Internal Derangements of the Temporomandibular Joint

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Definition of various internal derangements

Internal derangement is defined as any interference with smooth joint movement. Although the term therefore includes all types of intra-articular interferences that impede smooth functional joint movements, with regard to the temporomandibular joint (TMJ) the term is typically used interchangeably with disc displacement. In this article, several other types of internal derangements are discussed. Besides the common derangements, disc adherences, disc adhesions, subluxations, and dislocations of the disc–condyle complex are also discussed (Table 1).

Stegenga and de Bont [1] most recently made a case for a name change of the phenomenon of disc displacement. They argued that adhering to the so-called “12 o’clock position” as the normal position of the posterior band of the disc relative to the condyle might lead to overdiagnosis of this particular disorder, because a displaced disc does not always lead to clinical symptoms. They therefore proposed to replace the word “displacement” with “derangement,” which would indicate that the displaced disc actually interferes with smooth joint movement and causes some type of dysfunction to the individual. Imaging studies have found disc displacements in 23% to 33% of asymptomatic volunteers [2–4].

A disc derangement is defined as a malpositioning of the articular disc relative to the condyle and eminence. Theoretically, a disc may be displaced to varying degrees and in any direction (ie, anterior, posterior, lateral, or medial). Rarely is a disc displaced purely in one direction, with the possible exception of anterior displacement. Posterior displacements have been described but are infrequent [4–7]. Pure sideways displacements seem to be rare also [2,8] and may be related to more advanced stages of derangement [9]. The most common type of disc derangement is an anterior displacement [4]. Controversy exists about which type of displacement is next most common. Some studies report more often anteromedial derangements [10,11], some found more often anterolateral derangements [2,8], and others report an even distribution of anteromedial and anterolateral derangements in patients and healthy volunteers [4].

With regard to clinical diagnosis and treatment, two predominant stages of disc derangements are distinguished. The respective conditions are called disc derangement with reduction and disc derangement without reduction. In a normal TMJ, the disc is positioned over the condylar head with the posterior band situated in the 12 o’clock (superior to the condyle) position and the intermediate zone situated in the 1 o’clock (superior-anterior to the condyle) position. On opening the disc–condyle complex translates in a forward direction. Although the condyle also rotates forward, the disc relatively rotates in a posterior direction over the condyle. Disc derangement with reduction is typically defined as a condition in which the articular disc of the TMJ is (most often anteriorly) displaced while the mouth is closed and the teeth are together in maximal occlusion. On opening, the condyle pushes against the posterior band of the disc until the condyle is able to slide or snap under the posterior band of the disc, and the disc reduces to its position on top

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of the condyle. Overcoming the thick posterior band of the disc is believed to be responsible for the clicking or popping sound. On closing the mouth, the disc stays behind and slips off the condyle, which may be accompanied by a clicking sound. Typically, the opening click occurs later during the opening movement, whereas the closing click often occurs close to maximal occlusion.

Disc derangement without reduction is defined as a condition in which the condyle is unable to slide or snap back underneath the disc. The (anteriorly) displaced disc thus does not reduce to its position on top of the condyle during the opening movement. The disc is obstructing further translation of the condyle and consequently the opening and contra-lateral movements are impaired.

Disc adherence is defined as a temporary sticking of the disc either to the fossa or to the condyle. Adherence can be caused by prolonged static loading or lack of lubrication or a combination thereof. Oftentimes patients report difficulties with jaw opening on awakening. On attempts to move the jaw, generally the adherence can be overcome; this is often accompanied by a loud single pop or click. The condition should not be confused with disc derangement with reduction or subluxation. Another condition that has similar characteristics has been termed anchored disc phenomenon [12]. It is believed that the disc is stuck to the fossa because of compromised lubrication. A strong adhesive force prevents the disc from being separated from the fossa or condyle by simply moving the jaw. This phenomenon may resemble a disc derangement without reduction, although a history of clicking is frequently absent and the limitation of mouth opening is said to be more severe [12]. Disc adhesion is defined as a fibrotic connection between the disc and the condyle, or the disc and the fossa. This condition is characterized by limited jaw movements. In contrast with an adherence, an adhesion cannot be overcome by simple jaw movements. This condition should be distinguished from disc derangement without reduction or fibrous ankylosis. For disc adherence or adhesion to occur the disc does not have to be deranged.

