A Review on the Celiac Trunk Compression Syndrome: Some Anatomic Clinical-Surgical Aspects

Una Revisión del Síndrome de Compresión del Tronco Celiaco: Algunos Aspectos Anatómicos Clínicos-Quirúrgicos

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PETRELLA, S. & PRATES, J. C. A review on the celiac trunk compression syndrome: Some anatomic clinical-surgical aspects. **Int. J. Morphol.,** 26(2):293-304, 2008.

SUMMARY: The objective of this study was to review some celiac trunk compression syndrome aspects such as: symptom-posture relationship; absence of symptoms; syndrome-age relationship; angiographic study on anatomy of the celiac trunk stenosis; congenital or acquired origin; invasive diagnostic tests; surgical and postoperative results.

KEYWORDS: Arterial occlusive disease; Celiac artery; Celiac plexus; Diaphragm; Syndrome

Clinical radiologic study of the correlation between abdominal symptoms with celiac trunk compression by diaphragm crura, introduced a new nosological entity into the abdominal vascular pathology field – the celiac trunk compression syndrome (Dunbar et al., 1965). Since then, several cases have been reported with this syndrome (Debray & Leymarios, 1968; Fadhli, 1968; Harjola, 1968; Edwards, 1969; Hivet & Lagadec, 1970; Stanley & Fry, 1971; Joubaud et al., 1977).

Several terms have been proposed for its designation, as compression of the celiac trunk (Dunbar et al.; Terpstra, 1966), celiac trunk syndrome (Harjola & Lahtiharju, 1968), celiac compression syndrome (Marable et al., 1968), median arcuate ligament syndrome (Carey et al., 1969), compression of the celiac trunk by arcuate ligament of the diaphragm (Hivet & Lagadec), aortic channel syndrome of the diaphragm (Bobbio, 1968).

The term “median arcuate ligament syndrome” came to be often quoted as “celiac trunk compression syndrome”, as if to emphasize the hemodynamic aspect of its cause (Szilagyi et al., 1972). Warter et al. (1976) chose to denominate it as a phrenoceliac disease, taking into consideration the most complete expression to identify either its etiologic nature or the pathogeny of the lesion.

Symptoms of the celiac trunk compression syndrome. The symptoms of this syndrome are characterized by the triad, postprandial abdominal pain of cramp like nature, disorders in the function of intestinal canalization and weight loss. This symptomatology has similar characteristics to intestinal angina caused by atherosclerotic occlusive lesions of the major splanchnic vessels (Mikkelsen & Zaro, 1959; Dunbar et al., 1965; Bobbio et al., 1967; Carl et al., 1971). However, postprandial discomfort is less severe than in intestinal angina (Marable et al., 1966).

There are some clinical aspects that may differentiate the celiac trunk compression from atherosclerotic celiac-mesenteric ischemia, such as the predominance of pain up to the level of the superior quadrant of the abdomen, and the loss of weight due to intentional reduction in the amount of food and not as a result of malabsorption process (Bobbio et al.; Bobbio & Zanella, 1971). Also, differently from diarrhea with blood in the feces and of occasional malabsorption of the atheromatic mesenteric arterial diseases, diarrhea in the celiac trunk syndrome is more related to the irritable bowel than to malabsorption (Gutnick, 1984).

Age range related to the occurrence of syndrome. Several authors have observed that this disorder mainly affects young females, between 20 and 50 years old (Dunbar et al.; Marable...
et al., 1966; Lord et al., 1968; Cormier & De La Fontaine, 1970; Warter et al., 1970a; Loffeld et al., 1995). The female-male ratio is 4:1 (Trinidad-Hernandez et al., 2006). Age can eliminate the diagnosis of mesenteric arterial insufficiency of atherosclerotic origin (Marable et al., 1966) and the predominant action of the atheroma (Warter et al., 1970a). Atheroma plaques are not frequently associated to celiac trunk stenosis by median arcuate ligament (Warter et al., 1970a). Nevertheless, it was observed in patients with ages ranging from 60 to 80 years, celiac trunk compression associated to atherosclerosis located in the narrowed segment of this artery (Bobbio & Zanella; Drèze et al., 1972; Marable et al., 1968; Sautot, 1962).

Higher syndrome incidence in ectomorphic females can be explained by closer relationship between celiac trunk and the arcuate ligament. In these females the origin of both structures is frequently higher (Lindner & Kemprud, 1971). Angiographic studies in 17 patients, ten of them asymptomatic, with occlusion or severe stenosis of the celiac trunk, trying to correlate the abdominal angina to the unintentional discovery of the lesion, revealed that most of the symptomatic patients are under the age of 40 years and suffered from arcuate ligament syndrome. The asymptomatic ones are older and affected by various degrees of atherosclerosis (Cornell, 1971).

The occurrence of this syndrome in mid-age patients is not understandable since median arcuate ligament anomaly seems to be congenital. However, a feasible answer is that the effects of the compression may become manifest clinically later in life when the hemodynamic compensation mechanisms due to compression begin to fail (Warter et al., 1970a; Bobbio & Zanella).

Manifestation of this syndrome during the childhood or adolescence has seldom been described (Foertsch et al., 2007).

Relationship between body posture and pain. Clinical reports demonstrate that some body position postures have been adopted by patients suffering from this syndrome in order to relieve pain. The relief came adopting a knee-chest position (Dunbar et al.; Marable et al., 1966; Fadhli; Harjola, 1968; Houdard et al., 1970; Leger et al., 1970; Drèze et al.; Joubaud et al.; Abate et al., 1980; Lawson & Ochsner, 1984; Mulder et al., 1971; Tseng et al., 2007), by abdominal pressure (Lawson & Ochsner), by resting (Edwards et al., 1970), by lateral decubitus (Joubaud et al.) and in recumbency position (Leger et al., 1970). It was suggested that the knee-chest position would relieve the pressure on the celiac trunk by gravitating the viscera and diaphragm forward (Fadhli). It was also observed that pain worsens under physical effort (Fadhli; Edwards; Hived & Lagadec; Joubaud et al.; Williams et al., 1985), hours in a standing position (Joubaud et al.; Dreze et al.), upright posture, fatigue, emotional disorder, hunger (Williams et al.; Warter et al., 1976), recumbency (Edwards et al.; Plate et al., 1981) sitting position and decubitus (Van De Berg et al., 1972), during running (Baldasarre et al., 2007) and physical activity (Mensink et al., 2006; Foertsch et al.). These results indicated that, under physical effort, the arcuate ligament contraction against aorta causes discomfort (Hivet & Lagadec). Thus, the postural influence becomes an eventual sign of celiac trunk compression syndrome (Edwards).

