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Special Article

The True Ponte Osteotomy: By the One Who Developed It

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Abstract

Study Design: Technique and applications.
Objectives: To define the anatomy, biomechanics, indications, and surgical technique of the true Ponte osteotomy.
Summary of Background Data: The Ponte osteotomy, originally developed for thoracic kyphosis, was the first one to obtain posterior shortening of the thoracic spine, maintaining the anterior column load-sharing capacity. It has become a widely applied technique in various types of spine deformities and a frequent topic of presentations at meetings and in scientific articles. Several of them offer unquestionable evidence of an incorrect execution, with consequently distorted outcomes and erroneous conclusions. A clearing up became essential.
Methods: Our original experience is based on a series of 240 patients with thoracic hyperkyphosis operated in the years 1969-2015, at first with a standard posterior Harrington technique and then by using the Ponte osteotomy with different instrumentations. A series of 78 of them, operated in the years 1987-1997, who had Ponte osteotomies at every level, is presented.
Results: The average preoperative kyphosis has been corrected from 80° (range 61°-102°) to 31° (range 15°-50°) by a substantial posterior shortening.
Conclusions: A number of publications use the term *Ponte osteotomy* loosely for by far incomplete resections and mixing it up with Smith-Petersen's osteotomy. The true Ponte osteotomy is capable of producing marked flexibility in extension, flexion and rotation, justifying its wide use in thoracic deformities, mainly in scoliosis. An exact performance of the osteotomy with adequate bony resections, including the laminae, is an absolute condition to take full advantage of its properties.
Level of Evidence: Level IV, therapeutic study.

Keywords: Ponte osteotomy; Smith-Petersen osteotomy; Thoracic kyphosis; Posterior column shortening; Flexibility; Scoliosis; Kyphoscoliosis; Ankylosing spondylitis

Introduction

The lead author's aim in the years 1984-1987, to correct long-segment thoracic kyphosis by a shortening of the posterior column in a single posterior stage, resulted in the development of this osteotomy. All other techniques in use obtained correction mainly or only by lengthening the anterior column. Since then, the Ponte osteotomy has become a widely applied technique in various types of spine deformities and a frequent topic of presentations at meetings and in scientific articles. Several of them offer unquestionable evidence of a wrong technique and consequently distorted outcomes and erroneous conclusions [1,2]. Another fact that needs to be cleared up is a frequent confusion with Smith-Petersen's osteotomy, mistakenly used interchangeably [1,3,4]. The notable differences between the two osteotomies are in the type and amount of resections, in the different anatomy of the regions they were originally developed for, that is lumbar versus thoracic and also in the grading in Schwab's Osteotomy Classification—Grade 1 for Smith-Petersen osteotomy and Grade 2 for Ponte osteotomy [5].

Smith-Petersen's osteotomy was described in 1945 for the correction of a flat lumbar spine from ankylosing spondylitis. The only time it was performed at thoracic levels gave "no objective evidence of improvement" [6]. This osteotomy consists in a narrow resection of lumbar

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facet joints and in a detachment of ligamentum flavum from the inferior margin of the lamina and inferior articular process (Fig. 1). There are no resections of the laminae. If used to obtain flexibility in thoracic kyphosis, correction is obtained by a wide opening of anterior disc spaces and a lengthening of the anterior column.

The Ponte osteotomy, developed in 1987, consists in a wide resection of thoracic facet joints as well as of laminae and in a complete removal of the ligamentum flavum (Fig. 2). Thoracic kyphosis, the original indication, is corrected by a substantial shortening of the posterior column, obtained by closing the gaps of osteotomies, preferably through segmentally applied and apically directed compression forces. The absence of anterior column lengthening due to major openings of anterior disc spaces preserves the immediate and long-term load sharing capacity and the stability of correction.

