Chronic intractable pain presents a treatment challenge for interventional pain physicians. Previous studies have demonstrated the efficacy of high frequency spinal cord stimulation at 10 kHz (10 kHz SCS) in providing durable pain relief, along with high long-term responder rates in both a randomised controlled trial and real-world study setting.1,2 Despite these advances, a small number of patients may remain refractory to long-term pain relief, requiring a more versatile therapeutic approach to optimize their success (Fig 1 and 2.). The objective of this retrospective audit is to investigate how increased versatility and paired waveforms can improve outcomes in a select challenging population.

**Early Clinical Experience with Waveform Pairing**
- Retrospective audit, 493 patients across 4 Australian sites.
- Selected patients not achieving adequate pain relief and exhausted current therapy options
- Hypothesized as may needing additional waveforms or mechanisms of action to optimize pain relief
- Provided Frequency Pairing or BurstTM at physician discretion
- n=26 consecutive patients (Table 1)

**Table 1. Demographics**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predominant Back</td>
<td>10/26 (38.5%)</td>
</tr>
<tr>
<td>Back = Leg</td>
<td>6/26 (23.1%)</td>
</tr>
<tr>
<td>Other</td>
<td>10/26 (38.5%)</td>
</tr>
<tr>
<td>Predominant Leg</td>
<td>0/26 (0%)</td>
</tr>
</tbody>
</table>

**Waveform Pairing – Responder Rate**

- Frequency Pairing – 20/26 (77%
- Burst10k – 6/26 (23.1%)

**Results**

- Minimum Clinical Important Difference: Pain Relief
- Proportion of patients reporting a minimum clinical important difference (30%)3 in pain intensity from baseline

**Conclusions**

Promising results using waveform pairing combining LF or Burst with 10,000 Hz in difficult to treat patients
- Clinically meaningful improvements
  - MCID in pain relief improved from 30% to 76% at approx. two and a half months
  -Responder rates improved from 17% to 60% at approx. two and a half months
  - Improved sleep and function
  - Reduction in pain medications

Further real world data around waveform pairing will be collected and shared in the future

Here we demonstrate that increased versatility and paired waveforms may help improve therapeutic outcomes in difficult populations

**References**

**Method**
- **Introduction**
  - Direct Neural Inhibition
  - Paired Waveforms
  - Dorsal Column Stimulation

**Direct Neural Inhibition**
- Quiets neural activity by directly targeting dorsal horn above 5 kHz

**Paired Waveforms**
- Merging HF10 therapy with dorsal column stimulation for two simultaneous mechanisms of action

**Dorsal Column Stimulation**
- Quiets nerves indirectly by using dorsal column fibers

**Fig 1. Waveform Versatility – Paired Waveforms**

- There are two distinct mechanisms of action in spinal cord stimulation: Direct Neural Inhibition and Dorsal Column Stimulation. Direct Neural Inhibition directly targets pain causing neurons in the dorsal horn. Pre-clinical and clinical research shows this mechanism only becomes effective at frequencies above 5 kHz. The second mechanism is Dorsal Column Stimulation, which is based on mapping paresthesia to the pain location. Therapies that rely on this approach include traditional stimulation therapies at 40-60 Hz, burst waveforms or therapies at 1 kHz. With waveform versatility we can pair these unique mechanisms, gaining access to both mechanisms, independently or paired allows the versatility needed to achieve the best possible clinical outcomes.

**Fig 2. Waveforms Across Multiple Mechanisms**

- The various waveforms. The top graphic demonstrates constant delivery of 10,000 Hz, whilst pulse dosing delivers the same therapy in packets. Pulse dosing can reduce charge requirements significantly while maintaining efficacy.

- Frequency Pairing combines HF10 with traditional 40-60 Hz – either two frequencies or 1000 Hz or paired with a burst waveform.
- With the paired waveforms, the two mechanisms of action work simultaneously.

**Waveform Pairing – Quality of Life Outcomes**

- Improved SLEEP since last follow up*
  - Data available for n=18
  - Yes: 10/18 (55.5%)
  - No: 8/18 (44.4%)
- Improved FUNCTION since last follow up*
  - Data available for n=13
  - Yes: 14/13 (103.1%)
  - No: 5/13 (38.5%)
- Change in PAIN MEDICATION since last follow up*
  - Data available for n=21
  - Decreased: 8/21 (38.1%)
  - Increased: 12/21 (57.1%)

*Last Follow Up: (72.9 ± 12.6 days)