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Kirschner Wire Migration into Spinal Canal after Acromioclavicular Joint Fixation (Literature Review and Clinical Case)

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Abstract

Fracture and migration of metal implants is a well-known issue which is especially relevant for actively loaded zones with a high amplitude of physiological movements. The authors analyzed 17 publications dedicated to Kirschner wire migration into the spinal canal after fixation of acromioclavicular joint (ACJ) injury. The present paper contains literature review and own clinical case of the authors. The authors generalize the conceptions of migration causes, surgical tactics and prevention recommendations. The key reason of fracture and migration of Kirschner wires during fixation of ACJ injury is the instability of implants, trans-articular wire insertion during fixation of reduced dislocation of acromial end of the clavicle, insufficient immobilization and untimely implants removal after removal of immobilization. Implants migration into the spinal canal is the indication for their surgical removal irrespective of clinical signs. In the majority of studied publications authors described posterior approach or lateral approach aligned with the migration direction. No grafting techniques for dura mater defects were present in the studied literature. The authors of the current paper justify a surgical procedure for removal of migrated implant using a combined posterior and lateral approach on the own clinical case. The choice of procedure algorithm results from the need for prophylaxis of secondary spinal cord lesion and liquorrhea during removal of migrated implants from spinal canal.

Keywords: Kirschner wire migration, spinal cord lesion, liquorrhea, acromioclavicular joint, clavicle fracture.

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Introduction

Migration of implants is a serious complication after internal fixation which becomes especially hazardous in case implants shift into adjacent anatomical zones. Fractures with local displacement of Kirschner wires and other implants are frequently reported even after the correct initial insertion [1].

Mechanism of implants migration following ACJ fixation is not completely clear. The following reasons are considered the most probable: effect of multidirectional kinetic forces on acromial end of the clavicle [2], muscles contractions, respiratory movements, negative intrathoracic inspiratory pressure, gravitation forces and local bone resorption around the implant [3–7].

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The studied publications report lesions of esophagus, trachea, great vessels of the neck, lungs, aorta and heart by implants in patients who underwent surgical treatment of clavicle and ACJ injury including the lethal cases [3, 8–12].

Migration of implants into the spinal canal is associated with risk of a severe neurological deficit [5, 7, 13, 15] as well as with lesions of spinal cord, large vessels of neck and pleura during surgical procedure [14, 15].

The aim — is to call the attention to the rare complication after fixation of ACJ — migration of implant fragment into the spinal canal with consequent lesion of dura mater and spine cord roots. The authors present also a literature review on above issue and justification of surgical tactics.

Literature review

The authors found 17 publications in available literature dedicated to implants migration into the spinal canal in patients who underwent fixation of ACJ and clavicle injuries by various implants.

In the studied publications age of patients varied from 22 to 72 years, with prevalence of middle-aged patients. Patients in 11 papers were male, in 2 — women, in 4 papers gender of patient was not indicated. Period of time between surgical stabilization and implant migration was from 11 days to 12 years. In 11 cases migration was observed during the first year after surgery, of those in 7 cases — within 2 to 6 months. In all cases the wire entered the spinal canal through radicular foramen at levels from C5-C6 to Th2-Th3, in 9 cases — at C7-Th1 level. In 7 out of 12 publications the patients were operated on the right side (in 4 papers the side was not identified).

Indications of causes for implant migration were reported in 6 publications. In all cases migration was accompanied by instability represented by bone resorption or wire fracture. Sivakon S.V. et al. [16] consider trans-articular wire insertion, insufficient immobilization and untimely implants removal after removal of immobilization as the possible reasons for instability. Other probable causes for wire migration include anatomical and biomechanical features of the upper shoulder girdle, insufficient arm immobilization, negative inspiratory pressure, falling, body features (obesity in one case), recurrent injuries (falling) and load on operated limb.