Angiographic studies of the celiac trunk stenosis anatomy. The celiac trunk is originated in the anterior face of the aorta and draws a concavous superior and anterior curve (Hivet & Lagadec). The curve in “S” is lost with the compression by arcuate ligament (Olivier et al., 1970).

Some anomalous aspects of the celiac trunk direction and caliber obtained by lateral or profile aortography allowed the diagnosis of stenosis of this vessel by the median arcuate ligament, these signals being the precise evidence of this lesion. One of them is the vertical direction of the proximal segment of the celiac trunk, in its first centimeters, becoming parallel and compressed against the anterior wall of the aorta by the inferior margin of the arcuate ligament, that considerably compresses its lumen and provides to this vessel a notch in its anterior face shaped like an “ax blow” or “flute peak” (Hivet & Lagadec; Huguet et al., 1972; Joubaud et al.; Gutnick). Another aspect is the reduction or suppression of the 90° angle between the posterior face of the celiac trunk and the subjacent aorta, to visualizing the stenosed segment flattened against the aorta. The vertical course of the first centimeters of the celiac trunk leads to the disappearance of the parallelism with normal superior mesenteric artery (SMA), which acquires a closer proximity to that vessel (Bobbio et al.; Furnemont, 1974). Besides these aspects, poststenotic dilatation after the narrowed portion of the celiac trunk is frequent (Warter et al., 1970; Tongio et al., 1971; Huguet et al.; Joubaud et al.). Also, distally to the “notch”, the celiac trunk assumes a horizontal or oblique ascendant deviation (Olivier et al.; Hivet & Lagadec; Warter et al., 1976) as an “elephant’s trunk” (Bobbio et al.) or a “hook” (Tongio et al.; Karaban et al., 2007).

Two types of stenosis were observed by the lateral angiography in stenosis or occlusion cases, in the origin or proximal third of the celiac trunk, accordingly to the lumen involvement: the eccentric and the concentric stenosis. In the eccentric type, the lumen is inferiorly and/or superiorly asymmetrically compromised, and in the concentric type,
circumferentially (Bron & Redman, 1969). The compression of the celiac trunk by the crural fibers of the diaphragm and/or celiac ganglion produces an eccentric type stenosis in the superior part of the celiac trunk, differentiating from atheromatosus stenosis, which is generally of a concentric type (Deutsch, 1968; Bron & Redman and Brandt & Boley, 1978). Sometimes the presence of a periarterial neurofibrous envelope of the celiac trunk reveals itself as a concentric stenosis (Harjola & Lahtiharju; Tongio et al.).

Szilagyi et al. defines the terms compression and stenosis. So, stenosis generally assumed to be due to atherosclerotic changes in the intimae and appeared as a concentric diminution of the circumference of the artery, and compression appeared as an indentation in the downward curvature of this artery apparently brought about by the pressure of a sharp edge.

The compression of the celiac trunk by the median arcuate ligament acquires characteristics of stenosis that occurs slightly distant from the ostium, smooth and mostly short (Broussin et al., 1970).

Proposals were made in order to classify the different morphological and radiological characteristics of the celiac trunk stenosis, considering its more or less accentuated degrees (Warter et al., 1970b; Colapinto et al., 1972; Di Marino et al., 1972).

Warter et al. (1970b), in a study using lateral angiography of 48 individuals aged between 12 and 72 years (the majority with less than 50 years), with celiac trunk stenosis and, comparing the cases that have been published in literature, classified this stenosis into five types. According to the proposed classification, diaphragmatic stenosis of the celiac trunk is the most frequent, affecting younger individuals and figures in type I with three subtypes. Type I is characterized by an initial narrowing of the celiac trunk and a poststenotic dilatation with well established etiology in the literature. In IA and IC subtype, the narrowed and long part of the celiac trunk seems compressed against the aorta while in IB subtype, we noticed an empty gap between the stenosed segment and the aorta. Type II conforms to the celiac trunk a fusiform aspect with or without poststenotic dilatation and can also identify in this type the atheromatous isolated stenosis (Dunbar et al.) and the fibromuscular hyperplasia of the celiac trunk (Ripley & Levin, 1966). In type III, it is possible to verify the presence of superior and lower notches in the celiac trunk, with no poststenotic dilatation, including the compression by the celiac plexus hypertrophyated ganglions (Snyder et al., 1967) and by the periarterial fibrous envelope like a ring (Harjola, 1963). In type IV, the caliber of the celiac trunk is reduced and includes the Reuter & Olin’s atheroma (1965). Type V is characterized by complete obliteration of the celiac trunk, as in the congenital atresias (Moretti et al., 1965; Chavez et al., 1966), in the pancreatitis (Frumusan et al., 1968), and in the Debray & Leymarios’s retroperitoneal fibrosis.

If pathognomonic type IA is the most frequent and is found mainly in adults, it seems that in young people or in the slim woman the narrowed segment is longer (type IB) (Dreze et al.).

A similar study obtained by Colapinto et al. on 74 patients aged between 16 and 85 years, average of 50.9 years, classified four types of stenosis of the celiac trunk according to its prominent morphologic aspect. It was associated to Type I, a celiac trunk compression by the arcuate ligament or ganglia tissue and to the other II, III and IV types, the stenosis of atherosclerotic nature. Forty-seven cases (63%) belonged to type I, and 30 of these with stenosis greater than 50%. Type I occurred in all ages and both sexes.

Therefore, the majority of the angiographic images corresponding to the extrinsic celiac trunk stenosis fits in type I (Di Marino et al.).

The celiac trunk compression by median arcuate ligament occurs more distally (Marable et al., 1968).

The caliber of the portion of the celiac trunk that precedes a high grade stenosis, due to compression by median arcuate ligament, is slightly reduced (Hivet & Lagadec; Joubaud et al.).

The angle between the celiac trunk at its origin and the aorta in normal individuals decreases with age (Lindner & Kemprud).

