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Articoli/*Articles*

HISTORICAL EVOLUTION OF THE SURGICAL ANATOMY OF THE LIVER

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SUMMARY

The Authors report the history of the anatomy and surgical anatomy of the liver from the paleolithic age up to now. Particular emphasis has been reserved to the changing anatomical knowlegment in these last decades which represents the basis of the modern surgery of the liver.

The liver "The Myth"

Although the study of anatomy of the liver was well founded through the centuries, dating back as far as the primitive man, a detailed knowledge of the intrahepatic anatomy has only been surfaced over the past six decades.

Among all the abdominal organs the liver was the first one to attract the attention and curiosity of man. Since the paleolithic age (drawings on rocks of Roussignac) the liver was considered an essential organ. As far back as the Assyrian-Babylonian time the liver was considered the most important organ of the sacrificed victims it was used to make prophecies; the first documentation started with Agadés dinasty (Sargon I

Parole chiave/*key words*: History - Liver - Surgical anatomy - Hepatic Segments

and Noram-Sin, XXVII-XXVIII centuries B.C.). Believes and superstitions regarding the liver were subsequently diffused to other group of peoples (Ittiti, Egyptians, Greeks, Lydians, Etruscans, Romans)[1, 2].

Common superstitious customs to appropriate enemies virtues[1, 2] by eating the livers of enemies killed in a battle has been conserved through the centuries and spread among far distant populations such as Mic Mac Indians of North-America, Bakongo Bantù of Africa, tribes of Indo-China, Ceylon, Borneo and Australia[2].

Because Prometheus, according to the Greek myth, taught the human race the use of fire, he was condemned by Jove to be tied on to a mountain where every day, for eternity, a bird of prey would eat part of his liver which would continue to regenerate during the night, demonstrating how old is the knowledge of liver regeneration.

The Etruscans were the first people to instituzionalize the study of the liver for divinatory purposes. They codified the liver inspéction (hepatoscopy) of the sacrified animals calling it *aruspicina*[3].

According to their code, the liver was the center of two essential principles of the universe, order and disorder: order was localized on the major lobe (imagined to be set up like a chessboard corresponding to productivity, work, light and the sun) and disorder was localized on the minor lobe (imagined to be set up like a circle corresponding to uncontrolled proliferation, the night and the moon). Such an example is the Etruscan liver of the civic museum of Piacenza (Fig. 1)[4].

Plato believed that the image of the soul and ideas were reflected on to the liver. The liver was considered the center of the vegetative soul where passions, rage and love were located; Oratius, a latin poet, said *Si tonere jecur quaeris idoneum* (by eating the liver one becomes strong). Aristotele, which considered the heart as the centre of circulation, believed that the liver was the centre of blood formation; a concept which was further searched by Pergameno, a pupil of Galenus,

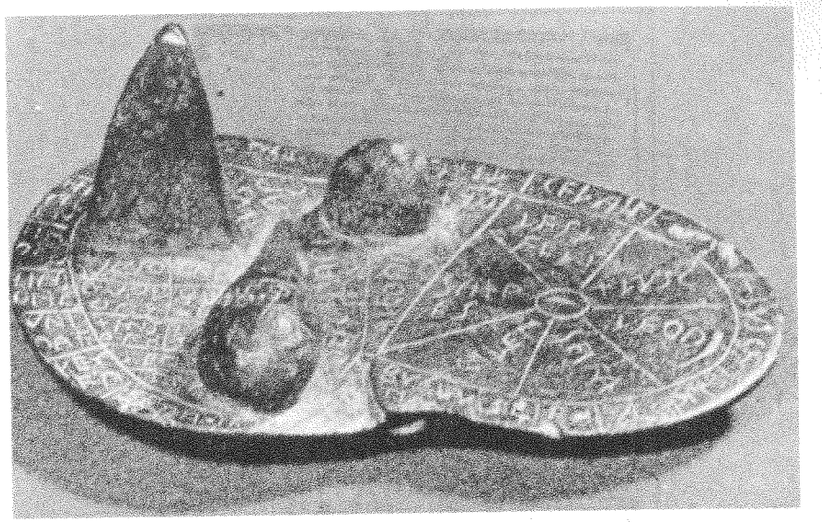

Fig. 1: Etruscan liver in the civic museum Or Piacenza.

who defined the liver *Instrumentum haematoseos* (haemopoetic organ). During that period (about 200 B.C.) the liver was considered to be plurisegmented (Fig. 2) and this belief persisted up to the time of Vesalius (1543)[5].