Subluxation (sometimes referred to as hypermobility) is defined as an overextension of the disc–condyle complex on opening. On opening, the disc–condyle complex passes beyond the eminence. Typically, this is accompanied by a dull thud-like sound. The sound may be reciprocal (ie, may occur on opening and on closing). The sound typically occurs, unlike in the case of disc derangement, late in the opening phase (almost at maximum opening) and early in the closing phase. The subluxation may be habitual, meaning that the disc–condyle complex passes the eminence back and forth without causing pain, discomfort, or dysfunction during routine opening. Several cross-sectional studies have attempted to relate generalized joint hypermobility to TMJ hypermobility, yet the results of a systemic review revealed that controversies about this continue [13].

A joint dislocation is similar to a subluxation in that the condyle–disc complex passes beyond the eminence. In this case, however, the patient is unable to close the mouth because the disc–condyle complex is trapped in front of the eminence.

### Etiology/pathophysiology

The most common etiologic factor in the development of internal derangements is trauma. Macrotrauma, such as a hit or blow to the face, may result in direct tissue injury and immediate derangements of the TMJ components. Oral intubation and dental/surgical procedures that involve prolonged mouth opening or excessive forces, such as difficult extractions, also have the

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propensity to cause direct tissue injury. In addition, such trauma could result in elongation of ligaments, creating internal joint laxity, which may set the TMJ up for a slower development of disarrangement. Under normal physiologic conditions, a balance exists in synovial joints between tissue breakdown and repair. When the balance is disturbed by a mechanical, biomechanical, or inflammatory insult the internal cartilaginous remodeling system may fail, resulting in accelerated tissue breakdown [14]. The intrinsic changes in the joint components may induce a disc derangement.

Microtrauma may be another etiologic factor in the development of internal derangements. Microtrauma is defined as application of prolonged repetitive forces, such as in clenching or grinding. The repetitive forces may result in tissue failure in several ways. When the force is within physiologic limits, but is applied to articular cartilage that has a reduced adaptive capability, or when the force exceeds the adaptive capability of normal cartilage, tissue degeneration may ensue [15].

Under normal physiologic conditions, a balance also exist between formation of free radicals and neutralizing mechanisms [16,17]. Mechanical loading of the joint may result in local hypoxia. Reperfusion of hypoxic cells can lead to an explosive increase in free radicals [16]. These free radicals may lead to degradation of hyaluronic acid, which is an important component of synovial fluid. Degradation of hyaluronic acid in turn may impair the lubrication of the TMJ [18]. The impaired lubrication may increase friction between the surfaces of the different joint components. Not only could this lead to adherences or an anchored disc but also it may precipitate a disc derangement [19]. In addition, it has been proposed that adhesions may be formed by free radical–mediated crosslinking of fibrinogen and fibronecin [20].

Indirect trauma, such as that related to acceleration-deceleration (whiplash) injuries in the absence of a direct trauma to the face, has been related to symptoms of temporomandibular disorder (TMD). The most recent prospective controlled study indicated that 1 out of 3 patients who had whiplash accidents without direct trauma to the head developed TMJ pain or associated symptoms within 1 year of the accident compared with 1 out of 16 of the control group [21]. In contrast, a previous prospective study showed that there were no differences between whiplash patients and controls at 6 months regarding TMJ pain and clicking [22].

Clinical diagnosis, including imaging and differential diagnosis

The most salient sign of a disc derangement with reduction is a repeatable, audible click on opening. Often there is also a click on closing, but this may be less noticeable. When there is a closing click it is called reciprocal clicking. On occasion the click is not audible but may be heard by auscultation. In addition, the shift in disc position may be felt by palpation. The click may coincide with a momentary deviation from the midline during the opening movement. Other signs of disc derangement with reduction may include a click on protrusion or lateral movements. Typically, the mouth opening is not restricted and this condition usually is not painful by itself [23].

Conventional radiographs may be used to rule out degenerative joint diseases. Generally, a disc derangement with reduction presents with no to mild radiographically visible degenerative changes. These changes are mostly limited to flattening and sclerosis [24]. The clinical diagnosis of disc derangement can be confirmed by soft tissue imaging, although the mild nature of this condition does not necessitate routine soft tissue imaging. Differential diagnosis may include adhesions, deviation in shape, or arthritis.

The most salient sign of an acute disc derangement without reduction is sudden limited mouth opening. The patient’s history in the case of disc derangement without reduction is essential and usually includes a sudden cessation of clicking accompanied by a limitation of mouth opening. The clinical signs are related to the obstruction of translation of the condyle by the disc. They include a limited mouth opening, limited contralateral movement, deflection on protrusion, and opening to the ipsilateral side [23,25]. This condition is often accompanied by pain. Palpation of the affected joint may be painful and reveals a limited translation of the obstructed condyle.