The angio graphic aspect of the intrinsic and extrinsic stenosis of the celiac trunk ranges from a minimum “notch” to complete occlusion (Ducellier et al., 1974). It was observed that stenosis of the celiac trunk by the arcuate ligament presents different percentages of stenosis of luminal diameter, considered to be mild (less than 50%), moderate (50 to 75%), or severe (greater than 75%) (Colapinto et al.). In some cases, the percentage of the stenotic area is greater than 50% (Koikkalainen & Köhler, 1971; Levin & Baltaxe, 1972; Szilagyi et al.; Ducellier et al.; Ghosn et al., 1982; Thevenet et al., 1985; Mensink et al.; Trinidad - Hernandez et al.), in others lesser than 50% (Szilagyi et al.), in others still 50% (Lord & Tracy, 1980; Loffeld et al.) or total (Rubush, 1970; Cornell; Ghosn et al.; Loffeld et al.; Lawson & Ochsner; Jaik et al., 2007).
Noninvasive diagnostic tests. The grade of stenosis, the systolic and diastolic velocities of flow in the celiac trunk and branches and narrowing, can be evaluated by the use of noninvasive tests: doppler ultrasonography (Trinidad-Hernandez et al.; Farma & Hoffman, 2007; Foertsch et al.; Jaik et al.; Tseng et al.), digital subtraction angiography (Desmond & Robert, 2004; Mensink et al.; Foertsch et al.; Tseng et al.), spiral computed tomography (CT) angiography (Baldassarre et al.), multislice CT (Karaban et al.), multidetector CT angiography (Farma & Hoffman; Ilica et al., 2007; Tseng et al.), magnetic resonance angiography (Dordoni et al., 2002; Foertsch et al.; Gioviczki & Duncan, 2007).

The modality doppler ultrasonography (Dordoni et al.; Trinidad-Hernandez et al.; Farma & Hoffman; Foertsch et al.; Ilica et al.), the magnetic resonance angiography (Foertsch et al.) has been also used postoperatively to confirm adequacy of velocity systolic and diastolic of flow in the syndrome.

Duplex imaging showed that preoperative velocity systolic of the celiac trunk was 363 cm/s (Jaik et al.) and 450 cm/s (Trinidad-Hernandez et al.) and the postoperative was 145 cm/s (Jaik et al.) and 182 cm/s (Trinidad-Hernandez et al.). Ilica et al. using the multidetector tomography observed that preoperative systolic velocity of the celiac trunk was greater than 200 cm/s.

Recently, it was introduced the gastric exercise tonometry able to identify patients with suspected celiac trunk compression syndrome (Mensink et al.).

Jaik et al. were the first to treat this syndrome successfully using the da Vinci TM (Institute Surgical, Sunnyvale, CA, USA) via robotic-assisted laparoscopy (telemanipulation), an approach minimally invasive surgery for division of the arcuate ligament.

The congenital origin of the syndrome. The young age of the patients favors of the congenital nature of this syndrome (Warter et al., 1970a; Warter et al., 1976). The familiar observations of mother and daughter (Van de Berg et al.; Dondival & Drèze, 1972), two sisters (Warter et al., 1974), father and his sons (Warter et al., 1976) and two twin brothers (Bech et al., 1994), all of them with celiac trunk compression syndrome reinforces this conviction.

All these malformations due to a probable pleiotropic genetic factor can be grouped, or accept that these dysmorphic syndromes (myotonic dystrophy, Marfan syndrome) may occasionally include, through its different manifestations, a celiac trunk stenosis. In this case the celiac trunk compression by the arcuate ligament will have a very precise genetic etiology (Dondinval & Drèze).

The confirmation of an identical formation of mother and daughter does not fit in this frame and genetic studies that have been undertaken lead to believe in a congenital malformation due to an embryologic development problem, probably due to an autosomal dominant gene (Drèze et al.).

Theory of the syndrome acquired origin. The control of karyotypes did not reveal anomalies in any case (Warter et al., 1976).

It is possible to suppose that the arterial narrowing is an acquired process, although the diaphragmatic abnormalities appear to be congenital (Carey et al.). Some authors conjecture the acquired nature and believe it to be a sclerosis process (inflammatory or degenerative) that causes a cicatrization retraction of the cruciform fibers of the diaphragm with resultant descent of the inferior margin of the aortic hiatus, reducing the space delimited by it. Supporting this hypothesis there is also the frequent association of sclerosis process of an adipose-cellular connective tissue, in individuals older than 50 years, occupying the retroperitoneal space around the aorta, involving up to the nervous structure of the celiac plexus and acquire an intimate anatomic-topographic relationship with the celiac trunk and with its branches. It is considered that this acquired factor, but with pathogenic bases, appears in a specific moment of life and alters the normal anatomic conformation, determining the arterial compression and affecting the flux of that area, in the anatomic conditions of the compressed vessel and in its poststenotic dilatation. The extended friction of the fibrosclerotic structure over the celiac trunk could cause alterations in the muscular-elastic tonicity of the vessel and later will induce to form the atherosclerotic lesion of this vessel or the aorta (Bobbio et al.).

Coexistence of celiac trunk compression and SMA. The uncommon occurrence of reported cases on simultaneous compression of the celiac trunk and SMA by the arcuate ligament can be explained by the particular disposition of these trunks in the aorta. Its origins are close and at times, the initial segments of both are stuck together (Watson & Sadikali, 1977; Langeron et al., 1980).

Lower SMA disposition explains the smaller stenosis grade of this artery in relation to the celiac trunk that can be totally occluded (Langeron et al.). In some cases, a total obstruction of the celiac trunk with only one concave impression in SMA was observed angiographically (Loffeld et al.), a slight narrowing of the SMA, the celiac trunk
compressed by left crus of the diaphragm and an adenopathy and fibrous reaction around the celiac trunk and SMA (Cornell), and a moderate SMA stenosis without any significant hemodynamic implication (Edwards; Lord et al.). Also, a total occlusion of the celiac trunk with SMA stenosis of approximately 90 to 95% was demonstrated (Broussin et al.; Langeron et al.; Lawson & Ochsner; Houssin et al., 1979), stenosis 50% of the SMA (Mulder et al.; Tison et al., 1989; Bech et al.), and a total SMA occlusion with the left crus being more involved than the arcuate ligament in the compression of the SMA, which has its origin on the left side of the aorta (Watson & Sadikali; Bacourt et al., 1984). A thick transversal fibrous formation tightly compressing the SMA (Langeron et al.) and the compression of a common celiac-mesenteric trunk by an abnormal crus of the diaphragm was observed. Arteriography revealed that the left crus performed a closer compression in the SMA than in the celiac trunk, both arteries originating on the left side of the aorta and very close to each other (Gautier et al., 1965).

Arteriographic diagnosis is more difficult in occlusive lesions. Therefore, in the case of the occluded celiac trunk, the SMA stenosis is the best diagnostic argument and in the occlusion of both arteries, the young age and the atheroma’s absence orientate the diagnosis (Bacourt et al.).