Clinical picture in five publications demonstrated signs of spinal cord damage such as inferior paraparesis, tetraparesis or Brown-Sequard's syndrome [5, 7, 14, 17]. Radicular pain corresponding to the level of wire intrusion into the spinal canal was reported in three cases [4, 13, 18]. In two cases clinical signs included lungs and pleura injury (emphysema and pneumothorax) without a neurological deficit [19, 20]. L. Minić et al. (2016) in their paper described liquor hypotension syndrome [13] as the key clinical sign. Asymptomatic migration of Kirschner wire into the spinal canal was described by S. Bennis [21].

In the majority of cases (10 publications) the authors used lateral approaches (supraclavicular, thoracotomy) for removal of a foreign body from the spinal canal ensuring wire removal along it's axis. Such tactics was utilized in patients without signs of spinal cord and roots injury as well as in patients with severe neurological symptoms (Loncán et al., 1998; Regel J.P. et al., 2014) [7, 17]. Nikolsky M.A. et al (2006) and P. Fransen et al (2007) used a combination of supraclavicular and posterior approaches to mobilize the wire in lateral direction and ensure control over its removal [7, 14]. P. Fransen et al. (2007) discuss in detail the advantages of approaches combination. In particular, the authors indicate the control over intradural hemostasis, sealing of dura mater and preventing displacement of distal wire end during its removal [14]. The similar advantages of control from the side of spinal canal are reported by W. Mamane et al (2009) [19].

In two cases the authors reported liquorrhea from defect of dura mater during the surgery [20, 21]. Postoperative liquorrhea was not described in any of the publications. At the same time the applied method of desling the dura mater is not described in the publications. When discussing surgical tactics [14, 19] some authors indicate a possibility to control liquorostasis from approaches through spinal canal. A combination of symptoms resembling liquor hypotensions was reported as a dominant clinical sign in the case of L. Minić (2016). Remarkably no signs of liquorrhea were observed [13] intraoperatively during wire removal through transthoracic approach. Yawei Li et al. (2011) reported liquorrhea in wound canal during wire removal from thoracoscopic approach. No signs of liquor hypotension and liquorrhea prior to surgery or postoperatively were described, grafting of liquor fistula was not performed [20].

The authors of referred publications indicate various methods to prevent implants migration including technical and organizational recommendations.

The majority of authors mention the need to inform surgeons on probability of such complications. Some publications stress the importance of patients' awareness on possible failure and migration of implants [6, 14, 18]. Regular X-ray control with an interval of 2–4 weeks and implants removal after fracture site consolidation or at appearance of instability signs are considered mandatory by the majority of the authors. Many authors recommend to remove wires in 6-8 weeks after the surgery [5, 6, 14]. A strict immobilization of injury site [19] and excluding the abduction of operated limb over 90° [5, 6] are mandatory. Sivakon S.V. et al. believe necessary to remove implants prior to starting rehabilitation and restoration of active limb movements [16].

J. Liberski emphasizes the need to evaluate the physical activity level of a patient, patient's ability to self-care as well as ability to comply with recommendations. The author recommends to choose other fixation methods in athletes and people with active way of life, in elderly people and people who need aid as well as in non-compliant patients (alcohol and drug abuse, mental disorders) [22]. Nikolsky M.A. also supports limitation of indications for wire fixation for treatment of clavicle and ACJ injuries [7].

Certain authors, in particular, P.Fransen, indicate increased reliability of fixation after bending the distal end of wire at 90° [14]. At the same time, Yawei Li considers that internal fixation using wires for clavicle and ACJ injuries should be acknowledged as a high risk manipulation. The publication underlines migration probability of all wire types — plain, threaded and wires bent at the end [20]. Saad Bennis also indicated insufficient reliability of wire fixation and considers plate fixation as a safer procedure with less frequent non-unions and migration risk [21].