In the medioeval age the liver was considered to be the center of the natural spirit for which Dante Alighieri said *Quale dimora in quella parte ove si ministra lo nutrimento nostro* (the house from which the nutrition comes from). While in Europe the catholic culture prevented scholars of anatomy from dissecting cadavers up to XV and XVI centuries the Arabs knew the human liver and Nafis (an arabic scholar) approximately described it.

Human Hepatic Anatomical Studies

With the establishment of the Renaissance culture, multiple anatomical contributions were founded on cadaveric dissec-

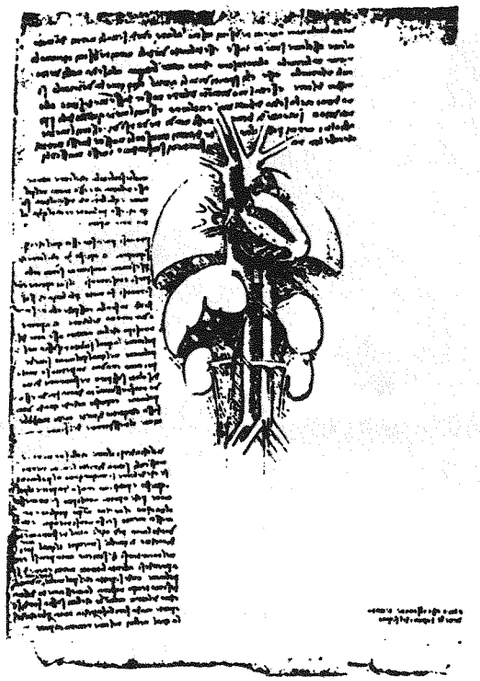

Fig. 2: The plurisegmented liver as described by Galeno (200 B.C.).

tions. Leonardo da Vinci and others (Fig. 3) placed under question the traditional anatomical concepts of Galenus which was believed to be the dogmatic truth up to that period.

Bartolomeus Eustachio (1578-1625) described the suspensory and round ligaments and divided the liver in right, left, quadrate and Spigelian lobes.

Before that period Paracelsus founded the basis of liver biochemestry by describing some vital function of the liver, while Malpighi proposed the histological fondaments of hepatic structures[1-2]. In 1654, Glisson had given an accurate description of the hepatic capsule which invested the portal vein and its blood supply. He also described the common trunk of the

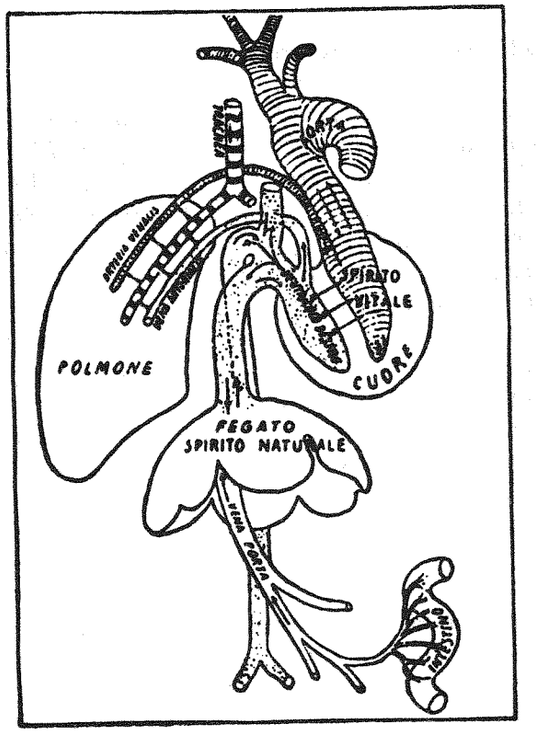

Fig. 3: The liver in an anatomical drawing Or Leonardo da Vinci (XV Century A.C.).

middle and left hepatic veins before joining the inferior vena cava[6].