Generally, an acute disc derangement without reduction presents with no to mild radiographically visible degenerative changes. If the derangement persists and becomes chronic, usually pain subsides and joint mobility increases, even without treatment [26,27]. Mobility-related clinical signs and symptoms may gradually fade, although crepitus may emerge [28]. At the same time, degenerative changes may become radiographically visible [24]. These changes are generally moderate, consist predominantly of flattening and sclerosis of the load-bearing areas of the joint, and most...
often stabilize over a few years [24,29,30]. In cases with severe degenerative changes, occlusal disturbances, such as anterior open bite or a unilateral open bite, may develop. In general, the visible osteoarthritic changes should be seen as articular remodeling in an attempt for the joint to establish a new balance between form and function [30]. Conventional radiographs may be used to identify degenerative changes. The position and shape of the disc can be observed with soft tissue imaging, but unless surgery is planned, routine imaging is not warranted. Differential diagnosis may include arthritis, disc adherences or adhesions, fibrotic ankylosis, myospasm, and neoplasia.

Adherences are difficult to diagnose clinically. The most important information, the transient inability to open the mouth wide after a period of static loading, resolved by moving or manipulating the jaw, and the accompanying single pop, may be derived from the history. Rarely do these types of adherences occur while the patient is in the clinic. The disc may be anchored for a more prolonged time when the patient is unable to overcome the adhesive force between the surfaces of the disc and the fossa [12]. In such cases, the patient presents with limited mouth opening, deflection to the ipsilateral side on opening and protrusion, and restricted contralateral movements. The restriction of the mouth opening may be more severe than in the case of disc derangement without reduction because the adhesive force prevents any translation in the joint and mobility is strictly dictated by rotation of the condyle. Technically speaking, adherences can occur in the lower joint space also, in which case rotation of the condyle is impaired. The clinical presentation of a patient who has an adherence in the lower joint space is similar to that of a patient who has an upper joint space adherence. Because movement of the condyle is now dictated by translation, the movement may be irregular with a sensation of stiffness.

Conventional radiography is not indicated to detect adherences but may be used to rule out degenerative changes. Magnetic resonance imaging may be used to depict a static (ie, nonmoving) disc. Differential diagnosis may include disc derangements.

Persistence of adherences and articular tissue changes related to osteoarthritis may result in adhesions [20]. Adhesions are common in painful TMJs with limited mobility that are refractory to conservative therapies [31]. Adhesions are difficult to diagnose clinically, and the history and clinical findings obtained from the patient who has adhesions may not differ from those of a patient who has disc derangement without reduction or anchored disc.

Adhesions can be detected by arthroscopy, magnetic resonance arthrography, and plain film arthrography, although medial adhesions seem to be more difficult to discern with the latter technique [32]. Differential diagnosis may include disc derangement without reduction, prolonged adherence, and fibrous ankylosis.

A joint dislocation is commonly known as an “open lock.” The patient is unable to close the mouth or fully occlude. There may be considerable variability in the extent that the mouth remains open. The patient may present with a prognathic profile and class III malocclusion attributable to the protrusion of the mandible.

A conventional radiograph, such as a transpharyngeal or transcranial projection with “closed” mouth, reveals that the condyle is dislocated in front of the eminence.

Treatment and prognosis

If a disc derangement with reduction is asymptomatic (ie, the patient is not bothered by it) this condition does not warrant treatment [33]. Clicking and disc derangement may persist for several years without any progression and without development of radiographically visible degenerative changes [24,28]. In addition, signs and symptoms of temporomandibular disorders in the general population fluctuate considerably over time and rarely result in significant dysfunction [34,35]. Taking into account the possibility of spontaneous resolution, the initial treatment should be limited to nonaggressive measures, such as counseling (reassurance and education, rest, instructions to avoid loading, control of contributing factors, such as parafunctional habits) and mild analgesic or anti-inflammatory medicines [36].