Parallel to the activity of the compression by the arcuate ligament, the celiac- mesenteric nervous plexus contributed to the compression (Bacourt et al.). Evidence obtained with surgical intervention demonstrates a thick nervous tissue corresponding to the celiac-mesenteric ganglia surrounding the SMA (Houssin et al.).

Studies realized by several authors demonstrated the recovery of beats of arterial pulse with re-expansion of the celiac trunk and SMA and the disappearance of the bruit after liberation of tight fibrous formation of transversal disposition (Langeron et al.; Lawson & Ochsner; Bacourt et al.).

Rare angiographic experiments revealed the aorta compression or indentation on its anterior face, simultaneously to the celiac trunk compression by the arcuate ligament (Bacourt et al.; Ilica et al.). Fadhli was the first author to demonstrate this simultaneous compression, causing symptoms of intermittent claudicating of the lower extremities and abdominal angina, due to obstruction of the aorta and celiac trunk, respectively. The compression was caused by very tight ring of the aortic hiatus, encompassing the aorta and celiac trunk just proximal to its trifurcation. The postoperative patient was free of symptoms and gained weight.

**Celiac trunk and branches compression.** In patients with arcuate ligament compression syndrome, it was demonstrated that the diaphragmatic orifice crosses the celiac trunk in front of aorta, this vessel being involved by the abnormally tight diaphragmatic arcade close to the left gastric artery (Olivier et al.).

Hepatic artery stenosis by fibrous ring (Debray et al., 1967; Leger et al., 1967), stenosis of the celiac trunk and hepatic artery (Bessot et al., 1970), stenosis of the celiac trunk and their splenic and gastric branches (Van de Berg et al.; Trinidad-Hernandez et al.) were observed arteriographically in patients with epigastric pain, loss of weight and digestive problems.

**Absence of symptoms in syndrome.** The anatomic abnormality of the celiac trunk by compression of the median arcuate ligament can occur in asymptomatic individuals (Sutton, 1967) and frequently (Stoney & Wylie, 1966). Patten et al. (1991) state that this syndrome is an uncommon angiographic and surgical finding, rarely symptomatic.

In asymptomatic patients with isolated compression of the celiac trunk by the arcuate ligament and/or celiac ganglia (Rob, 1965; Drapanas & Bron, 1966; Sutton; Charrette et al., 1971; Colapinto et al.; Levin & Baltaxe; Guibert et al., 1980; Meaney & Kistner, 1967; Stoney & Wylie), and with compression SMA and of the celiac trunk (Houssin et al.; Langeron et al.) the stenosis of these vessels was incidentally found through angiography performed for other affections.

Levin & Baltaxe analyzed 50 patients with celiac stenosis due to arcuate ligament compression and/or celiac plexus with complete absence of abdominal symptoms or referring to the gastrointestinal tract, submitted to lateral aortogram by other clinical causes. Twelve were observed with stenosis at 50% or more.

**Angiography after an abdominal trauma incidentally revealed the double celiac trunk and AMS compression (Langeron et al.).**

Typical angiographic findings in asymptomatic individuals do not invalidate the arcuate ligament syndrome, since it is well known that the atherosclerotic occlusion of both celiac trunk and SMA can also be asymptomatic (Colapinto et al.).

Asymptomatic character in cases of the celiac trunk compression by the arcuate ligament led to the hypothesis that the collateral vessels from the SMA supply the terminal branches of the celiac trunk without compromising the
blood flow (Stoney & Wylie; Sutton). Similarly, in the double celiac trunk and SMA compression, the absence of symptoms seems to depend on the existence of a prominent Riolan’s arcade (Houssin et al.). It is clear that in the asymptomatic individual the arcuate ligament section is performed to prevent a decompensation of vascularization in the visceral splanchnic area up to now supplied by the inferior mesenteric artery through the Riolan’s arcade (Langeron et al.).

Based on angiographic findings demonstrating both asymptomatically and symptomatically individuals with compression syndrome presented developed collateral vessels, it was supposed that the symptoms are not caused by the lack of collateral vessels (Cornell). Levin & Baltaxe finds a collateral circulation in the frontal aortogram or in the superior mesenteric arteriogram in only 3 of the 12 asymptomatic patients with celiac trunk compression syndrome. (Terpstra; Marable et al., 1966; Stoney & Wylie; Marable et al., 1968; Harjola; Harjola & Lahtiharju; Snyder et al.; Taheri, 1968; Jamieson & Grieg, 1970).

It is possible that the complete celiac trunk hemodynamic liberation depends from the arcuate ligament section as well as from resection of the periarterial neurofibrous tissue (Balmes et al., 1971; Harjola & Lahtiharju; Hivet & Lagadec; Lindner & Kemprud; Conti et al., 1973; Van De Berg et al.; Watson & Sadikali; Daskalakis, 1982 and Ghosn et al.). In some patients, a certain degree of periarterial fibrosclerosis can be intra-surgically observed (Drèze et al.). In some cases an extensive celiac plexus denervation and a periarterial sympathectomy have been performed (Cormier & De La Fontaine; Watson & Sadikali).

Tahery verified the celiac trunk compression release after a division of the right crus of the diaphragm associated to ganglionectiony.

In the compression cases of the celiac trunk by the arcuate ligament (Drèze et al.; Joubaud et al.) and associated SMA (Houssin et al.) when the very dense fibromyovascular envelope formed by nervous and lymphatic ramifications involving both arteries and celiac trunk branches was sectioned, an arciform bridge, considered to be the diaphragmatic arcuate ligament was observed crossing the celiac trunk. A dense tissue of approximately 5 mm thick continuous with the arcuate ligament was divided to release the artery (Lord & Tracy).

Some authors believe that despite the celiac plexus section be an inevitable surgical act during celiac decompression, this limited plexotomy is not responsible for cure of the symptom (Marable et al., 1968).

Williams et al. during the decompression of the celiac artery by dividing the arcuate ligament, tried not to damage the celiac ganglia and to divide only the intercalating fibers of the celiac plexus as they crossed the celiac trunk. Considering that they managed to cure the symptoms by simply dividing the arcuate ligament, they concluded that the limited periarterial sympathectomy alone would not produce lasting relief of the symptoms.

Also, the recurrence of pain after arcuate ligament section denied this belief (Stanley & Fry).