Clinical case

64 year old patient underwent Kirschner wires fixation in 1997 for injury of right ACJ. Two years postoperatively, after working in a garage (repairing vehicle in a supine position), the patient felt pain and observed a skin contusion in the area of right shoulder joint. After another year patient started to feel pain in neck irradiating to the right arm. The patient did not seek medical advice or aid. During routine examination in 2016 the fluorogram revealed a foreign body of a metal density in spine projection.

CT scans of spinal canal on C6-C7 level confirmed presence of a 4.5 cm long foreign body (wire), located obliquely in the anterior third of spinal canal, it's proximal end located at the level of C7 arc root on the left, distal wire end was in right radicular foramen of C6-C7 at the level of lateral margin of articular facets (Fig. 1).

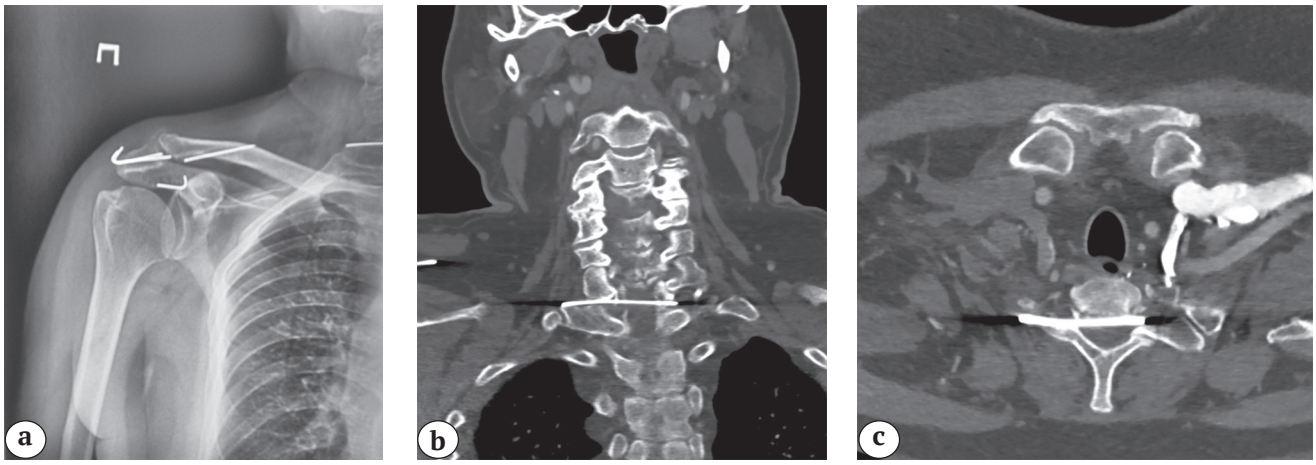

Fig. 1. Preoperative cervical spine X-ray images:
a — X-ray images of the right shoulder after acromioclavicular fixation with K-wire, the disruption of one of the spokes is seen, distal part of other spoke located at the level of C7;
b — CT-scan of the cervical spine, there is foreign body of metal density, penetrating right radicular foramen C6-C7;
c — axial plane — K-wire in the spine canal

At admittance the patients complained on local pain in neck irradiating along the medial surface of the right forearm and hand which increased during straining efforts and coughing. Neurological symptoms included root syndrome of C8 on the right. No general cerebral, conducting or meningeal symptoms were observed.

Surgery was performed on 3.05.2017: removal of intradural foreign body (K-wire fragment) at the level of C7-Th1 from combined approach, grafting of dura mater defect.

General anesthesia was applied with patient in the lateral decubitus. The authors used a lateral supraclavicular approach to first cervical rib on the right between trapezoid and posterior scalene muscles (Fig. 2 a). C8 nerve was identified over transverse process Th1 exiting radicular foramen C7-Th1, level of manipulations was verified by image intensifier. Visual examination and palpation did not reveal any foreign bodies in the zone of manipulations (Fig. 2 b).

