

# Total claviclectomy as a rescue procedure

## Case report and literature review

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### ABSTRACT

Clavicle non-union is an uncommon cause of thoracic outlet syndrome. A case of brachial plexopathy by previously infected clavicle pseudarthrosis is described. Total claviclectomy was performed for symptom relief. From literature analysis we conclude that total claviclectomy is an option to be taken into account when therapeutic options have exhausted. Functional results could be adequate when total claviclectomy is indicated in cases of infection, plexopathy or sarcoma.

**Key words:** Claviclectomy; plexopathy, pseudarthrosis; thoracic outlet.

**Level of Evidence:** IV

### CLAVICULECTOMÍA TOTAL COMO PROCEDIMIENTO DE RESCATE. REPORTE DE UN CASO Y REVISIÓN BIBLIOGRÁFICA

### RESUMEN

La pseudoartrosis de clavícula es una causa infrecuente de síndrome del opérculo torácico. Se describe un caso de plexopatía braquial por pseudoartrosis previamente infectada de clavícula. La paciente fue sometida a una claviclectomía total para aliviar los síntomas. Del análisis de la literatura citada, se concluye en que la claviclectomía total es una opción por considerar si se han agotado las opciones terapéuticas. Los resultados funcionales pueden ser satisfactorios cuando se la indica por infección, plexopatía o sarcoma.

**Palabras clave:** Claviclectomía; plexopatía; pseudoartrosis; opérculo torácico.

**Nivel de Evidencia:** IV

### Introduction

Clavicle fracture is relatively frequent, representing between 5% and 10% of all skeletal fractures<sup>1</sup>, and about 80% are clavicle-middle-third fractures.<sup>2,3</sup> They have classically been considered “benign” fractures with adequate response to conservative treatment, high bone healing

rates and satisfactory functional results.<sup>3,4</sup> However, nowadays there is enough evidence to affirm that bone healing by conservative treatment does not always imply good clinical results.<sup>5</sup> Moreover, according to bibliography a significant percentage of cases show mal-union and pseudoarthrosis,<sup>6,7</sup> what causes great pain and dysfunction due to shoulder biomechanics disorders.<sup>8</sup>

Conflict of interests: The authors have reported none.

For that reason, surgical indications for this type of fracture have lately widespread, and nowadays this alternative is not only taken into account in open fractures, fractures with neurovascular injury,<sup>9</sup> polytraumatized patients and those with “floating shoulder”, but also in those with >15-20 mm shortening, no contact between main fragments, comminution or vertical third fragment.<sup>10,11</sup>

Open reduction and internal fixation with anatomic angular locking plates has become one of the most frequently offered therapeutic alternatives.<sup>12</sup> Results with this type of treatment can be satisfactory in high percentages of cases,<sup>13</sup> but this procedure is not free from complications such as sensitive disorders in supraclavicular nerve territories, surgical wound dehiscence, intolerance to osteosynthesis, infection and pseudoarthrosis.<sup>14</sup>

Less frequently mal-union, exuberant bone callus<sup>15</sup> or pseudoarthrosis in clavicle-middle-third can cause disorders in the costoclavicular space generating nervous compression at brachial plexus level,<sup>16-18</sup> mainly at the level of the antero-medial secondary trunk where, in general, the ulnar nerve is the most seriously affected.<sup>19,20</sup>

Total claviclectomy is an exceptional, rescue surgery and has been used as a last resort in cases of clavicle symptomatic infection, tumor, mal-union and pseudoarthrosis.<sup>21</sup> Moreover, it has been carried out as the treatment of the thoracic outlet syndrome with vascular or nervous injury and in cases of postoperative chronic pain.<sup>21-28</sup>

We present an infrequent case of brachial plexopathy secondary to previously infected clavicle pseudoarthrosis, where the indication was total claviclectomy for symptoms relief. The analysis of this case has brought about bibliographic review in the issue.

### Case

Seventy-six years old female in good health condition with history of right radical mastectomy (treatment of breast cancer 10 years before) consults for intense pain and redness 6 months after fracture reduction and osteosynthesis in her right clavicle (Figure 1). Routine lab results are: increased ESR and RCP, lack of bone healing, and osteolysis at the level of the fracture line. Scintigraphy shows remarkable hyper-uptake at right clavicle level. We perform surgical toilet. Microbial isolation results in bacterial culture show *Staphylococcus epidermidis*. After initial antibiotic treatment and given the bad results, we carry out surgical toilet and osteosynthesis material removal (Figure 2). Histopathology results are negative for osteomyelitis. The patient receives postoperative specific suppressor antibiotic treatment; infection resolves and the patient does well.

One year later, she consults reporting intense pain in surgical area (VAS 7/10), numbness sensation and paresis



▲ **Figure 1.** Right clavicle X-ray six months after reduction and osteosynthesis showing lack of bone healing with osteolysis in fracture line.



▲ **Figure 2.** Right clavicle X-ray after removing osteosynthesis material.

thesias radiated to medial aspects of arm and forearm up to her hand; Roos test is positive. Symptoms become exacerbated with acute burning pain at arm adduction on the horizontal plane.

