Author Year Country Research Design Sample Size	Methods	Outcomes
Ihalainen et al. 2017 Finland Prospective Cohort N=37	**Population:** Mean age: 61.2 yr; Gender: males=31, females=6; Injury etiology: Sport=2, Transport=6, Fall=28, Unknown=1; Level of injury: C1-C4=32, C5-C8=4, Unknown=1; Level of severity: AIS A=8, AIS B=3, AIS C=5, AIS D=21; Mean time since injury: 16.4 days. **Intervention:** Clinical swallowing trial and Videofluoroscopic Swallowing Study (VFSS) to identify laryngeal penetration or aspiration. **Outcome Measures:** Rosenbek's Penetration-Aspiration Scale (PAS), risk factors for laryngeal penetration or aspiration.	1. Results of the PAS divided patients into two groups: penetrator/aspirators (n=19) and non-penetrator/aspirators (n=18). 2. The two groups were significantly different in necessity for bronchoscopy (p=0.042), coughing (p=0.007), and changes in voice quality (p=0.004).
Shem et al. 2012 USA Prospective Cohort N=40	**Population:** Mean age: 41.0 yr; Gender: males=31, females=9; Injury etiology: Motor vehicle accident=9, Fall=7, Gunshot wound=3, Diving=6, Bicycle accident=4, Motorcycle accident=2, Other=9; Level of injury: C4 or higher=29, C3 or lower=11; Level of severity: Not reported; Mean time since injury: 14.3 days. **Intervention:** Presence of dysphagia was determined in patients using a Bedside Swallowing Examination (BSE), and a Videofluoroscopy Swallow Study (VFSS). **Outcome Measures:** Risk factors for dysphagia, medical complications resulting from dysphagia.	1. Significant risk factors for dysphagia included: age (p=0.016), tracheostomy tube (p=0.013), mechanical ventilation (p=0.003), and nasogastric tubes (p=0.027). 2. There was a trend towards significance for halo vest usage as a risk factor (p=0.076). 3. In terms of medical complications, individuals with dysphagia have significantly higher occurrences of pneumonia (p=0.004). 4. There was a statistical trend for longer length of stays for individuals with dysphagia (p=0.064), and days to BSE was marginally significant (p=0.047).
Shem et al. 2012b USA Prospective Cohort N=39	**Population:** Mean age: 41.6 yr; Gender: males=30, females=9; Injury etiology: Motor vehicle accident=9, Fall=7, Gunshot wound=3, Diving=6, Bicycle accident=4, Motorcycle accident=2, Other=8; Level of injury: C4 or higher=28, C3 or lower=11; Level of severity: Not reported; Mean time since injury: 14.1 days. **Intervention:** Presence of dysphagia was determined in patients using a Bedside Swallowing Examination (BSE), and a Videofluoroscopy Swallow Study (VFSS). Sensitivity and specificity of the BSE was determined in reference to the VFSS. **Outcome Measures:** Risk factors for dysphagia, medical complications resulting from dysphagia.	1. Dysphagia diagnosis was significantly associated with: mechanical ventilation (p=0.005), presence of pneumonia (p=0.007), older age (p=0.015), a tracheostomy (p=0.019), a nasogastric tube (p=0.023), and a greater length of stay (p=0.023). 2. There was a trends towards significance for halo vest use as a risk factor (p=0.066), and days to BSE (p=0.068) as a complication.
Shem et al. 2011 USA Prospective Cohort N=29	**Population:** Mean age: 41.0 yr; Gender: males=22, females=7; Injury etiology: Motor vehicle accident=5, Fall=7, Gunshot wound=3, Diving=3, Bicycle accident=3, Motorcycle accident=3, Other=5; Level of injury: C1=1, C2=3, C3=7, C4=10, C5=4, C6=2, C7=2; Level of severity: Not reported; Mean time since injury: 12.9 days. **Intervention:** Presence of dysphagia was determined in patients using a Bedside Swallowing Examination (BSE), and a	1. Significant risk factors for dysphagia included: age (p=0.028), presence of a tracheostomy (p=0.047), and use of a nasogastric tube (p=0.029). 2. Non-significant risk factors included: presence of a halo vest (p=0.081), posterior spine surgery (p=0.090), anterior spine surgery (p=0.82), gender (p=0.43), presence of a head injury (p=0.26), high versus low tetraplegia (p=0.79), complete injury (p=0.30) and presence of a collar

	Videofluoroscopy Swallow Study (VFSS). **Outcome Measures:** Risk factors for dysphagia, medical complications resulting from dysphagia.	(p=0.97). 3. Individuals with dysphagia had significantly higher occurrences of pneumonia (p=0.016). 4. As well for individuals with dysphagia, complications that trended towards significance included: need for bronchoscopy (p=0.054) and length of stay (p=0.064).