Skin and subcutaneous fat incision was made in projection of spinous processes C6-Th1, periosteum detached from spinous process and lamina of C7 on the right, from the medial part of C7-Th1 joint. Flavectomy and medial facetectomy of C7-Th1 on the right were performed. A Kirschner wire fragment was visualized in the spinal canal, dura mater was perforated above root of C8. After mobilization of epidural veins and C8 root the wire was displaced into the right radicular foramen and removed from supraclavicular approach (Fig. 2 c). The authors observed transparent colorless liquor in the wound discharging from the defect of dura mater (Fig. 2 d). Defect of dura mater was closed by Tachocomb plates. Hemostasis was consistent at ABP of 130/90 mm Hg. Valsalva test proved no liquorrhea. Wounds were sutured in layers without drainage.

Postoperative period was uncomplicated, wounds healed by primary tension, patient discharged from the hospital on 6th day after the surgery. At control examination in 1.5 months after the surgery the scars did not demonstrate any inflammation signs, neurologically a regress of radicular pain was observed. The patient was sent to a trauma surgeon for removal of remaining fixation elements in the area of the right ACJ.

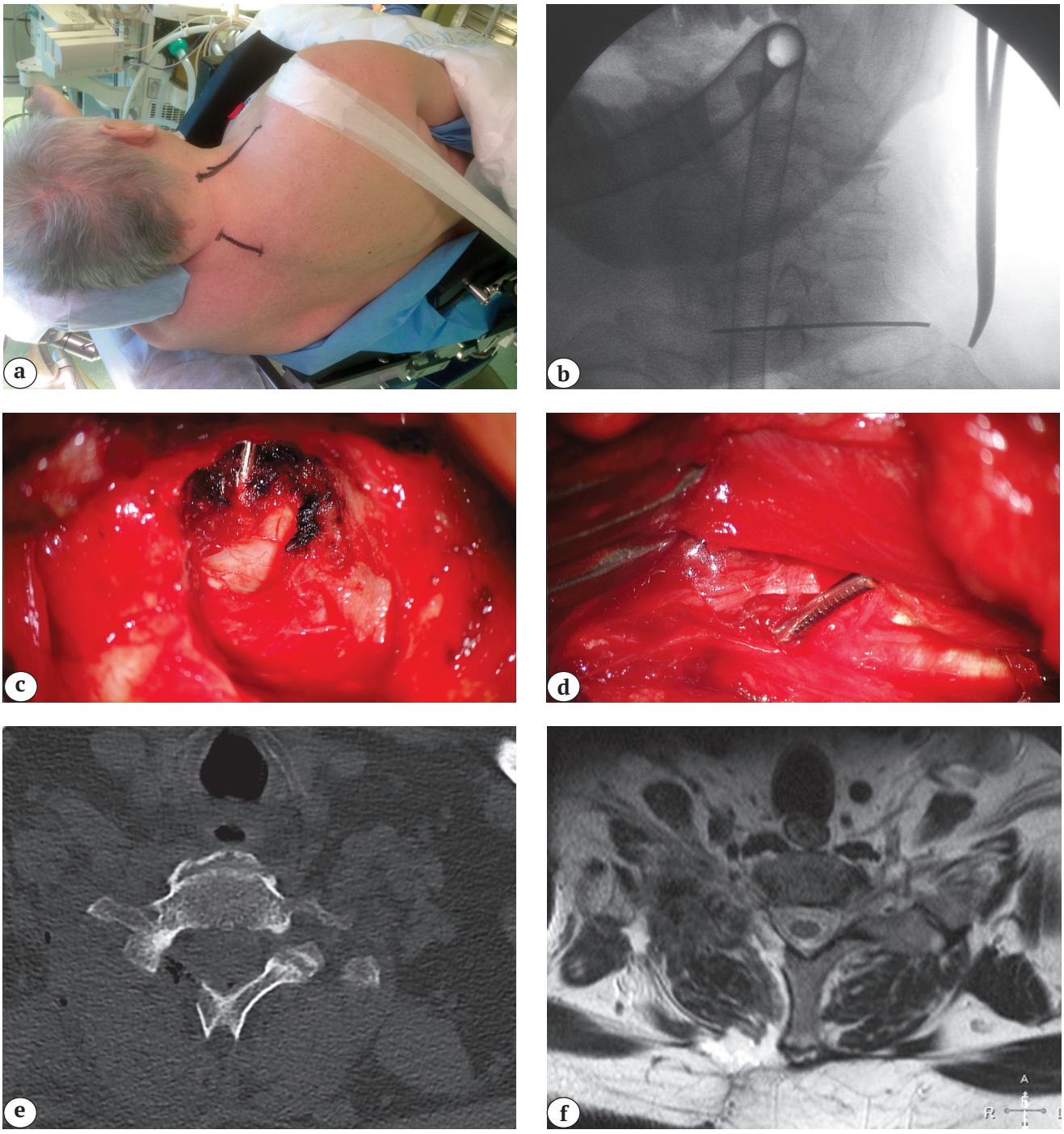

Fig. 2. Procedure stages and postoperative X-ray control:
a — patient positioning on surgical table — lateral decubitus, marked right supraclavicular and posterior median approaches;
b — intraoperative X-ray control during supraclavicular approach — manipulation area corresponds to level C7-Th1;
c — interlaminectomy, medial facetectomy on the right at level C7-Th1, wire is visualized, dura mater perforated at the level C8;
d — wire displaced in lateral director is seen at the level of exit from radicular foramen of C7-Th1;
e — CT after the surgery;
f — MRI after the surgery

Rationale for surgical tactics

Tactics for the procedure was chosen based on the analysis of the main surgical stages — visualization, mobilization and removal of foreign body from spinal canal. Insignificant prominence of proximal wire end from radicular canal and it's curvature created a potential risk of deflection of distal end of the implant with consequent lesion of neural tissue during implant mobilization, fixation and traction. Thus, to prevent a secondary injury to spinal cord during main surgical stages it's required to control positioning of the distal wire end in the spinal canal. Preliminary visualization of fragment exit point from the radicular canal C7-Th1 is necessary due to a potential damage to large vessels of the neck during wire mobilization laterally to the spine.

