Author Year Country Research Design Score Sample Size	Methods	Outcome
Fenton et al. 2016 USA RCT PEDro = 6 Level 1b N = 33	**Population:** 33 patients with cervical SCI on MV (25M, 8F) Mean (SD) age: 33.1 (11.7) years. **Treatment:** control – standard MV V_T (10 ml/kg); experimental – higher ventilation V_T (20 ml/kg). **Outcome Measures:** Days to ventilator weaning, FVC, peak inspiratory pressure (PIP); plateau pressure, pulmonary adverse events, and Borg scale.	1. No significant between group difference in number of days for ventilation weaning, even after controlling for age. 2. No significant between group difference in increase of FVC. 3. Significant between group difference in increase of PIP and plateau pressure each day.
Gundogdu et al. 2017 Turkey Case control Level 3 N = 35	**Population:** 35 patients with cervical SCI with MV and/or TOT tube for a prolonged period (defined as the need for ≥ 21 consecutive days); 28 males and 7 females; mean (SD) age 29.2 (± 12.1) years; high tetraplegia (n = 7) and low tetraplegia (n = 28). **Intervention:** Implementation of a respiratory rehabilitation protocol, consisting in respiratory assessment (nutritional, cough strength, diaphragm, dysphagia and aspiration, and red flags periodic assessments), and in respiratory management (clearance of airway secretions, ventilator muscle training, MV weaning, swallowing therapy, TOT decannulation and discharge planning	1. MIP, MEP, and PCF values of MV-dependent patients before/after the weaning protocol were significantly improved ($p = 0.005$, $p = 0.005$ and $p = 0.012$, respectively). Pre/post treatment PCF values were also significantly improved in tracheostomized patients ($p < 0.001$). 2. 70% of MV-dependent patients were successfully weaned from MV and TT, and TOT closure was possible in 96% of the cases. In total, 85.7% of patients were decannulated. The mean duration of weaning from MV and TT decannulation were 37.0 ± 11.6 and 31.7 ± 16.9 days, respectively.

	and vaccination). Patients were retrospectively divided in two groups (with periods from 3 to 12 weeks): ● MV-dependent patients (n = 10) underwent respiratory rehabilitation, MV weaning and a TT decannulation program. ● Tracheostomized patients (n = 25) underwent respiratory rehabilitation and a TT decannulation program. **Outcome Measures:** Diaphragmatic (chest X-ray, conduction study, needle EMG and fluoroscopy), respiratory (mean MIP, mean MEP, mean peak cough flow [PCF]) and swallowing (mean bedside dysphagia screening test, mean flexible fiber optic endoscopic evaluation of swallowing, total dysphagia, weaning time, TT decannulation time, weaned from MV, decannulated completion) evaluation.	
Toki et al. 2021 Japan Retrospective case series Level 4 N = 14	**Population:** 14 patients with SCI and ASIA A; 13 males and one female; mean age 28.1 years; level of injury C1 (n = 8), C2 (n = 5), and C3 (n = 1); and referred for switching their mechanical respiratory systems from TOT ventilation to NIV. **Treatment:** Protocol of NIV which assess ventilator setting, interface, and respiratory training in 5 steps.	1. 11 patients were switched to NIV during hospitalization. 2. History of TOT ventilation of <1 year correlated with successful switching (100%), compared with TOT ventilation of ≥1 year (57%, P < 0.05). The use of NIV did not cause major clinical complications during a period of 2 years. 3. The reasons for failure of NIV in the remaining (n = 3) patients were an episode of loss of consciousness during

	Outcome Measures: Respiratory function tests were measured before and after NIV (VC, maximal insufflation capacity, glossopharyngeal breathing [GPB] maximum single breath capacity, and CPF). Patients who were successfully switched to NIV underwent physical examination and respiratory function tests (clinical neurological status, post-discharge complications, ventilator-free tolerance, and social status) more than 2 years (11 to 71 months) after discharge from the hospital.	NIV step 4 protocol, concerning about change in lifestyle and fear of difficulty in expectoration, and the advice against the use of NIV of family physician.
Kaufman et al. 2022 USA Pre – post Level 4 N = 10	**Population:** 10 patients with ventilator-dependent cervical tetraplegia and ASIA A, 7 males and 3 females, mean age 28 (16-47) years, average time from injury 17 (1 – 48) months, and failed prior attempts at NIV and weaning protocols. **Intervention:** The treatment protocol included a surgical algorithm that involved DP, phrenic nerve reconstruction, and diaphragm muscle replacement. Treatment selection was based upon the extent of neuromuscular dysfunction, prior failed attempts at pacemaker implantation, and duration of paralysis: ● Group I - Pacemaker alone (n = 2).	1. PW (4/10) or CW (4/10) was achieved in 80% of patients whereas the remaining two patients (Group II) have demonstrated ↓VR without weaning (NC) as of the most recent follow-up (<1 year). 2. The mean duration from surgery to observed ↓VR was 4 months, and the overall mean follow-up was 23 months (range = 6–58 months). 3. Complications consisted of one patient who developed post-operative mucous plugging managed conservatively, and three patients who required pacemaker lead or receiver replacement due to malposition or malfunction.