Electromyography shows severe injury of right brachial plexus, whereas X-rays show lack of bone healing with segmental bone defect of about 20 mm (Figure 3). In March 2015, given the lack of response to conservative treatment, we decide to carry out total claviclectomy.

Surgery is performed with the patient in beach chair position under general anesthesia and interscalene block. We carry out a longitudinal approach on the patient's previous scar. Upon confirming the lack of bone healing in her clavicle-middle-third, we go on to clavicle subperiosteal resection and fibrous tissue removal, at all times protecting the underlying neurovascular structures. We remove the whole clavicle (Figures 4 and 5). The sternocleidomastoid muscle is stitched to the pectoralis major, the trapezius and the deltoid muscles, just as it is described by Abbott and Lucas.<sup>26</sup> There are no intraoperative complications. The night consecutive to the surgery the patient reports that the burning pain in her shoulder radiating to her forearm and her hand has disappeared.

At the end of the second postoperative week, we remove stitches and call off the use of sling, starting a physiotherapy program on the patient. During the third week consecutive to the surgery, her arm's mobility is complete and painless (Figure 6). At postoperative month six, the patient has no symptoms, and her absolute Constant score is 75 (contralateral-90.3%). At physical examination there is scapular dyskinesia with shoulder forwards and downwards displacement, but the patient does not report any worry about the esthetic aspect of her shoulder (Figure 7).



▲ **Figure 3.** X-ray before claviclectomy showing downwards displacement of distal fragment and segmental bone defect.



▲ **Figure 4.** Intraoperative imaging after total resection of right clavicle.



◀ **Figure 5.** X-ray after total claviclectomy.



◀ **Figure 6.** Aesthetic looks and mobility three weeks after total claviclectomy.

## Discussion

In 1934 Codman used to say: “We are proud of the fact that our brain is more developed than that of animals, but we could also show our clavicle off...In my opinion, the clavicle is one of the most important skeletal inheritances



▲ **Figure 7.** Aesthetic looks and mobility one year after total claviclectomy.

by ancestors for human beings, because they depend on their clavicle more than most animals (except simians) to use their hand and arms”.<sup>29</sup>

Schematically, the clavicle might have five main functions:

- 1) (Punctual) distance support between scapula and sternal bone.<sup>26</sup>
- 2) Support for muscular insertions (sternocleidomastoid, trapezius, deltoid and pectoralis major muscles).<sup>26</sup>
- 3) Protection of underlying neurovascular structures.<sup>26</sup>
- 4) Shoulder balance (strength transmission from the trapezius muscle to the scapula through coracoclavicle ligaments and thus avoidance of shoulder downwards displacement).<sup>26</sup>
- 5) Milestone in shoulder esthetics.<sup>30</sup>

The thoracic outlet syndrome (TOS) describes a number of signs and symptoms caused by compression on the brachial plexus or the subclavian blood vessels across their thoracic pathway. Injury can be vascular, neurologic or combined, depending on the affected structure. Compression can take place in three different locations: the in-

terscalene triangle, the costoclavicular space and the sub-acromial space (pectoralis minor). Not only mal-union or bone healing with hypertrophic callus<sup>15</sup> but also clavicle pseudoarthrosis are infrequent causes of costoclavicular space decrease; however, if any they can cause nervous compression (especially on the antero-medial secondary trunk<sup>20,31</sup>) or vascular compression; it is most frequently seen venous than arterial compression.

In the treatment of this particular patient we considered the different therapeutic options:

- a) Two-time bone reconstruction with Masquelet’s technique.
- b) New osteosynthesis with structural bone graft.<sup>32</sup>
- c) Osteosynthesis with vascularized bone graft.<sup>33</sup>
- d) Partial claviclectomy.<sup>15-18, 31</sup>
- e) Total claviclectomy.<sup>2</sup>

Taking into account clavicle functions and opinions such as those expressed by Codman, the orthopedic surgeon should do his or her best to avoid clavicle resection. However, there are exceptional circumstances under which the aforementioned therapeutic options seem to

be insufficient or hardly predictable in terms of results; therefore, total clavicle resection becomes a therapeutic option to think about.

Among the factors that motivated total clavicle resection in our patient we can mention her increased risk of pseudoarthrosis with any type of graft and also that of infection (history of radiotherapy and infection), along with the fact that partial clavicle resection has failed in showing better results than those that total clavicle resection has—there are reports on plexopathy recurrence due to bone regeneration after hemi-clavicle resection.<sup>18</sup>

The first reports on clavicle resection were Delatour's who, in 1903, reported satisfactory results in three cases of total clavicle resection due to sarcoma and in one of partial clavicle resection due to plexopathy secondary to exuberant bone callus.<sup>21</sup> Since, there have been few articles on the issue (Table), and results were mostly satisfactory.

The quoted bibliography shows the following authors' coincidences happening:

- The main clavicle function is to support muscle insertions.

