciences require pipetting, and typically each researcher has an own set of instruments. With increasing demand of better instruments, more and more attention has been paid not only to accuracy and precision, but also to user-friendly features, especially those reducing the incidence of repetitive fatigue and injury (like carpal tunnel syndrome or other upper limb disorders).

Traditionally, pipetting has been done almost exclusively by suction using glass pipettes, before plunger-operated mechanical pipettors were developed by the end of 1960s. In these devices, an air cushion (i.e. air-displacement) separates the sample - which is aspirated into the plastic tip - from the piston inside the pipettor. Yet, results with mechanical pipettors are still user-dependent, although not to the same degree as with mouth suction pipettes. Experience and skill as well as high degree of accuracy are still required by the user to reach high quality results. Moreover, handling of these devices require considerable amount of static work for the muscles of the whole arm and shoulder. In fact, prolonged use of mechanical pipettors, dispensing and dilution devices, requiring a strong force with the thumb to enforce pipette action, result in work-related upper limb disorders (WRULD) to the users. WRULD is a group of disorders that most commonly develop in workers using excessive and repetitious motions of upper extremities. These include hand and shoulder joint fatigue, different type of painful and disabling tendosynovitis, various other muscular and tendon injuries, and generative arthritis. According to a recent study (1), the prevalence of hand ailments among laboratory technicians (from university research laboratories) were found to be twice as high as among employees in general. Moreover, there was an increased risk of hand and shoulder ailments associated with more than 300 hours pipetting per year. Based on the assumption of 44 work weeks per year, to avoid risks for hand ailments one should not use a mechanical pipette for more than 1-2 hours a day! However, many laboratory workers perform repetitive pipetting tasks for a full working day several days a week throughout the year. The increased stress and monotonous work tasks straining the arm does not only harm the worker, but in turn cause errors in pipetting. Accurate and precise pipetting performance is critical in laboratory analysis, particularly in highly sensitive tests where a small mistake in pipetting can cause a large error in the final result.

Not only the excessive pipetting, but features of the pipettor affect the ergonomy in pipetting work: the design of the plunger, weight and length of the pipettor, the force needed to place and eject tips and how the pipettor fits to hand (finger support). The wrist is in constant bending movement when the fluid is transferred from tubes held in the opposite hand to e.g. microplate lying on the table, not to mention the thumb abducted radially and rotated inwards whilst pipetting. The longer the plunger travels, the bigger the movement of the thumb. Depending on a manufacturer the plunger travel can vary up to 0.5 cm in 100 µl volume, the difference being even bigger with larger volumes. In addition, the force needed for plunger operation varies from pipettor manufacturer to another and from model to model. Figure 1 lists the weight needed to move the plunger in pipetting and in blow-out function of the most common mechanical plunger-operated pipettors. The total pressure applied could be in the region of several thousand kilograms. This is excluding the force needed to eject tips. Taking into account the weight of pipettor, body style, tip eject pressure, particularly on multichannel pipettors, it is evident that problems should not be unexpected.