In 1732, Winslow, demonstrated by injection of air that the hepatic veins followed the portal capillaries and were not contained in the intraparenchymal digitation of Glissonls capsule[7].

During the 18th century, dissections had the following result: the liver was divided into right and left lobes by the falciform and round ligaments and into minor lobes (the caudate lobe of Spieghel and the quadrate lobe of Haller).

Anatomical Basis for Liver Surgery

In 1870, Von Bruns carried out a partial hepatectomy for a gunshot wound of the liver. Hangenbeck, in 1872, resected the left lobe of the liver for tumor. In 1880, Tait of Edinburgh introduced the operation of hepatotomy. In 1888, Rex started to lay down the fundamentals of modern liver anatomy. He established a regional nomenclature of the major branches of the portal vein, the hepatic duct, the artery and veins. He described the recess which carries his name by the left branch of the portal vein; Rex's terminology was adopted in part by Mall (1906), Evans (1912) and Melnikoff (1924)[8-10]. In 1906 Mall calculated that there were over a million small terminal arteries in the liver, one for every portal unit. He also demonstrated that the portal vein never comes to the surface of the liver and never anastomoses as the hepatic arteries and hepatic veins do[10].

Modern Anatomical Concept applied to Surgery

Ten years later, Cantlie[11] of Ireland demonstrated that the liver can be divided in two separate anatomical functional parts, divided, not by the falciform or round ligaments, but by a fissure which corresponds to the middle hepatic vein that goes from the left margin of the inferior vena cava to the gallbladder bed.

The major technical problem for early liver resection was hemostasis . In 1896, blunt needles were introduced by Kousnetcoff and Pensky[12]. The use of magnesium plates in 1903 and cartilage plates in 1905 were recommended to prevent the hemostatic sutures from cutting through the liver capsule by Pay, Martina and Stam respectively[13]. Garré (1907) advocated identification and ligation of intrahepatic vessels when performing liver resection[13]. Pringle (1908) pointed out that hemorrhage from the liver could be controlled by achieving compression of the portal triad between the index and thumb[14].

Clamps have been applied successfully across the portal triad for 23, 12 and 9 minutes by Raffucci and Wangenstein (1950), Burch (1954), Alves (1957), Tung and Lin (1961)[15-20] Bernhard and his associates demonstrated that the liver can tolerate vascular inflow occlusion for 60 minutes under hypothermia of 30°C[21-22]. Delva and Associates (1984) reported hepatic vascular exclusion in humans (clamping of portal triad, occlusion of inferior vena cava below and above the liver at times associated with supraceliac aorta clamping) without the use of venous shunts, refrigeration or administration of heparin for a minimum of 24 minutes and a maximum of 65 minutes with success[23]. Wendel performed successfully right hepatic lobectomy in 1910[24]. The advances of liver surgery started with a better understanding of the intrahepatic anatomy. Mortens of Germany (1920) and Wendel concluded that despite the small amount of anastomosis at the capsule of the liver, the right and left hepatic arteries are essentially end arteries[24].

In 1927, McIndoe and Counsellor introduced the modern concept for controlled anatomic resection and reconfirmed the functional division of the liver between the imaginary line from the gallbladder bed to the vena cava. They demonstrated the independence of the left and right portal and biliary systems and the existence of arteriolar anastomoses between the right and left liver at the level of the caudate lobe. They also demonstrated that the intralobal vascular anastomosis was insufficient to guarantee enough blood supply to the hemilivers in case the main trunk to one of the hemilivers was occluded[25]. These observations were confirmed in 1935 by Carvalha and Rodrigues and in 1937 by Adrias, Huard and Thon Than Tung[7, 26].

In this period Tung, a Vietnamese from the French School and an Assistant in Anatomy in Huard laboratory studied liver dissections on formalized livers. With this system, Tung studied and classified 300 livers and came to the conclusion that the organ is segmented like the lung and has a repetitive biliovascular and hepatic veins distribution, as Melnikoff (1924) had pointed out previously[17, 26, 27].

In 1939, Tung published for the first time, the surgical technique of left lobectomy with intraparenchimal ligature of the pedicles[26].