Shin et al. 2011 Korea Retrospective Cohort N=121	**Population:** Mean age: 44.9 yr; Gender: males=105, females=16; Injury etiology: Motor vehicle accident=81, Fall=26, Diving=4, Other traumatic=7, Non-traumatic=3; Level of injury: Cervical SCI; Level of severity: AIS A=72, AIS B=20, AIS C=19, AIS D=10; Mean time since injury: 178.35 days. **Intervention:** Presence of dysphagia/aspiration was determined using Videofluoroscopy Swallow Study (VFSS). **Outcome Measures:** Aspiration prevalence, risk factors for aspiration.	1. VFSS found aspiration in 10 patients. 2. Aspirators compared to non-aspirators were significantly older in age (p=0.044). 3. Aspiration was more common for patients with tracheostomy (p=0.011). 4. Significantly higher incidences of aspiration were found for patients with symptoms of dysphagia (p=0.002) and signs of dysphagia (p=0.001).
Seidl et al. 2010 Germany Retrospective Cohort N=175	**Population:** Mean age: 43.5 yr; Gender: males=144, females=31; Injury etiology: Fracture 1 vertebral body=73, Fracture 2 vertebral bodies=47, Fracture >2 vertebral bodies=16, Spondylodiscitis=15, Contusio spinalis=10, Tumour=5, Spinal stenosis=4, Nuclear pulposus prolaps=3, Knife wound=1, Postoperative=1; Level of injury: C0=1, C1=1, C2=4, C3=14, C4=58, C5=53, C6=33, C7=6, C8=5; Level of severity: Frankel A=103, Frankel B=19, Frankel C=21, Frankel D=24, Frankel E=8; Time since injury: Participants were recruited within 8 wk of their injury. **Intervention:** Swallowing ability was examined with a clinical bedside bolus-swallowing test by a speech therapist, and an endoscopic-swallowing test. **Outcome Measures:** Risk factors for dysphagia.	1. Swallowing disorders were most common in patients with the highest grade of sensorimotor deficit, however this was not significant (p>0.05). 2. Posterior and combined approach surgery patients had a non-significant higher rate of swallowing disorders (p>0.05). 3. Swallowing disorders increased significantly with lower levels of tetraplegia (p<0.05), tracheotomies (p<0.05), and duration of ventilation (p<0.05).
Brady et al. 2004 USA Case Control N=131	**Population:** *Dysphagia Group (n=72):* Mean Age=55.5yr; Gender: Male=13, Female=59; Type of Injury: Traumatic injury (66.4%), Non-traumatic (30.6%); Respiratory Status: Tracheotomy tube=24; Type of Cervical Spine Surgery: Anterior=31, Posterior=11, Combined=10, None=20. *Non-Dysphagia Group (n=59):* Mean Age=55.9yr; Gender: Not Reported; Type of Injury: Traumatic=40, Non-traumatic=19; Respiratory Status: Tracheotomy tube=6; Type of Cervical Spine Surgery: Anterior=14, Posterior=18, Combined=4, None=23. **Intervention:** Chart reviews were conducted on patients admitted to two rehabilitation hospitals within a 27mo period. All patients were screened for dysphagia upon admission. Those clinically suspected of experiencing dysphagia were referred for further evaluation with a speech-language pathologist. **Outcome Measures:** American Speech-Language-Hearing Association National	1. The presence of a tracheostomy tube to assist the patient was significantly predictive of the occurrence of dysphagia (p=0.002) with one in three dysphagic patients having had a tracheostomy inserted compared to one in ten non-dysphagic patients. 2. There was a significant difference between the two groups concerning the type of surgery. Dysphagic patients were significantly more likely to have undergone cervical surgery, particularly the anterior approach, compared with the non-dysphagic patients (p=0.02). 43.1% of patients with dysphagia underwent anterior approach surgery. 3. ASHA NOMS scores at discharge revealed that the presence of a tracheostomy tube (p=0.02), receiving fewer days of treatment (p=0.04) and demonstrating aspiration (p=0.0001) were negative predictors of

	Outcomes Measurement swallowing level scale (ASHA NOMS), type of surgery, respiratory status. Reviewed data had been collected at admission and at discharge from rehabilitation.	dysphagia recovery.
Kirshblum et al. 1999 USA Case Control N=187	**Population:** Mean age: 44.3 yr; Gender: males=156, females=31; Injury etiology: Fall=64, Motor vehicle accident=65, Gunshot wound=9, Diving=31, Other=18; Level of injury: C7 and below=15, C6=21, C5=43, C4=63, C3=25, C2 and above=20; Level of severity: AIS A=71, AIS B=5, AIS C=59, AIS D=48, AIS E=4; Median time since injury: 30 days (range: 5-264 days). **Intervention:** Videofluoroscopic Swallowing Study (VFSS) to confirm the presence of dysphagia. **Outcome Measures:** Risk factors for dysphagia.	1. Significant predictors for dysphagia included: older age (p=0.028), history of tracheostomies (p<0.0001), ventilator status (p<0.001), anterior approach cervical spine surgery (p=0.016), higher level injuries (p=0.012), and ASIA impairment classification (p=0.02).