It is possible to suppose that in cases of cure of the symptoms, a more extensive resection in the area of the celiac trunk origin, consequently involving the celiac ganglion division could be the cause of symptom cure (Edwards et al.).
It is appropriate to be restricted only to the sectioning of the nervous structure that narrows the celiac trunk and its branches, respecting the other elements (Bobbio et al.).

It was arteriographically demonstrated stenosis of the celiac trunk due to fibrosis of ganglion, and the total cure of the symptoms and disappearance of the abdominal bruit after sectioning nervous fibers (Rob, 1966; Snyder et al.).

After surgery and biopsy it becomes difficult to decide whether the responsible component for the celiac trunk compression is the arcuate ligament or the celiac ganglion fibrosis (Edwards et al.; Colapinto et al.). However, several cases do not need the extrinsic stenosis surgical treatment of the celiac trunk by arcuate ligament since it does not cause any problem (Joubaud et al.).

The arterial blood flow and pressure of the aorta and its branches should be recorded before and after releasing the compression of the celiac trunk (Daskalakis). Specific pressure gradients are measured intra-surgically (Dunbar et al.; Stone & Wylie; Terpstra; Lord et al.; Carey et al.; Edwards et al.). These pressure gradients present individual variations and can be weak (Dunbar et al.; Balmes et al.) or absent (Carey et al.). Some authors reported gradients between 5 and 30 mmHg (Dunbar et al.), others of approximately 30 mmHg (Lord et al.; Lord & Tracy) or between 20 and 60 mmHg (Stone & Wylie), between the aorta and the celiac trunk. If the prestenotic segment of the celiac trunk is masked by the muscular fibers of the diaphragm pillars, it becomes difficult to measure the pressure gradient of this vessel (Houdard et al.).

The “thrill” is clearly palpable, with variable intensity and, at times, does not even exist (Houdard et al.; Tseng et al.). A diminished pulse pressure within the celiac arterial bed and a “thrill” of this artery suggest compression (Stanley & Fry). It was verified in patients with SMA and trunk celiac bed and a thrill with recovery of its normal caliber, and pressure gradient crossing the stenosed segment remains significant, a revascularization of the segment with sequel is needed by resection of this segment, followed by anastomosis or reconstruction by autograft, bypass, transplant or endarterectomy. The histological results of these high grade stenosis with alterations and fragilities of the vessel walls, is frequently related to fibrosis or intimai hyperplasia, at times with associated atheromatosis lesions (Stone & Wylie; Lord et al.; Hivet & Lagadec; Olivier et al.; Lindner & Kemprud; Houssin et al.; Daskalakis; Thevenet et al.; Edwards; Edwards et al.). The moderate changes in the intimai by fibrosis and hyperplasia are likely reversible in young patients and do not need reconstruction (Charrette et al.). The arterial pressure of the hepatic or left gastric artery, before and after release of the compressive band of the celiac trunk, is a more sensitive and reliable test in order to evaluate the immediate results. If there is no significant increase, arterial reconstruction can be promptly undertaken (Daskalakis).

The arterial reconstruction abolished pressure gradient and post-surgical arteriograms confirm the patency of the reconstructed segment (Lord et al.).

The permanence of abdominal bruit after arterial compression surgical dilatation, suggests as cause the persistence of a poststenotic dilatation, which can be sufficient to cause turbulences (Watson & Sadikali). These signals can disappear after months or not disappear completely (Conti et al.).

Control arteriography. Postoperative control aortogram confirms anatomic correction of the celiac trunk deformity with recovery of its normal caliber, and revascularization through the collaterals (Bacourt et al.; Lawson & Ochsner; Hivet & Lagadec; Houdard et al.; Snyder et al.; Tridico et al.). The return of the normal angiographic patterns represents the most definitive proof that the improvement in the clinical picture of ischemia depends on the restoration of normal anatomical relationships at the level of the aortic canal of the diaphragm (Bobbio & Zanella).

Presurgical duration of the symptoms. Presurgical duration of the symptoms is variable. It was verified that in a patient the abdominal pain originated in his childhood (Conti et al.), in another, 65 years old, abdominal pain lasted 30 years (Loffeld et al.).

Postsurgical results and follow-ups. Although the percentage of the favorable surgical results is not known, in different series described in literature, they appear compatible to approximately 86% (Warter et al., 1976). The
case selection in the literature of patients treated between 1971 and 1987, showed 82% of surgical success (Tridico et al.).

Literature shows results on a long term of 1 to 3 years (Lord et al.; Ghosn et al.; Williams et al.; Bacourt et al.; Mensink et al.), and 7 years (Foertsch et al.)

**REFERENCES**

Abate, S.; Ferulano, G. P.; Iaccarino, V.; Danzi, M. & Fresini, A. Compressione del tripode celiaco da parte del legamento arcuato del diaframma. *Min. Chir.*, 35:1273-8, 1980.  
Bacourt, F.; Brun, J. G. & Goeau-Brissonière, O. Compression associée du tronc coeliaque, de l’artère mésentérique supérieure et de l’aorte par le ligament arqué du diaphragm. *Presse Med.*, 13:731-2, 1984.  
Baldasarre, E.; Torino, G.; Siani, A.; Barone, M. & Valenti, G. The laparoscopic approach in the median arcuate ligament syndrome. *Swiss Med. Wkly*, 137: 253-4, 2007.  
Balmes, M.; Janbon, C.; Vergues, J. & Baissus, C. Sténose extrinsèque du tronc coeliaque par le ligament arqué du diaphragme. *Arch. Fr. Mal. Appar. Dig.*, 60:161, 1971.  
Bech, F.; Loesberg, A.; Rosenblum, J.; Glagov, S. & Gewertz, B. L. Median arcuate ligament compression syndrome in monozygotic twins. *J. Vasc. Surg.*, 19:934-8, 1994.  
Bessot, M.; Fays, J.; Piccioli, R.; Boileau, F. & Basquet, J. Sténoses de l’artère hépatique. *Chirurgie*, 96:457-66, 1970.  
Bobbio, A. La sindrome del canale aortico del diaframma (Stenosi da compressione del tronco celiaco). *Omnia Med.*, 46:595-608, 1968.  
Bobbio, A. & Zanella, E. Compression stenosis of the celiac axis (the aortic canal syndrome). Long term results of surgical decompression. *Surg. Italy*, 1:176-82, 1971.  
Bobbio, A.; Zanella, E. & Chiampo, L. La stenosi da compressione del tronco celiaco. *Minerva Chir.*, 22:1024-34, 1967.  
Brandt, L. J. & Boley, S. J. Celiac axis compression syndrome. A critical review. *Am. J. Dig. Dis.*, 23: 633-40, 1978.  
Bron, K. M. & Redman, H. C. Splanchnic artery stenosis and occlusion. *Radiology*, 92:323-8, 1969.  
Broussin, J.; Caille, J. M.; Basseau, J. P.; Grelet, P.; Diard, F. & Bellet, M. Syndrome d’oblitération du tronc coeliaque par ligament arqué. *J. Radiol. Electrol. Med. Nucl.*, 51: 826-8, 1970.  
Carey, J. P.; Stemmer, E. A. & Connolly, J. E. Median arcuate ligament syndrome. *Arch. Surg.*, 99: 441-6, 1969.  
Charrette, E. P.; Ivengar, S. R. K.; Lynn, R. B.; Poloschi, G. B. & West, R. O. Abdominal pain associated with celiac artery compression. *Surg. Gynec. Obstret.*, 132:1009-14, 1971.  
Chavez, C. M.; Mora, L. O.; Conn, J. H. & Fain, W. R. J. Congenital atresia of the celiac axis. *Arch. Surg.*, 93: 667-70, 1966.  
Colapinto, R. F.; McLoughlin, J. J. & Weisbrod, G. L. The routine lateral aortogram and the celiac compression syndrome. *Diagn. Radiol.*, 103:557-63, 1972.  
Conti, A.; Tateo, R.; Cacciatore, E. & Tuscano, G. El síndrome del ligamento arqueado. *Angiologia*, 25:171-6, 1973.  
Cormier, J. M. & De La Fontaine, P. Sténose extrinsèque du tronc coeliaque. *Chirurgie*, 96:453-6, 1970.  
Cornell, S. H. Severe stenosis of the celiac artery. Analysis of patients with and without symptoms. *Diagn. Radiol.*, 99:311-6, 1971.
Curl, J. H.; Thompson, N. W. & Stanley, J. C. Median arcuate ligament compression of the celiac and superior mesenteric arteries. *Ann. Surg.*, 173:314-20, 1971.