Several authors report the use of anterior repositioning appliances for the treatment of disc derangement with reduction with variable rates of success [37–41]. An anterior repositioning appliance is indicated in a patient who has painful clicking or frequent locking, if the clicking can be eliminated by having the patient close down in a protrusive position [42]. The patient is instructed to open the mouth; on doing so the deranged disc reduces to its position on top of the condyle. The patient is then allowed to close the mouth while keeping the mandible protruded, which prevents the disc from deranging again.
The ultimate treatment position is defined by the least protrusive position in which the disc remains in place. The correctness can be checked by having the patient open and close in the chosen position. The click should not reoccur when the position is chosen correctly. The anterior repositioning appliance should be worn at nighttime only. The goal of this treatment is to allow the retrodiscal tissues to recover and adapt and to bring the patient back to a pain-free clicking state. This procedure is not intended to recapture the disc or eliminate clicking permanently, because this has been shown to be unattainable [38,39,43–45].

In the case of an acute disc derangement without reduction, an attempt should be made to unlock the patient. This can be done by gently manipulating the affected TMJ in a downward and then medial direction. During this manipulation the disc may snap back onto the condylar head. Sometimes this procedure is sufficient and the patient may not lock for some time. If the patient locks again immediately on closing, however, an anterior repositioning appliance may be indicated. In such a case, after the patient has been unlocked, the appliance should be made immediately and worn full time for about 5 days, after which the patient should gradually reduce the use of the appliance to avoid malocclusion. Several surgical options are available for disc derangement with reduction; however, they are rarely indicated. These procedures are described below because they may apply to disc derangement without reduction.

If in the case of an acute disc derangement without reduction manipulation is unsuccessful to unlock the jaw, there are many nonsurgical and surgical options to choose from. Studies show that if minimal treatment is provided [28,29,46], or even if nothing is done [26,27,47], the signs and symptoms gradually improve. Treatment speeds up the natural progression process, however, and is primarily aimed at restoring the balance between form and function, also called adaptation [30]. Similar to disc derangement with reduction, nonaggressive measures, such as reassurance and education, rest, instructions to avoid loading, control of contributing factors (such as parafunctional habits), and mild analgesic or anti-inflammatory medicines, should be provided as first-line treatment [36]. An interocclusal appliance (ie, a stabilization appliance) may also be helpful if the patient complains of pain that is worse on awakening. Physical therapy aimed at reduction of pain and dysfunction may be indicated also [48]. Once the patient is pain free, additional treatments aimed at reducing the limited mouth opening should be implemented. These may consist of simple stretching exercises within a pain-free range performed by the patient, or manipulation techniques performed by a physical therapist. In rare cases the restriction of mouth opening is persistent and more aggressive therapies may be needed. Several studies show that a disc derangement without reduction responds well to nonsurgical treatment [28,30,49,50]. If these nonsurgical treatments fail, however, an evaluation for the appropriateness of surgical intervention is indicated.

As outlined in the Clinical Practice Guidelines for TMJ surgery of the American Association of Oral and Maxillofacial Surgeons, TMJ surgery is only indicated when nonsurgical therapy has been ineffective. TMJ surgery is not indicated for asymptomatic or minimally symptomatic cases and should not be performed in an attempt to prevent TMD [51]. Indications for surgery include moderate to severe pain or dysfunction that is disabling [51]. Most often surgery is indicated for persistent painful intracapsular conditions. When clicking is interfering significantly with the patient’s quality of life, however, and nonsurgical procedures have been ineffective to improve the patient’s quality of life, surgical procedures may also be indicated.

Although the guidelines state that surgical procedures are indicated only after reasonable efforts with nonsurgical modalities have failed, there may be one exception. When it is debatable whether the diagnosis is disc derangement without reduction or disc adherence, an arthrocentesis may be performed. An arthrocentesis is a minimally invasive procedure typically associated with good outcomes for patients who have a closed lock [52]. A disc adherence may be instantly released by such a procedure and recurrence of the adherence seems to be infrequent [53]. A locked jaw because of a deranged disc may also be resolved, although most frequently the improvement of dysfunction and mouth opening are not related to an improved disc–condyle relationship [54–58]. Although there are studies promoting the use of sodium hyaluronate during arthrocentesis, there are no controlled trials indicating that the use of sodium hyaluronate results in significantly better treatment outcomes than arthrocentesis alone [59].

Most surgical procedures for disc derangements are aimed at improving the disc–condyle
relationship. Such procedures include modified condylotomy, discoplasty, and disc repositioning. Another procedure includes discectomy with or without replacement of the removed disc.

Discectomy has long been advocated to reduce the mechanical problems related to disc derangements. Discectomies have resulted in elimination of pain and improvement of function. Success rates vary from 43% to 93% for this procedure [60–66]. Significant radiographically visible degenerative changes, which resemble those associated with degenerative joint disease, may occur with this procedure [61,66]. There seems to be no advantage to replacing the disc with temporary or permanent implants or grafts [61,67–70]. Evidence of the formation of a pseudodisc after discectomy has been reported [65,71].