Hayashi et al. 2017 Japan Retrospective case series N=298	**Population:** Median age: 64.0 yr; Gender: males=256, females=42; Level of injury: C3-C7; Level of severity: AIS A=98, AIS B=38, AIS C=127, AIS D=35; Time since injury: approximately 3 days. **Intervention:** Retrospective review of patients with acute cervical spinal cord injury for presence of dysphagia or not. Suspected associated risk factors for dysphagia were also recorded and put into a multivariable logistic regression. **Outcome Measures:** Risk factors for dysphagia.	1. Multivariable logistic regression analyses revealed that the following were significant risk factors for dysphagia: age greater than 72 yr (p=0.02), AIS A or B (p=0.008), and presence of a tracheostomy (p<0.001).
Shem et al. 2005 USA Case Series N=68	**Population:** Mean Age=33yr; Severity of Injury: ASIA A=36, ASIA B=7, ASIA C=12, ASIA D=13; Level of Injury: C2=1, C3=11, C4=56; Mean Time Post-Injury=8.8d. **Intervention:** Chart reviews were conducted on patients' medical records existing on the SCI National Database and were admitted to acute inpatient rehabilitation between 1998 and 2002. Data collected upon patient admission was analysed for contributing risk factors and predictors of dysphagia. **Outcome Measures:** Bedside Swallow Evaluation, type of surgery, presence of tracheostomy, ventilator status.	1. Although patients who also underwent cervical fusion surgery reported more cases of dysphagia and a longer mean time returning to a regular diet, cervical fusion was not a statistically significant risk factor for dysphagia. 2. Patients who had been intubated with a tracheostomy tube demonstrated a higher incidence of dysphagia than patients that did not receive a tracheostomy tube (p=0.0002). 3. Furthermore, patients with a tracheostomy tube took a significantly longer amount of time returning to their regular diet than non-tracheostomy patients (p<0.0001). 4. Patients who required ventilator support were also significantly more likely to experience dysphagia post-surgery (p=0.04) and took significantly longer to return to regular diet (p=0.0083). 5. The use of a Halo Skeletal Fixator was not significantly associated with diagnosis of dysphagia or mean time to eating a regular diet.
Chaw et al. 2012 USA Observational	**Population:** Mean age: 43.0 yr; Gender: males=57, females=11; Injury etiology: Motor vehicle accident=18, Fall=13, Diving=9, Bicycle accident=5, Gunshot wound=5, Motor	1. Risk factors that were significantly related to dysphagia included: ventilator status (p=0.012), presence of tracheostomy (p=0.028), and use of a NG tube (p=0.049).

N=68	cycle accident=4, Medical=4, Myelopathy=4, Trauma=4, Other=2; Level of injury: C1=2, C2=6, C3=14, C4=6, C4 (incomplete)=21, C5 (incomplete)=10, C6 (incomplete)=4, C7 (incomplete)=3, C8 (incomplete)=2; Level of severity: Complete=28, Incomplete=40; Mean time since injury: 31.8 days. **Intervention:** Bedside Swallowing Examination (BSE), which was followed by Videofluoroscopy Swallow Study (VFSS) within 72 hr. **Outcome Measures:** Risk factors for dysphagia.	Other risk factors were non-significant ($p>0.05$). 2. Individuals with dysphagia had significantly higher occurrences of pneumonia ($p<0.001$). 3. There were no significant differences between those with and without dysphagia on: bronchoscopy need ($p=0.23$), rate of re-intubation ($p=0.14$) or length of stay ($p=0.087$).
Abel, Ruf & Spahn 2004 Germany Observational N=73	**Population:** Mean age: 42.9 yr; Gender: males=51, females=22; Injury etiology: Trauma=56, Spondylitis=5, Tumour=3, Other=9; Level of injury range: C1-C7; Level of severity: AIS A (complete)=41, incomplete=32; Mean time since injury: Not reported. **Intervention:** Patients with cervical SCI admitted to an initial care facility between January 1997 to December 2000. Prevalence of pneumonia via x-rays, and dysphagia via methylene blue test and videofluoroscopic swallowing, were determined at intake and discharge. Changes in dysphagia status were observed after tracheostomies, surgery to the cervical spine and dietary restrictions. **Outcome Measures:** Risk factors for dysphagia.	1. Patients with higher levels of cervical injury are more significantly likely to have a swallowing disorder ($p<0.05$). 2. Tracheostomy was strongly associated with the incidence of dysphagia ($p=0.00014$). 3. Anterior spinal surgery did not result in a significant contribution to dysphagia ($p=0.42$). 4. Patients with oral phase problems required dietary modifications at a significantly higher rate than those with problems in the pharyngeal phase ($p=0.044$). 5. At discharge, 9/26 cases had their dysphagia resolved.