Daskalakis, M. K. Celiac axis compression syndrome. *Int. Surg.*, 67:442-4, 1982.

Debray, Ch. & Leymarios, J. Les sténoses non athérômeuses des troncs artériaux digestifs. *Sem. Hôp. Paris*, 39:2455-61, 1968.

Debray, C. H.; Leymarios, J.; Hardouin, J. P.; Cerf, M.; Paolaggi, J. A. & Hernandez, C. L. Les oblitérations ostiales progressives des artères digestives. Aspects clinique et arteriographique. A propos de six cas. *Press. Med.*, 75:691-6, 1967.

Desmond, C. P. & Roberts, S. K. Exercise-related abdominal pain as a manifestation of the median arcuate ligament syndrome. *Scand. J. Gastroenterol.*, 12:1310-3, 2004.

Deutsch, V. Compression of the coeliac trunk and the angiographic evaluation of its hemodynamic significance. *Clin. Radiol.*, 19:309-14, 1968.

Di Marino, V.; Tournigand, P.; Adhoute, B. & Mercier, Cl. A propos des compressions extrinsèques du tronc coeliaque. *J. Chir. (Paris)*, 104:289-306, 1972.

Dondival, P. & Drèze, Ch. Sténose du tronc coeliaque chez une mère et sa fille par compression due au ligament arqué médian du diaphragme. *J. Genet. Hum.*, 20:46-67, 1972.

Dordoni, L.; Tshomba, Y.; Giacomelli, M.; Janello, A. M. & Chiesa, R. Celiac artery compression syndrome. Successful laparoscopic treatment - a case report. *Vasc. Endovascular Surg.*, 36 (4):317-21, 2002.

Drapanas, T. & Bron, K. M. Stenosis of the celiac artery. *Ann. Surg.*, 164:1085-8, 1966.

Drèze, Ch.; Dodiñval, P.; Lombard, R.; Van De Berg, L.; Van De Berg, A.; Jacquet, N. & Booz, G. Compression du tronc coeliaque par le ligament arqué du diaphragme. Sept observations dont deux premières familiales. *Acta Gastroenterol. Belgica*, 35:529-48, 1972.

Ducellier, R.; Gasquet, C.; Barbier, J. & Morand, X. Aspects étiologiques des sténoses du tronc coeliaque. *J. Radiol. Electrol.*, 55:569-75, 1974.

Dunbar, D.; Molnar, W.; Beman, F. F. & Marable, S. A. Compression of the celiac trunk and abdominal angina. *Am. J. Roentgenol. Radium. Ther. Nucl. Med.*, 95:731-44, 1965.

Dunbar, D.; Molnar, W.; Beman, F. F. & Marable, S. A. Compression of the celiac trunk and abdominal angina. *Am. J. Roentgenol. Radium. Ther. Nucl. Med.*, 95:731-44, 1965.

Edwards, A. Coeliac axis compression syndrome. *Proc. R. Soc. Med.*, 62:488-90, 1969.

Edwards, A. J.; Hamilton, J. D.; Nichol, W. D.; Taylor, G. W. & Dawson, A. M. Experience with coeliac axis compression syndrome. *Br. Med. J.*, 1:342-5, 1970.

Fadhli, H. A. Congenital diaphragmatic obstruction of the aorta and the celiac artery. *J. Thorac. Cardiovasc. Surg.*, 55:431-3, 1968.

Farma, J. M. & Hoffman, J. P. Nonneoplastic celiac axis occlusion in patients undergoing pancreaticoduodenectomy. *Am. J. Surg.*, 341-4, 2007.

Foertsch, T.; Koch, A.; Singer, H. & Lang, W. Celiac trunk compression syndrome requiring surgery in 3 adolescent patients. *J. Pediatr. Surg.*, 42:709-13, 2007.

Fornier, T.; Koch, A.; Singer, H. & Lang, W. Celiac trunk compression syndrome requiring surgery in 3 adolescent patients. *J. Pediatr. Surg.*, 42:709-13, 2007.

Fortner, J. G.; Watson, R. C. Median arcuate ligament obstruction of celiac axis and pancreatic cancer. *Ann. Surg.*, 194:698-700, 1981.

Frumusan, P.; Bodin, F.; Hivet, M.; Conte-mari, J. & Cont, M. Les pancréatopathies d’origine ischémique. A propos de deux cas associant une artérite des membres, une artérite sténosante du tronc coeliaque et une pancréatopathie chronique diabétique. *Press Med.*, 76:563-6, 1968.

