

# Raising The Standard of Mechanical Pipetting

## - The Biohit Solution

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*Fig. 1. Biohit mLINE® meets the ergonomical demands of today.*

Occupational health physicians involved with laboratory workers report a number of individuals complaining pain in the forearm and neck particularly during periods of heavy pipettor use. Research undertaken recently in a leading ergonomics institute (1,2) has provided valuable information concerning elements of the design of commercial pipettors that may lead to these problems. The difficult features and suggestions for their improvement (in order of importance) were as follows: to make plunger operation lighter and easier, improve tip ejection and heavy cumbersome grip design, reduce weight, and improve volume adjustment.

Why these complaints? Because the handling of conventional mechanical pipettors demand a high degree of precision and a considerable amount of static work for the muscles of the whole arm and shoulder (3). In addition to static working positions, pipetting requires significant amount of strength, especially from the thumb. The force needed to depress the plunger to the first position varies from 2.8 N to 14.5 N depending on the manufacturer and the pipettor in use, and for the second position up to 44 N, that is 4.4 kg! When the plunger travel is taken into consideration, the work the thumb has to do for single pipetting multiplies to over 300 mJ in the worst case. As an example, if pipetting more than 1000 samples a day with a mechanical pipettor, one creates a total force for the thumb enough to lift an elephant! No wonder serious fatigue in the muscles of the hand, wrist and arm occur with conventional mechanical pipettors.

Listening to these ergonomical demands, the design of the Biohit mLINE® range has been carefully planned: The pipettor fits comfortably in hand, the ergonomic finger support and light weight reduce fatigue. Furthermore, the volume setting can be done easily by releasing the patented (4) locking button and turning the plunger to the desired volume on display. Most important, the forces needed for pipetting and tip ejection are extremely light, in fact the lightest on the market (Fig 1.).

### Pipetting force influences accuracy and precision

Most of the pipettors on the market are very accurate and precise and have gone through thorough factory testing. In practice, due to the forces needed by thumb, after several hours of pipetting it is extremely difficult to get the specified precision values with heavy and force demanding pipettors. In conventional pipettors, the lower the volume is, the more the spring is compressed and the more force it demands from the thumb to operate the plunger. High force together with small movements cannot be done with the same accuracy after hundreds of pipettings. Unlike other manufacturers, the Biohit mLINE® is light itself, and has a patented (5) spring mechanism, which gives it the lightest pipetting forces on the market (Fig. 2). This allows the pipetting to start always with constant and very low force regardless of the volume, which has a direct effect on pipetting accuracy. The smaller the force needed for minute piston movements (small volumes, like 0.5 microliters), the easier it is to pipette accurately.

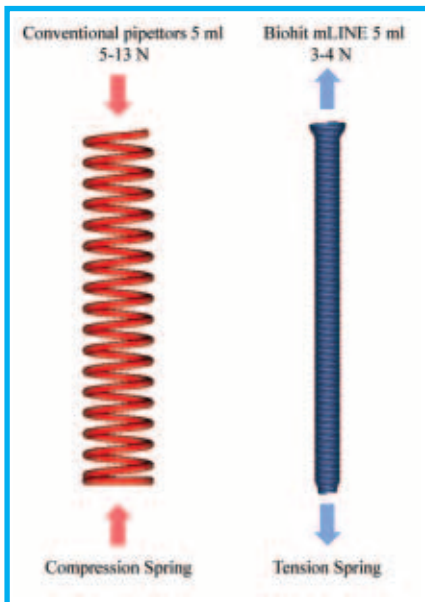


Fig. 2. Biohit mLINE® features a tension spring (right), which moves along with the volume adjustment mechanism, whereas all the other manufacturers use a compression spring (left) to adjust the volume. The tension spring allows light pipetting forces. In the 5 ml pipettor the difference can be 3-fold.

Due to its novel design, the maximum pipetting force of the mLINE® is less than the minimum pipetting force of most other manufacturers. The difference in pipetting work can be up to 4 times greater with conventional pipettors compared to Biohit mLINE® (Fig 3). Due to the low pipetting and tip ejection force of the Biohit mLINE®, the precision values stay easily within the specifications even after prolonged hours of pipetting. Moreover, as mLINE® is thermally insulated, the warmth of the hand does not affect the pipetting results at all, which may be the case with many other pipettors especially after several hours of constant pipetting. A comparison chart of precision during a 5 hours pipetting period between a conventional pipettor and Biohit mLINE® is shown in Fig 4.