	• Group II - Pacemaker + phrenic nerve reconstruction (n = 6). • Group III - Pacemaker + diaphragm muscle replacement (n = 2). **Outcomes measures:** Time from surgery to observed reduction in ventilator requirements (↓VR), specific ventilatory needs as of most recent follow-up [no change (NC), partial weaning (PW = 1–12 h/day without MV), or complete weaning (CW ≥ 12 h/day without MV)], and complications.	
Romero-Ganuza et al. 2015 Spain Retrospective Review Level 4 N = 228	**Population:** 228 patients with SCI Group 1: acute phase patients from ICU with respiratory failure (N=68; 49M 19F); mean age (SD): 53.8(16.6); AIS-A/B/C/D: 42/13/10/3; cervical/thoracic: 55/13; traumatic/nontraumatic: 40/28 Group 2: patients from community with respiratory complications or scheduled follow-ups (N=160). **Treatment:** MV. **Outcome Measures:** Institutionalization status, duration of MV, length of stay.	1. At discharge* of acute phase patients: 20 with permanent MV, 23/26 succeeded in weaning after a mean of 47.3(49.3) days, 13/22 already weaned patients received TOT closure, 5 expired; mean length of stay 195.6(110.4) days. 2. At discharge* of patients with complications: 9 patients admitted with MV, 6 weaned after a mean of 17.2(19.3) days; mean length of stay 53.1(56.3) days. 3. MV patients significantly more likely to be institutionalized after discharge* *discharge from intensive respiratory care unit (IRCU)
Wong et al. 2012 USA Case series Level 4 N = 24	**Population:** 24 participants with high cervical (C1-4) SCI (22M 2F); mean(SD) age: 33.4(16.6); DOI before transfer to SCI specialty unit (and start of treatment): 33.8(24.4) days.	1. The respiratory status of all the study patients improved with the specialized respiratory management administered in the SCI specialty unit. For most of these patients, respiratory

	Treatment: High Tidal Volume Ventilation (HVtV) treatment; High Frequency Percussive Ventilation (HFPV) treatment; and Mechanical Insufflation-Exsufflation (MIE) treatment. **Outcome measures:** V_T; days before being weaned to room air; peak inspiratory pressure (PIP); plateau pressure (Pplat).	improvements were noted within 1 week of admission to the SCI unit. 2. Tidal volume for all patients was stabilized at 12-15mL/kg ideal body weight (mean (SD) V_T = 1037.5 (140.8)). 3. Nine (37.5%) patients were weaned to room air in ≤7 days, and another 5 patients were weaned to room air in ≤14 days. The average time for 23 out of the 24 participants to be weaned to room air was 16.3 days (*SD* 20.8). 4. 23 (96%) patients were transitioned to portable ventilators (average time 7.7 days post admission SD 5.0). 5. 14 patients were weaned from the ventilator (average time 27.6 days post admission SD 12.9 days).
Onders et al. 2010 USA Case series Level 4 N = 20	**Population:** N=20 people with SCI (17M 3F); 16-61 years old; all with internal cardiac pacemakers; all tetraplegia; 0.5-24 YPI. **Treatment:** Implantation of DP electrodes. **Outcome Measures:** Hours of daily use of DP, implantation, negative interactions between cardiac pacemaker and DP (device-to-device interaction), conditioning, ability to wean from MV.	1. There were no peri-operative complications in any patients, nor device-to-device interactions in 19/20 patients. 2. There was device-to-device interaction in 1 patient, which was resolved by disabling the interacting electrode in question. 3. All patients achieved diaphragm paced V_T necessary to meet their basal metabolic needs. 14/20 patients finished conditioning with their diaphragm and reached their maximal goal. 4. Ten of the above 14 use DP 24 hours a day with no MV. 5. Three other patients use DP 8-12 hours during the day,

		with 1 reaching a maximum of 4 hours by choice. 6. The remaining 5 participants (excluding the early death), were still increasing their DP sessions through conditioning at the end of the study.
Gutierrez et al. 2003 USA Pre-post Level 4 N = 7	**Population:** 7 tetraplegia: C2(n=2), C4-C7(n=5), incomplete, all male, age range: 45-68 years, time on ventilator: 4-36 months. **Treatment:** Implementation of an evidence-based resistive endurance protocol designed to help discontinue MV by improving ventilatory muscle strength and endurance. **Outcome Measures:** Pulmonary function tests; on-ventilator endurance and off-ventilator endurance.	1. Participants with low tetraplegia achieved significant gains in inspiratory & and expiratory muscle strength, VC, mean on-ventilator endurance & off-ventilator endurance. 2. Participants with high tetraplegia had non-significant improvements in inspiratory and expiratory muscle strength and VC and were able to discontinue MV. 3. 4/5 participants with low tetraplegia were weaned from the ventilator. 1/5 low tetraplegic participants died.
Peterson et al. 1994 USA Case Series Level 4 N = 52	**Population:** Tetraplegia (C3-C4), ventilator dependent. **Treatment:** Retrospective review of 82 ventilator weaning attempts in 52 participants using intermittent mandatory ventilation (IMV), progressive ventilator free breathing (PVFB) or a combination of other ventilator weaning techniques. **Outcome Measures:** Successful ventilator weaning.	1. 26/82 weaning attempts used IMV, 34/82 used PVFB and 22/82 used a combination of various techniques. 2. PVFB weaning success rate was 67.6 % (23/34) and IMV was 34.6% (9/26) and other techniques was 11/22. 3. Overall 43/52 (83%) of participants were successfully weaned. 6/52 were partially weaned. 2/52 participants died.