Furnemont, E. La stenose du tronc coeliaque par le ligament arqué du diaphragme. A propos de deux observation. *J. Belg. Radiol.*, 57:443-50, 1974.

Gautier, R.; Barrié, J. & Sarrazin, R. Les angors abdominaux non athéromateux. A propos de deux cas. *Lyon Chir.*, 61:893-5, 1965.

Ghosn, P. B.; Rabbat, A. G.; Trudel, J.; D’amico, P.; Lecours, R. & Trudel, J. Celiac compression syndrome. *Can. Surg.*, 25:377-9, 1982.

Ghougassian, P. B.; Rabbat, A. G.; Trudel, J.; D’amico, P.; Lecours, R. & Trudel, J. Celiac compression syndrome. *Can. Surg.*, 25:377-9, 1982.

Gloviczki, P. & Duncan, A. A. Treatment of celiac artery compression syndrome: does it really exist? *Perspect. Vasc. Surg. Endovasc. Ther.*, 26:259-63, 2007.

Guibert, B.; Braillon, G.; Croisille, M.; Contassot, J. C.; Mayer, B. & Frecon, G. Sténose du tronc coeliaque par le ligament arqué. *Lyon Chir.*, 76:321-5, 1980.
Gutnick, L. M. Celiac artery compression syndrome. *Am. J. Med.*, 76:334-6, 1984.

Harjola, P. T. A rare obstruction of the coeliac artery. *Ann. Chir. Gynaecol. Fenn.*, 52:547-70, 1963.

Harjola, P. T. Coeliac axis constriction and abdominal angina. *Bull. Soc. Intern. Chir.*, 27:464-7, 1968.

Harjola, P. T. & Lahtiharju, A. Celiac axis syndrome. Abdominal angina caused by external compression of the celiac artery. *Am. J. Surg.*, 115:864-9, 1968.

Hivet, M. & Lagadec, B. Compression du tronc coeliaque par le ligament arqué du diaphragme. *Rev. Chir. Mal. Foie de la Rate e du Pancræs*, 45:129-34, 1970.

Hivet, M.; Lagadec, B. & Poilleux, J. Les sténoses chroniques du tronc coeliaque. *Chirurgie. Méun Acad. Chir.*, 96:483-6, 1970.

Houdard, C.; Carles, J. F.; Helenon, Ch. & Boschet, P. A propos d’un cas de compression extrinsèque du tronc coeliaque. *J. Chir. (Paris)*, 99:19-24, 1970.

Houssin, D.; Lecompte, Y. & Bismuth, H. Compression de l’artere mésoentérique supérieure et du tronc coeliaque par le ligament arqué médian. *Ann. Chir.*, 33:71-6, 1979.

Huguet, J. F.; Deronzier, R.; Burelle, H.; Abignoli, A. M. & Jouve, P. Les sténoses congénitales du tronc coeliaque. *J. Radiol.*, 53:895-6, 1972.

Ilica, A. T.; Kocaoglu, M.; Bilici, A.; Ors, F.; Bukte, Y.; Senol, A.; Vcoz, T. & Somuncu, I. Median arcuate ligament syndrome: multi detector computed tomography findings. *J. Comput. Assist. Tomogr.*, 31:728-31, 2007.

International Anatomical Nomenclature Committee. *Nomina anatomica*. 5th ed. Cidade do México, Medsi, 1984.

Jaik, N. P.; Stawicki, S. P.; Weger, N. S. & Lukaszczyk, J. J. Celiac artery compression syndrome: successful utilization of robotic-assisted laparoscopic approach. *J. Gastroenterol. Liver Dis.*, 16:93-6, 2007.

Jamieson, A. & Greig, J. H. Isolated celiac axis compression as a cause of visceral angina. *Canad. Med. Ass. J.*, 103:374-5, 1970.

Joubaud, F.; Pillet, J. & Boyer, J. Compression extrinsèque du tronc coeliaque par ligament arqué du diaphragme. *Sem. Hôp. Paris*, 53:157-64, 1977.

Karaban, O. I.; Kahriman, G. & Engin, A. Y. Celiac artery compression syndrome: diagnosis with multislice CT. *Diagn. Interv. Radiol.*, 13:90-3, 2007.

Kieny, R. & Cinqualbre, J. Indications et résultats de la chirurgie des sténoses et oblitérations des artères digestives. *Ann. Radiol.*, 19:387-93, 1976.

Koikkalainen, K.; Köhler, R. - Stenosis and occlusion in the coeliac and mesenteric arteries. *Ann. Chir. Gynaec. Fenniae*, 60:9-24, 1971.

Langeron, P.; Becquet, R.; Puppinck, P.; Descamps, C. L. & Sockeel, G. Double compression du tronc coeliaque et de la mésoentérique supérieure par ligament arqué. *Chirurgie*, 106:127-31, 1980.

Lawson, J. D. & Ochsner, J. L. Median arcuate ligament syndrome with severe two-vessel involvement. *Arch. Surg.*, 119:226-7, 1984.

Leger, L.; Chalmeau, M.; Brou, R.; Moullé, P.; Chapus, Y. & Lemaigre, G. Sténose ostiale de l’artère hépatique. *Press. Med.*, 75:456, 1967.

Leger, L.; Vigué, R.; Mouillé, P. & Dentan, Th. Sténose du tronc coeliaque. *Chirurgie*, 96:469-70, 1970.

Levin, D. C. & Baltaxe, H. A. High incidence of celiac axis narrowing in asymptomatic individuals. *Am. J. Roentgenol. Radium Ther. Nucl. Med.*, 116:426-9, 1972.

Lindner, H. H. & Kemprud, E. A clinicoanatomical study of the arcuate ligament of the diafragm. *Arch. Surg.*, 103:600-5, 1971.

Loffeld, R. J. L. F.; Overtoom, H. A. J. M. & Rauwerda, J. A. The celiac axis compression syndrome. *Digestion*, 56:534-7, 1995.

Lord, R. S. A.; Stoney, R. J. & Wylie, E. J. Coeliac-axis compression. *Lancer*, 2:795-8, 1968.

Lord, R. S. A. & Tracy, G. D. - Coeliac artery compression. *Br. J. Surg.*, 67:590-3, 1980.

Marable, S. A.; Kaplan, M. F.; Beman, F. M. & Molnar, W. Celiac compression syndrome. *Am. J. Surg.*, 115:97-102, 1968.

Marable, S. A.; Molnar, W. & Beman, F. M. Abdominal pain secondary to celiac axis compression. *Am. J. Surg.*, 111:493-5, 1966.
Meaney, T. & Kistner, R. L. Evaluation of intra-abdominal disease of obscure cause. *Arch. Surg.*, 94: 811-20, 1967.