The modified condylotomy consists of an intraoral vertical ramus osteotomy, in which the condylar segment is allowed to move slightly inferiorly [72]. This supposedly creates space to allow for a better disc–condyle relationship. The advantage of this procedure is that it avoids intracapsular surgery. The disadvantage of the procedure is that it is hard to predict what the position of the condyle will be and whether the condyle–disc relationship will improve. This procedure is generally only recommended in early stages of disc derangements with reduction [73], when it is more likely that the disc still has its original saddellike shape. Disc derangements in the absence of pain generally do not warrant treatment, and several more conservative treatment options have proven successful in the treatment of early disc derangements. The indications and use of this particular procedure are therefore limited.

Discoplasty is a surgical open-joint procedure in which the disc is repaired or its shape improved. Oftentimes this procedure is used concomitant with disc repositioning techniques. Although reports on pain and dysfunction are favorable, relapse of disc position is frequent [74,75]. Disc repair and disc repositioning can also be achieved with arthroscopy [76]. Similar positive treatment outcomes were obtained in a randomized study wherein one group of patients received open-joint surgery with disc repositioning and the other group was treated arthroscopically with lysis, lavage, and capsular stretch [75]. Note that in the latter case the arthroscopic procedure did not aim to improve the disc–condyle relationship.

Arthroscopy is a minimally invasive closed-joint procedure. It has proven successful for treatment of different stages of derangements, even if the main goal was not aimed at improving the disc–condyle relationship [77–82]. Mobilization seems of more importance for reduction of signs and symptoms of derangements. With arthroscopy, the deranged disc can be repositioned or reshaped [83].

Adherences may be treated with reassurance and education, instructions to avoid static loading of the TMJs, and control of parafunctional habits. If the patient reports that the jaw is also locked on awakening, an interocclusal appliance (ie, a stabilization appliance) may be indicated. If the patient and the health care provider are unable to unlock the jaw, arthrocentesis is indicated. Adherences can also be alleviated with arthroscopy [83], although this procedure may rarely be indicated in lieu of arthrocentesis.

Adhesions are difficult to manage with nonsurgical measures. To break adhesions lysis, lavage, and hydraulic distention may be sufficient. More likely, arthroscopy will be necessary to release or ablate adhesions [83].

An acute joint dislocation is treated by manipulation of the jaw in a slightly forward, then downward, direction. Once sufficiently cleared from the eminence, the condyle-disc complex snaps back into the fossa. Sometimes it is sufficient to ask the patient simply to yawn, on which the joint may overcome the eminence and return to the fossa. The manipulation technique should be taught to the patient in addition to instructions to avoid opening wide. In case of a chronic dislocation, the patient may need to be put under general anesthesia to unlock the jaw. In addition, intermaxillary fixation may be needed to avoid relapse. When a patient suffers from uncontrollable repeated dislocations, treatment depends on the cause of these dislocations. Eminectomy, by way of arthroscopy or the traditional open-joint surgery, has been a widely used method to treat recurrent or habitual dislocations [84–86]. Although this method was originally described in 1951 by Myrhaug [87], estimates of its efficacy are mostly based on small sample case series or case reports. Other methods used to reduce the recurrent or habitual dislocations include techniques aimed at creating a barrier to limit condylar translation [88–91] and injection of sclerosing agents [92]. Downfracturing of the eminence, placement of miniplates or screws, or cranial bone or other autografts have been used to create barriers. No randomized controlled trials or comparative trials were found in the English
literature regarding the efficacy and safety of these procedures. If dystonia or spasm of the lateral pterygoid is responsible for the dislocations, injections with botulinum toxin may be useful [93,94].

Summary with an emphasis/impact on oral surgeons

TMJ internal disc derangements most often respond well to nonsurgical methods. An asymptomatic click does not warrant treatment. In line with the Clinical Practice Guidelines for TMJ Surgery, surgical options should only be used in cases of moderate to severe persistent pain or dysfunction, after reasonable conservative treatment has proven ineffective. Possible exceptions are acute disc adherences, and adhesions, in which surgical methods, such as arthrocentesis and arthroscopy, may be the first treatment of choice. For disc derangements, a multitude of surgical procedures are available, but recent advances in technology and philosophy direct the surgical procedures of choice toward the minimally invasive technique, arthrocentesis, with arthroscopy as the next alternative.

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