Technical Note

Thermo Scientific ClipTip Technology – Part 3 Reduce the Risk of Repetitive Strain Injury (RSI)

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Key Words

- **Repetitive Strain Injuries (RSI)** – is a general term used to describe the pain from muscles, nerves and tendons caused by repetitive movement and overuse.

- **Ergonomics** – is the design of equipment and work arrangements to improve working posture, and to ease the load on the body, thus reducing instances of repetitive strain injury.

Introduction

Pipetting is repetitive work performed with the thumb, fingers and wrist (1,2,3). Research has shown that repetitive working movements are connected with upper limb strain injuries, or pain symptoms in the forearm, wrist and hand. Pipetting has been identified as a source of exacerbated upper limb symptoms, especially if performed for over 300 hours per year (1).

A pipetting cycle consists of attaching a tip, aspirating liquid, dispensing liquid and ejection the tip. For attaching a tip the whole hand is used whereas pressing the plunger and the tip ejector are most often performed using the thumb. Due to the design of multichannel pipettes, higher tip attachment, ejection and pipetting forces are generally needed and this leads to higher risk of getting RSI.

In this technical note we concentrate on the forces needed for tip attachment and tip ejection with multichannel pipettes. Forces were measured for Thermo Scientific™ F1-ClipTip™ and pipettes from other manufacturers.

Friction-based tip attachment

Most pipetting systems utilize friction-based tip attachment systems where the tip is attached and sealed to the tip cone by friction. A certain amount of force is required to achieve a sufficient seal. The force required varies between different manufacturers and pipette-to-tip interface designs. In addition, the applied tip attachment forces vary between users.

It´s common that excess force is applied to ensure that tips won´t loosen during pipetting. Using extra force may cause the tips to inadvertently stick onto the tip cone which then requires increased tip ejection force. In a worst case scenario tips have to be detached by hand, increasing the risk of contamination. In addition, excess force causes premature tip cone wearing resulting in an impaired seal.

Also, a common feature associated with multichannel pipetting is the need of rocking and banging the pipette to attach the tips firmly. These additional repetitive movements further add strain to the shoulder and arm area.

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ClipTip Interlocking Technology

The innovative ClipTip interlocking tip attachment technology is based on flexible clips being distributed evenly around the upper edge ring of the tip. The force needed to attach the ClipTip tip is equal to the force needed to open the three flexible clips, requiring no friction to keep the tip attached. Due to this unique technology, the tips are attached and ejected with minimal force. During tip attachment the shape of the tip cone opens the clips. The clips lock the tip behind the flange creating a complete seal with the sealing ring which also prevents them from potentially falling off. Tip ejection is achieved by opening the clips with the clip opener mechanism.

Materials and Methods

1. Minimum tip attachment and ejection force measurements

The minimum tip attachment and ejection forces were measured from 12-channel pipettes with a volume range 20/30–300 µl. The test samples were F1-ClipTip with an interlocking tip attachment mechanism, and three models with a friction-based tip attachment mechanism (Manufacturers A, B and C). One pipette model had a cylindrical tip fitting design, one a conical tip fitting design and spring loaded tip cones and one a conical tip fitting design.

The minimum tip attachment force was the force that was needed to achieve a complete seal between the tip and the tip cone of the pipette. The seal was confirmed by aspirating liquid into the tip and checking that there was no leakage. Touch-off was not included in the measurements.

The tip attachment and ejection forces were measured in a standardized way using a balance for the attachment force and a digital force gauge for the ejection force.

The tests were performed with pipette tips recommended by the manufacturer of each pipette model. The measurements were repeated five times with each pipette and the mean of the results was calculated.

2. Typical tip attachment force measurements

Typical tip attachment forces were measured using a balance. The test pipette was a traditional friction-based 12-channel pipette together with compatible tips. Users were asked to apply the force they normally would use to attach the tips. Attachment was done by pushing the pipette against the tips. There was no hand-tightening of tips to ensure a sufficient seal. The applied forces were recorded.

Results

1. Tip attachment and ejection forces

The results of the measurements are shown in Figures 1 and 2.

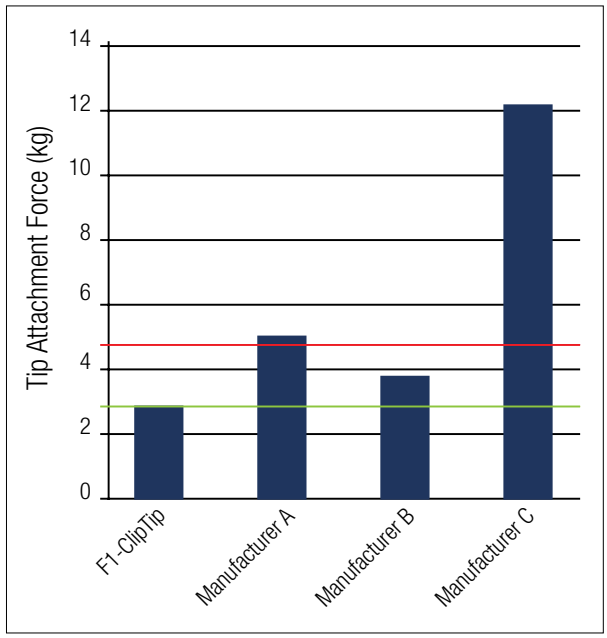

Figure 1. Minimum tip attachment forces with 300 µl 12-channel pipettes. The red line shows the average tip attachment force with friction-based systems enabling filling a microplate with the same tips. The green line shows the average tip attachment force with the ClipTip interlocking system enabling filling a microplate with the same tips.