## Tip sealing and tip ejection force

Like pipetting forces, there is a huge variation in tip ejection force depending on the manufacturer. Whereas Biohit mLINE® requires only 17 N force to eject the tip, the force of

the competitors' pipettors varies from 21 to 51 N (Fig 5). The Biohit Optiload system featuring spring loaded tip cones allows pipettor tips to be picked up with a constant force. That in turn secures optimal tip sealing and reduces tip ejection force considerably. Moreover, the tip ejector design is rounded and ergonomically convenient.

## Volume adjustment with locking mechanism

In volume adjustment, the most important requirement is that the volume should not change accidentally. To avoid this, many pipettors on the market have extremely heavy-to-turn adjustment systems, still having the risk of volume alteration during pipetting. In Biohit mLINE® the volume adjustment is stepless, extremely light and fast to adjust, and after adjustment the volume is locked (4).

## Calibration and in-house service

The calibration of the mLINE® has been made as user-friendly as possible. With the calibration tool, which also acts as a tube cap opener, calibration is done accurately and fast. Most important, it allows fine adjustment. Due to the special transmission mechanism, even very small increments in calibration can be done easily and safely. The

construction of mLINE® ensures that no additional tools are needed to open the pipettor. Whereas in many pipettors opening requires extra tools and up to 12 parts need to be disassembled, cleaned and assembled back in the right order, in mLINE® only 3-4 parts need to be cleaned.

## Protecting the pipettor and the sample

If no protection (filter tips or filter in the pipettor tip cone) is used in pipetting, the pipettor is contaminated easily. Even when working with buffers or aqueous solutions, small amounts of liquid get inside the pipettor tip cone and the tip cone becomes contaminated. However, special attention should be paid to the problem when working with infectious, radioactive or DNA samples. In addition, poor individual pipetting techniques or foaming samples may cause even more severe contamination than presented above.

The Biohit mLINE®s features a tip cone filter (6) that protects both the sample and the pipettor from contamination while pipetting. Moreover, the mLINE® features a unique filter ejection system by which the filter can be removed safely without touching it (7). Very often the filter is enough to protect the pipettor. However, only autoclaving ensures that the pipettor is almost certainly free from dangerous pathogens or the agent of concern.

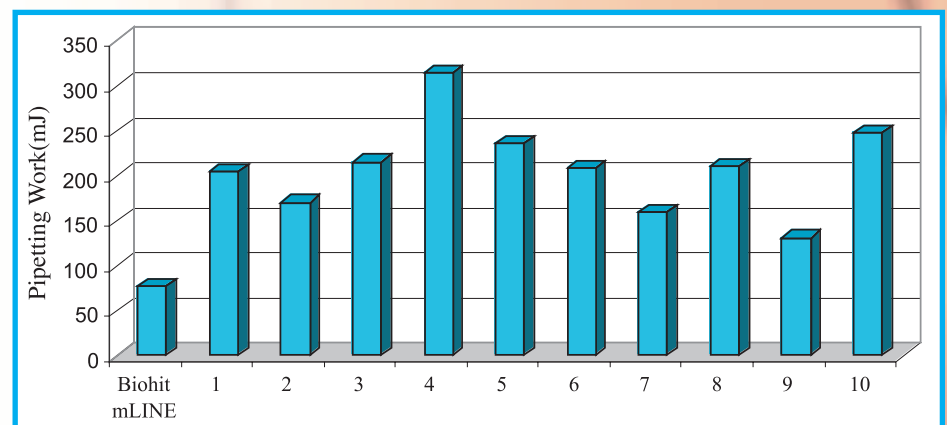


Fig. 3. The maximum pipetting force and work of the mLINE® is less than the minimum pipetting force of the pipettors of most other manufacturers (1-10).