Mensink, P. B. F.; Petersen, A. S.; Kolkman, J.; Otte, J. A.; Huisman, Ad. B. & Geelkerken, R. H. Gastric exercise tonometry: The key investigation in patients with suspected celiac artery compression syndrome. *J. Vasc. Surg.*, 44: 277-81, 2006.

Mikkelsen, W. P. & Zaro, J. A. Intestinal angina. *New Engl. J. Med.*, 260:912-4, 1959.

Morettin, L. B.; Baldwin-Price, H. K. & Schreiber, M. H. Congenital absence of the celiac axis trunk. *Am. J. Roentgenol.*, 95:727-30, 1965.

Mulder, D. S.; Rubush, J. & Lawrence, M. S. Celiac axis compression syndrome. *Can. J. Surg.*, 14:122-6, 1971.

Olivier, C.; Rettori, R. & Di Maria, G. Sténoses non athéromateuses et compressions du tronc coeliaque. *Chirurgie*, 96:471-82, 1970.

Patten, R. M.; Coldwell, D. M. & Bem-Menachem, Y. Ligamentous compression of the celiac axis: CT Findings in five patients. *Am. J. Roentgenol.*, 150:1101-3, 1991.

Plate, G.; Eklöf, B. & Vang, J. The celiac compression syndrome: myth or reality? *Acta Chir. Scand.*, 147: 201-3, 1981.

Reuter, S. R. & Olin, T. Stenosis of the celiac artery. *Radiology*, 85:617-27, 1965.

Ripley, R. & Levin, S. M. Abdominal angina associated with fibromuscular hyperplasia of the celiac and superior mesenteric arteries. *Angiology*, 297-310, 1966.

Rob, C. Disease of the celiac and mesenteric arteries. *Bibl. Gastroent.*, 8:149-67, 1965.

Rob, C. Surgical diseases of the celiac and mesenteric arteries. *Arch. Surg.*, 93:21-32, 1966.

Rubush, J. L. Celiac axis compression syndrome. *Rev. Surg. Dis.*, 27:215-6, 1970.

Sautot, J. Sténose du tronc celiacque. *Lyon Méd.*, 207:1481-6, 1962.

Snyder, M. A.; Mahoney, E. B. & Rob, C. G. Symptomatic celiac artery stenosis due to constriction by the neurofibrous tissue of the celiac ganglion. *Surgery*, 61:372-6, 1967.

Stanley, J. C. & Fry, W. J. Median arcuate ligament syndrome. *Arch. Surg.*, 103:252-8, 1971.

Stoney, R. J. & Wylie, E. J. Recognition and surgical management of visceral ischemia syndrome. *Ann. Surg.*, 164:714-22, 1966.

Sutton, R. A. L. Coeliac axis stenosis. *Proc. R. Soc. Med.*, 60:139-41, 1967.

Szilagyi, D. E.; Rian, R. L.; Elliott, J. P. & Smith, R. F. The celiac artery compression syndrome. Does it exist? *Surgery*, 72:849-63, 1972.

Tahery, S. A. Abdominal pain due to isolated narrowing of the celiac artery. *Vasc. Dis.*, 5:90-5, 1968.

Terpstra, J. L. Intestinal angina secondary to compression of the coeliac axis. *Arch. Chir. Néerl.*, 18:245-53, 1966.

Thevenet, A.; Domergue, J. & Joyeux, A. Traitment chirurgical des sténoses du tronc coeliaque par ligament arqué du diaphragme. *Chirurgie*, 111: 851-6, 1985.

Tison, E.; Brullard, B.; Goullard, L.; Degroote, P.; Millaire, A.; Prat, A. & Ducloux, G. Compression coeliomésenterique double par le ligament arqué. Une cause rare d’angor abdominal du sujet jeune. *J. Mal. Vasc. (Paris)*, 14:26-31, 1989.

Tongio, J.; Beeckman, P.; Kieny, R. & Warter, P. Aspects angiographiques des stenoses des arteres digestives. *J. Belg. Radiol.*, 54:639-49, 1971.

Tridico, F.; Zan, S.; Bruno, F.; Suffat, P. P.; Morino, M.; Contessa, L.; Iozzia, C. & Sorisio, V. La sindrome da compressione del tronco celiaco. Considerazioni su di un caso clinico. *Min. Cardioangiol.*, 36:385-90, 1988.

Trinidad-Hernandez, M.; Keith, P.; Habib, I. & White, J. V. Reversible gastroparesis: functional documentation of celiac axis compression syndrome and postoperative improvement. *Am. Surg.*, 72:339-44, 2006.

Tseng, Y. C.; Tseng, C. K.; Chou, J. W.; Lai, H. C.; Hsu, C. H.; Cheng, K. S.; Peng, C. Y. & Chen, Y. F. A rare cause of mesenteric ischemia: celiac axis compression syndrome. *Intern. Med.*, 46:1187-99, 2007.

Van De Berg, L.; Lombard, R.; Drèze, Ch.; Guffens, J. M.;
Delvigne, J. & Van De Berg, A. Traitement chirurgical des sténoses du tronc coeliaque. Acta Chir. Belg., 5:334-51, 1972.

Warter, J.; Storck, D.; Kieny, R. & Tongio, J. Sténoses congénitales du tronc coeliaque. Arch. Fr. Mal. Appar. Dig., 59: 765-80, 1970a.

Warter, J.; Storck, D.; Kieny, R.; Tongio, J. & Warter, P. Aspects radiologiques des sténoses du tronc coeliaque. J. Radiol. Electrol., 51:721-30, 1970b.

Warter, J.; Storck, D.; Gillet, B. & Tongio, J. Nature congénitale des sténoses par compression diaphragmatique du tronc ciliaque. Nouvel argument en faveur de cette interprétation: les cas de deux soeurs. J. Med. (Strasbourg), 5:369-75, 1974.

Warter, J.; Storck, D.; Kieny, R. & Tongio, J. La maladie phrénico-coeliaque. Ann. Radiol., 19:361-70, 1976.

Watson, W. C. & Sadikali, F. Celiac axis compression. Experience with 20 patient and a critical appraisal of the syndrome. Ann. Intern. Med., 86:278-84, 1977.

Williams, S.; Gillespie, P. & Little, J. M. Celiac axis compression syndrome: factors predicting a favorable outcome. Surgery, 98:879-87, 1985.