The results show that with the F1-ClipTip Pipetting System, the tip attachment forces needed were 25% to 81% of the forces needed with friction-based pipettes (Manufacturers A, B and C). Forces tested were the ones required to attach the tip and dispense once without leakage.

When using the same tips for multiple dispensing (for example when pipetting into a microplate) they may loosen and eventually fall off due to decreased friction between the tip cone and the tips. In the previous note (2) we showed that with friction-based systems—when applying an attachment force of 3.8 kg—tips were attached, but some tips fell off after pipetting 8 times. An average force of 4.8 kg was needed to complete a microplate by using the same tips without tips falling off during dispensing.

With the F1-ClipTip Pipetting System all tips remained attached with the minimum attachment force of 3.0 kg. Thanks to the interlocking tip interface, once the ClipTip tips are attached, they are locked until released by the tip ejector. This prevents tips falling off or loosening in the middle of the assay.

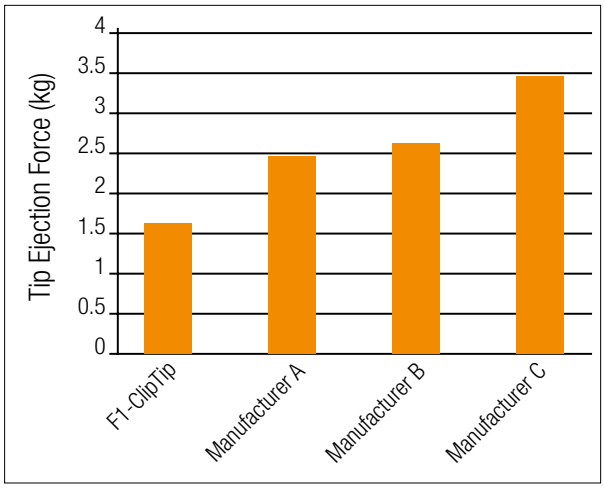

Figure 2. Minimum tip ejection forces with 300 µl 12-channel pipettes.

Tip ejection forces of the F1-ClipTip Pipetting System were 50% to 71% of the forces needed with traditional friction-based pipettes (Manufacturers A, B and C).

The F1-ClipTip System showed both low tip attachment and ejection forces compared to pipette systems with friction-based tip attachment technology. The low forces reduce the strain on thumb and upper limbs, resulting in lower risk of RSI—combined with outstanding comfort.

2. User variation

Figure 3 shows the forces randomly selected users applied when attaching tips with traditional friction-based pipettes.

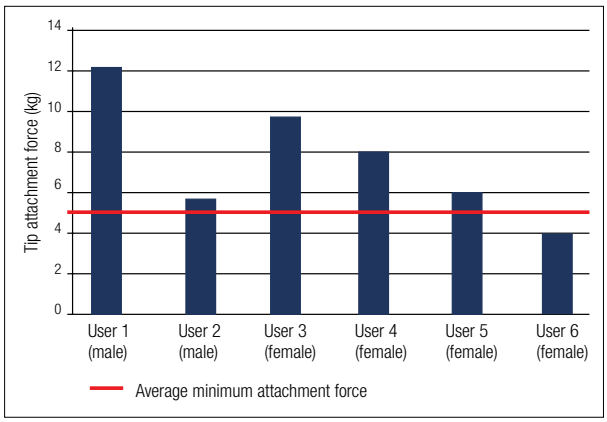

Figure 3. Tip attachment forces applied with 300 µl friction-based 12-channel pipettes.

Tip attachment forces applied by different users varied between 4 kg and 12 kg. The force used was over 5 kg in most cases, and that was enough to attach the tips. Unnecessary force was applied by two users. This might explain the earlier experience of tips falling off during pipetting. The user wants to minimize the risk of tips getting loose or falling off, and over-tightens the tips. However, over tightening of tips may cause them to leak due to worn out tip cones, and potential air gaps in the seal. With one user the force was below 4 kg which may result in tips falling off during pipetting, or leakage may occur.

The ClipTip technology allows users to easily apply the correct attachment force ensuring secure tip attachment and a complete seal. Together with the "click" sound, users will quickly learn to apply the correct attachment force. This will result in decreased user-to-user variation when compared to friction-based systems.

With the F1-ClipTip pipetting system users does not have to worry whether the tip attachment force applied is high enough to keep the tips attached through the entire assay. If sufficient force is not reached during attachment the tip remains in the rack making it impossible to perform an assay with loose or leaking tips.

Altogether, F1-ClipTip pipetting system offers users worry free pipetting, and newfound security.

Conclusion

In this technical note we showed the lightness required for tip attachment and ejection when using F1-ClipTip pipettes. Even with 12-channel pipettes the forces needed were minimal, which helped to improve pipetting ergonomics and reduce the risk of RSI—particularly in multichannel pipetting. The secure tip attachment of the F1-ClipTip System increases confidence, and reduces strain and user variation in everyday pipetting.

References

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