Correction of thoracic hyperkyphosis can be achieved by direct or indirect modes. A direct mode corrects by acting primarily on the involved structure, in this case mainly bone. An indirect mode corrects by acting primarily on uninvolved or less involved structures, which are ligaments and discs. Since rigid kyphosis is mainly a bony deformity, a direct mode of correction through bony shortening of the posterior spine seems more logical. Moreover, shortening the convexity of a spinal deformity provides greater safety than lengthening the concavity. Surgical techniques obtain correction by combining anterior lengthening and posterior shortening of the spine. Each technique, however, primarily lengthens the anterior spine or primarily shortens the posterior spine. It is important to note that in thoracic hyperkyphosis there is an increased length of the spinal canal, with the dural sac and the spinal cord taking a shorter and straighter route [7]. In severe cases, an anterior displacement of both the dural sac and cord can be present, with

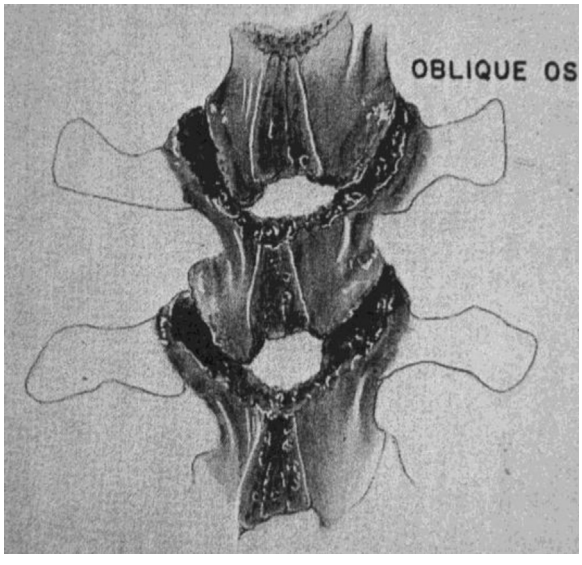

Fig. 1. Smith-Petersen's osteotomy. The original drawing.

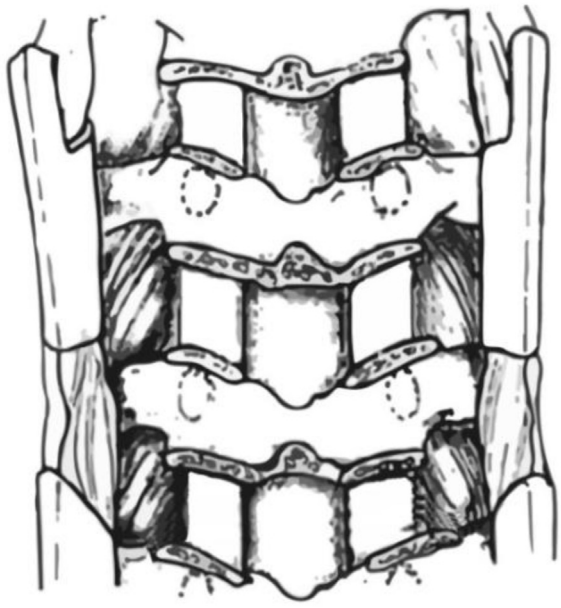

Fig. 2. Ponte osteotomy.

reduction or even obliteration of the anterior epidural and subarachnoid spaces. A consequent widening of the posterior epidural space will result.

Surgical treatment of thoracic kyphosis began with the standard posterior technique described by Harrington, consisting in two parallel compression rods and fusion. Correction was almost entirely obtained by lengthening of the anterior column. Marked losses of correction and a large number of implant failures induced surgeons to abandon this method [8]. The combined anterior/posterior technique, consisting in anterior discectomies, followed by an instrumented posterior fusion, became the treatment of choice [9]. Correction was obtained in two stages and by a marked lengthening of the anterior column. Intercorporal cages or other structural devices were needed to restore the anterior column support. Considering that hyperkyphosis is not only an anterior shortening but also a marked lengthening of the posterior column, it became evident that a substantial posterior shortening with preservation of the anterior column length and its load-sharing capacity would be an appropriate and stable form of correction. On this basis, the Ponte osteotomy has been developed. Anterior lengthening at midthoracic levels, where one single anterior longitudinal artery supplies the anterior two thirds of the spinal cord [10], also represents a high neurologic risk (see below).

Biomechanics

To fully understand the rationale of posterior column shortening by segmental Ponte osteotomies, one has to define the motion of the spinal column in extension. Any motion of an object in a plane can be explained by knowing