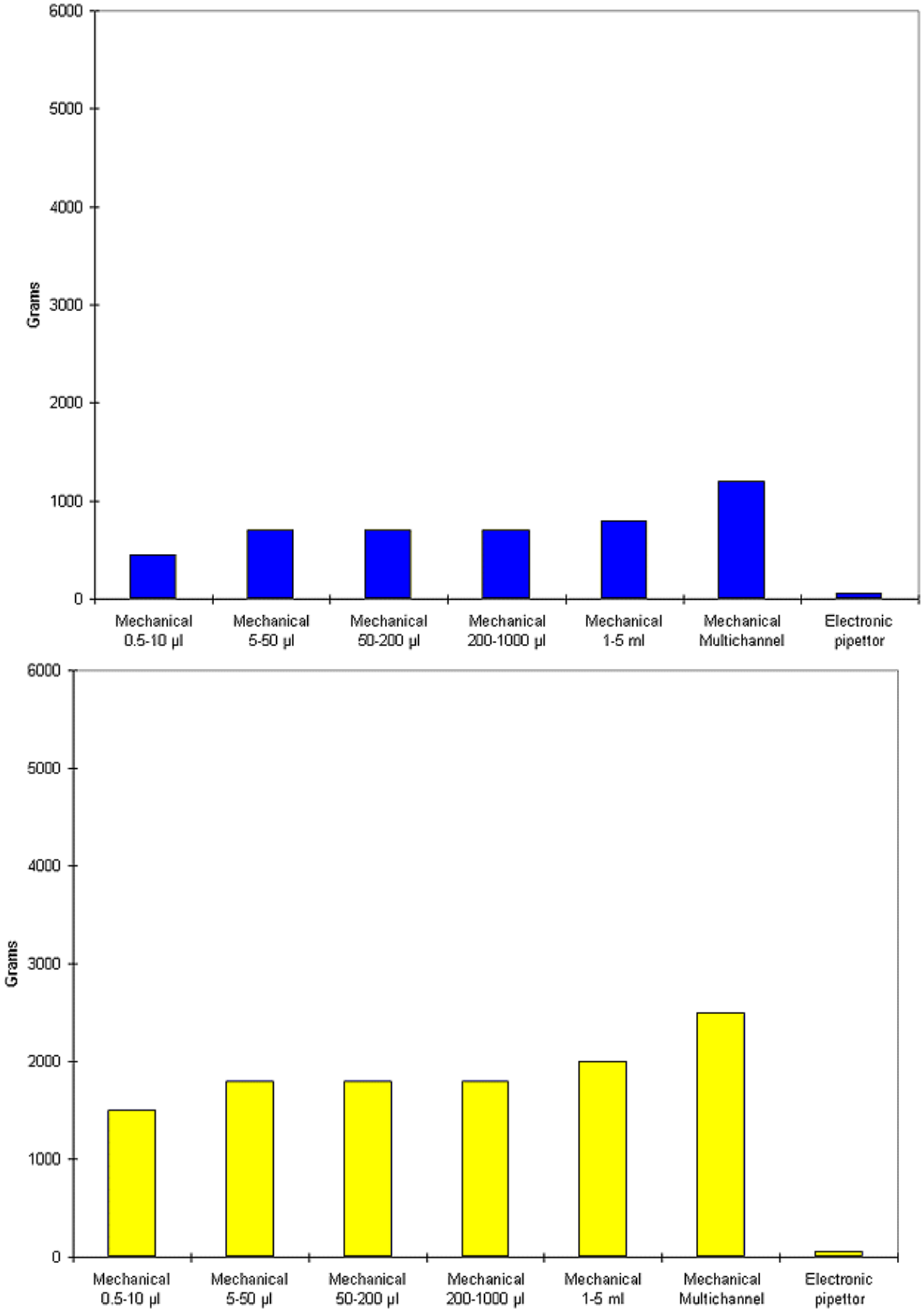

Figure 1. The weight needed to move the plunger in pipetting (A) and in blow-out function (B) of the most common mechanical plunger-operated pipettors.

There is now a range of products on the market that can help to reduce these risks, they are hand-held electronic pipettors, the Biohit Proline range. An electronic pipettor is a part of a new generation of automatic technology which combines electronics, precision mechanism, and

material technology in a way that radically improves liquid dosing. Biohit Proline electronic operates much like a human hand at its best. It is infatigable and no longer requires the enduring muscular efforts typical for mechanical pipettors. The pressure for thumb for both pipetting and blow-out is only 60-70 grams, less than 10% of the pressure needed for a mechanical pipettor. Furthermore, it removes the majority of human error in pipetting, and increases the accuracy and especially precision of liquid handling (Figure 2). The invention in electronic pipettors has made it possible to cover the most important liquid handling operations in a single device: Accurate transfer of required quantities of liquid (actual pipetting), as well as dosing, diluting and mixing liquid samples. Yet, there is no increase in size compared with the conventional devices.

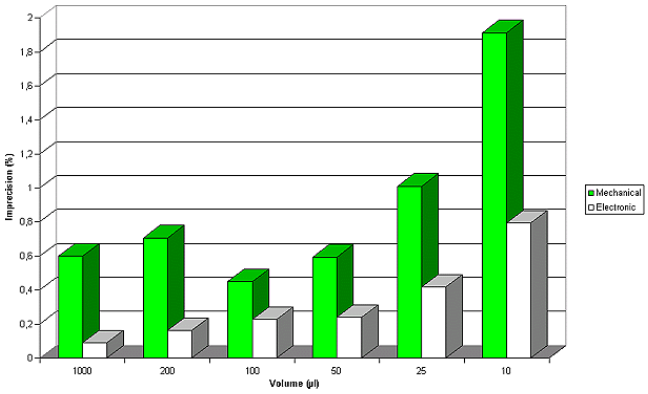

Figure 2. Comparison of imprecision of 10 subsequent results of 9 lab assistants using mechanical and electronic pipettor

Figure 3. Biohit Proline Electronic pipettor minimises the risk for work-related upper limb disorders.

Special attention has been paid to the design of the Proline range: The instrument fits comfortably in hand, the ergonomic finger support and light weight reduce fatigue, the actuating button sits conveniently under the thumb and the whole hand tip ejector is precisely placed for minimal exertion. In addition multichannel models incorporate a stepped ejection mechanism and elastomer tip cones, which guarantee one handed ejection even with 12 channel units, and ensure perfect seal with Biohit tips. The results is less strain, while preserving the control feel of the mechanical pipettor. Simple keyboard and LCD display showing the present function also help to eliminate operator error (Figure 3).

Prospects

Health and safety at work has become more and important within the recent years. Electronic pipettors are finding favour in many laboratories worldwide in response to increasing workloads and the spread of work-related upper limb disorders. Legislation will eventually be more comprehensive in this area, but already now the European Union legislative powers have decided to focus their attention to workplace. In fact, a few years ago the first claim for WRULD against British Telecom was successfully concluded in an "out of court" settlement in the London law courts. Many countries are imposing pipettor weight restrictions and most have guidelines for liquid handling. These are at the moment without central accredition, but this will probably arrive in no time.

References

1. Björksten M.G. et al. Hand and shoulder ailments among laboratory technicians using modern plunger-operated pipettes. Applied Ergonon 25(2) 88-94, 1994

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