**Table.** Bibliography account

Year	Author	n	Indication	Follow-up	Results	Notes
1903	Delatour <sup>21</sup>	2	Sarcoma	-	Excellent	-
1941	Gurd <sup>23</sup>	1	Pathologic fracture	-	Good	-
1946	Copland <sup>25</sup>	2	Pathologic fracture Complex fracture	-	Good	-
1954	Abbott and Lucas <sup>26</sup>	1	Sarcoma	10 years	Excellent	-
1977	Spar <sup>22</sup>	2	Infected pathologic fracture	-	Regular	Previous limitation to mobility Radiotherapy history
1985	Baratz and cols. <sup>36</sup>	2	Infection	-	Good	-
1986	Wood <sup>24</sup>	5	Pseudoarthrosis Thoracic outlet syndrome	-	Excellent	-
1990	Waissman and cols. <sup>30</sup>	4	Infection Thoracic outlet syndrome Sarcoma	-	Excellent	-
1993	Lord and Wright <sup>37</sup>	35	Thoracic outlet syndrome		Excellent and good: 28 Regular: 6 Bad: 1	Results were bad in a mentally impaired patient with self-provoked injuries
1998	Gaulke and Schmitz <sup>38</sup>	1	Sarcoma	3 years	Excelente	Rowing
2007	Kirshnan and cols. <sup>39</sup>	6	Infected pseudoarthrosis 3 Pseudoarthrosis + Thoracic outlet syndrome 2 Post partial clavicle resection pain 1	-	Good	Subclavian vein injury 1 Infection 3
2007	Oheim and cols. <sup>27</sup>	5	Infection	-	Excellent	The subperiosteal pocket should be preserved and stitched
2007	Wessel and Schaap <sup>28</sup>	6	Infection 3 Postoperative pain 3	-	Excellent Bad/Pain	Complete mobility. Complete mobility. Unsatisfied
2007	Kapoor and cols. <sup>40</sup>	3	Tumor	3.3 years	Good	Satisfied
2011	Argintar and cols. <sup>41</sup>	1	Bipolar dislocation	1 year	Excellent	-
2012	Ye and Zhang <sup>42</sup>	9	Sarcoma	-	Good	Mild decrease in strength Complete mobility at 3.4 week
2013	Camargo and cols. <sup>35</sup>	1	Thoracic outlet syndrome	-	Regular (DASH 41)	Symptoms remain Shoulder downwards displacement
2013	Rubright and cols. <sup>34</sup>	5	-	10 years	Good	Minimal functional deficit Mild scapular dyskinesia

- Such function remains if sternocleidomastoid muscle-pectoralis major muscle-deltoid muscle continuity is maintained, stitching the muscles to one another after clavicle resection.

- If there is infection they suggest subperiosteal resection, whereas in the case of sarcoma extraperiosteal resection should be chosen.

- The scapula-sternal bone distance does not change significantly after total claviclectomy.

In 2013, Rubright assessed five patients 5 and 10 years after total claviclectomy using the DASH (Disability of Arm, Shoulder and Hand), the SF-36 (Short-Form-36), the SST (Simple Shoulder Test), the ASES (American Shoulder and Elbow Surgeons), the UCLA (UCLA Shoulder Test), the HSS (Hospital for Special Surgery Rating Scale) and the Constant scores, along with isokinetic tests, range of motion tests and kinematic analyses. The author concluded that the clavicle contributes to the global strength and mobility of the shoulder (patients subject to claviclectomy lose 33% of adduction strength) and it participates in the coordination of the scapular-humeral rhythm. Patients were able to compensate clavicle absence with minimal functional deficit. Although objective results worsened after a while —some slow loss of compensatory capabilities), patients perceived the function of the affected limb as normal.<sup>34</sup>

We have found few articles reporting regular or bad results in total claviclectomy. In 1977, Spar<sup>22</sup> published two cases with limitations to active mobility and mild

weakness after total clavicle resection. Both patients showed mobility limitation before the surgery, though, with oncologic history and history of radiotherapy in their clavicle region, and infected pathologic fracture. It is worth mentioning that in both cases pain decreased. On the other hand, in 2007 Wessel<sup>28</sup> published a series of six cases; three of them were not satisfied with total claviclectomy results. In the three cases, surgical indications were due to post-traumatic pain that remained after the surgery. The other three patients had satisfactory results. In 2013, Camargo<sup>35</sup> published one case showing bad results after total clavicle resection and the resection of the first rib to treat TOS.

The patient's symptoms stayed and they showed shoulder depression after the surgery. The kinematic analysis showed an increase in scapular mobility, but shoulder biomechanics remained relatively preserved during active shoulder elevation. Mobility was good in all the cases dealt with.

## Conclusions

Total claviclectomy is an infrequent surgery whose indication is justified when we have run out of therapeutic options. Functional results can be good and it might not cause mobility limitation. According to our bibliographic revision, the assessed patients were satisfied with results when surgical indications were due to sarcoma, infection or plexopathy.

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