In the present case the authors observed a point-contact defect of dura mater localized on it's lateral surface superior to root origin, which stipulated choice of grafting method.

An opportunity to decrease risk of iatrogenic damage to spinal cord and postoperative complications by combination of lateral and posterior approaches stipulated the chosen surgical tactics.

Discussion

Migration of Kirschner wire fragments into spinal canal is one of possible complications with a high rate of neurological deficit [4, 5, 7, 13, 14, 17, 18] following fixation of ACJ injuries. Wire failure as a consequence of instable fixation is the main cause of such complication and demands close attention of the surgeon and patient during the whole period of fixation in place [6, 7, 14, 18, 20, 21].

Such complication is the indication for surgical treatment to prevent progressing of neurological deficit and further migration [7, 14, 19]. The authors consider it justified to use combined lateral and posterior approaches in all cases of intra-canal positioning of migrated implant irrespective of degree of neurological deficit. In such cases, the tasks of surgical manipulations through spinal canal are the prophylaxis of spinal cord lesions during wire removal, wire mobilization in lateral direction, control over intradural hemostasis and prophylaxis of liquorrhea.

Probably, the termination of liquorrhea described by Yawei Li and M. Ljubodrag [13, 20] in their cases without any supplementary manipulations during wire removal from lateral thoracotomic approach can be explained by a point-contact defect of dura mater and narrow wound canal in paravertebral soft tissues. At the same time, in authors' opinion the link between liquor routes and natural body cavities or surgical wound always poses a risk of liquorrhea and requires accurate defect sealing and isolation of area of dura mater grafting from natural and iatrogenic cativites.

Kirschner wires fixation of ACJ is accompanied with a risk of disabling and lethal complications [5, 7, 12–15]. Probability of life threatening complications due to migration of implants make us believe that the present method is not sufficiently reliable and safe.

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