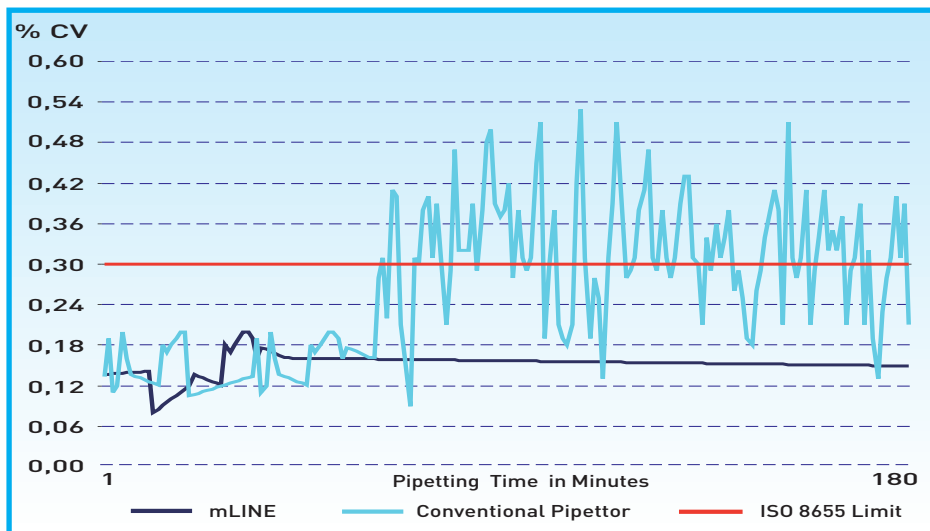


Fig. 4. Performance test of Biohit mLINE® (yellow line) and a conventional pipettor (blue line). Pipettors were tested over a 5-hour period with sets of 5 repeat weighings of 500 microlitres 180 times. The same trained operator was used. As shown, it is very hard to meet the specifications (red line, ISO 8655-2) with a force demanding pipettor after prolonged pipetting hours, whereas the light action of mLINE® allows the same reproducibility over the whole period.

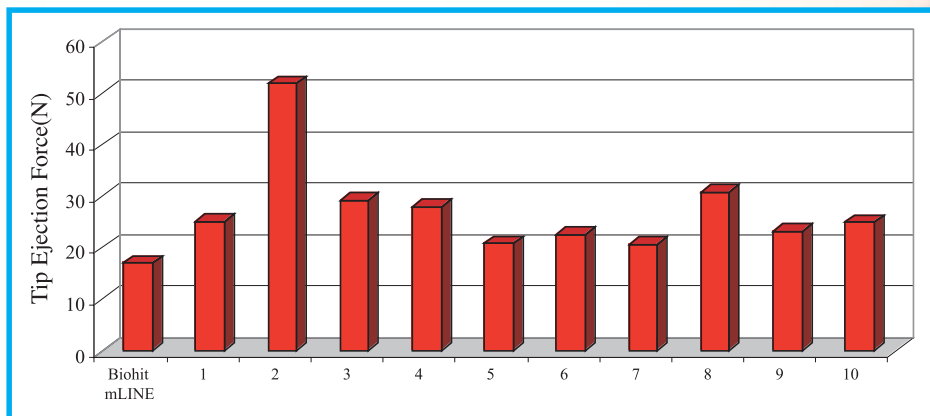


Fig. 5. The Biohit Optiload system featuring spring loaded tip cones allows pipettor tips to be picked up with a constant force. That in turn reduces tip ejection force considerably compared to conventional pipettors (1-10).

## Sterilizing the pipettors

Why would anyone want to sterilize pipettors? Simply to remove any possibility of sample carryover or to protect the personnel. In laboratories, where bacterial or viral elements of an extremely dangerous nature may come into contact with pipettors (nowadays SARS virus, HIV, Anthrax spores, Haemorrhagic Fevers etc.) there is a clear argument for complete and reliable sterilization. It is also necessary to ensure that the tools in use can be sterilized without affecting them.

Not all the common sterilizing techniques, such as chemical "disinfection", gaseous

(ethylene oxide) sterilization or irradiation, are guaranteed to sterilize. There is no single chemical that can be guaranteed to eliminate all biological agents within a sufficiently short period of time. Ethylene oxide is highly toxic and mutagenic. Beta or gamma radiation is highly effective, but requires special facilities and is not cost effective for laboratory use. UV-irradiation is not effective for the inner parts of the pipettor as the rays cannot penetrate.

Autoclaving is one of the most widely used techniques for sterilizing. It is economical, relatively quick and effective. During autoclaving heat damages all cellular macromolecular structures including nucleic acids and the cytoplasmic membrane.

Steam sterilization under pressure to attain temperature of 121° C kills also endospores. Autoclaving today is the most reliable way to sterilize pipettors.

When choosing a pipettor, make sure it is fully autoclavable, as in many pipettors only the lower part can be autoclaved or it is not autoclavable at all. If autoclaving is done frequently, make sure that the pipettor is not only fully autoclavable, but also autoclavable without disassembling first - like Biohit mLINE®.

## Closing words

In laboratories, the very nature of the work means a high level of concentration, precision and repetition. Any responsible laboratory manager should realize that work related upper limb disorders could lead to staff health problems. It was in 1991 when Biohit first communicated our concerns over repetitive strain injury (RSI). The new mLINE® range, with its effortless accuracy is a culmination of that research and development.



## References

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## A Promise of Lighter Handling


**mLINE<sup>®</sup>**

Mechanical Pipettors



### Effortless Accuracy

- Fully Autoclavable
- Fast and Light Volume Adjustment
- Lowest Pipetting and Tip Ejection Forces



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