In the 1950 Hjortsjo of Sweden was the first to clearly describe the segmental division of the liver by fissures. The liver was separated in right and left, by a main lobar fissure (Hauptgrenzsplt). The right side was further divided by the right lateral and intermediary fissures in dorsocaudal, intermediate and ventrocranial segment. The left half was divided by the umbilical fissure (Nebengrenzsoulsc) and left fissure in a medial, dorsolateral and ventral lateral segments[28, 29] (Fig. 4 a).

In 1950, Healey and Schroy showed that each true hepatic lobe (right and left) is divided in two segments: right posterior, right anterior and left medial and left lateral. Respectively segments (posterior, anterior, medial and lateral) were further divided in superior and inferior subsegments[30-31] (Fig. 4 b). Goldsmith and Woodburne (1957) described very accurately the blood supply of the medial segment of the liver, and proposed a surgical anatomical division of the liver by three paralobar planes[32]. These segments were delineated by a lateral right fissure, a median fissure and an umbilical fissure which divide the liver in a posterior, anterior, median and lateral segment and a caudate lobe. The lateral segment is further divided by a left fissure which corresponds to the left hepatic vein. The right lobe is further divided in the middle giving origin to four subsegments (Fig. 5).

Subsequently, Couinaud 1957, synthesized the anatomical surgical division in sectors and then in segments[33-34] (Fig. 4 c, Tab. I).

The division included eight segments: segment I is the caudate lobe, segment II is the left lateral, segments III and IV are part of the left paramedian sector, segments V and VIII are part of the right paramedian sector and 1962 Ton That Tung of Vietnam[17] divided the liver in segments and subsegments. In Tung's division was included a dorsal segment (caudate lobe) which corresponds to segment I of Couinaud; a lateral segment

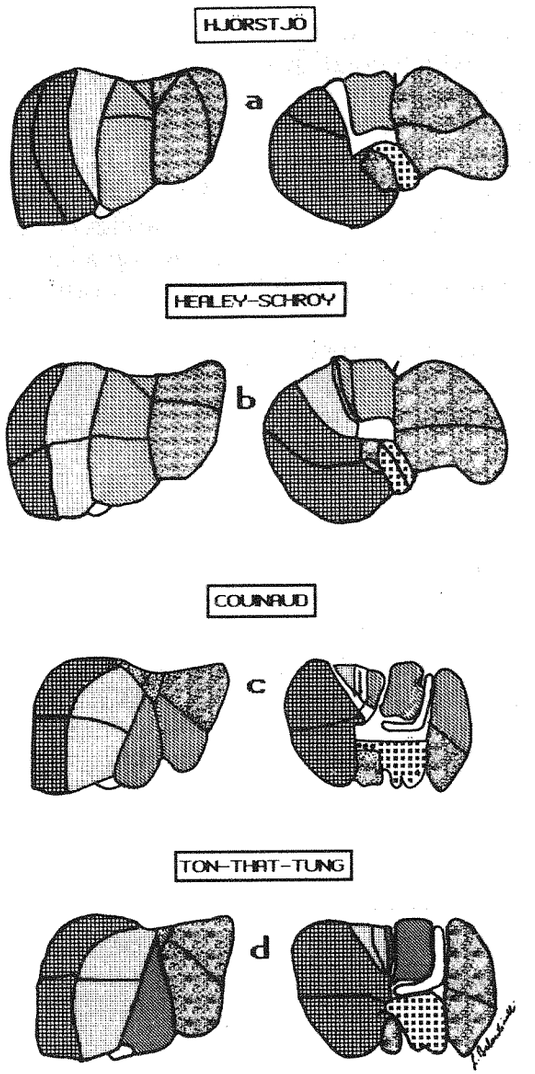

Fig. 4: Division Or the liver according to: Hjorstjo (a), Healey-Schroy (b), Couinaud (c) and Ton That Tung (d).

which corresponds to segments II and III of Couinaud; a median segment which corresponds to segment IV of Couinaud; an anterior segment which corresponds to segment V and VIII of Couinaud and a posterior segment which corresponds to VI and VII segments of Couinaud (Fig. 4 d, Tab. I).

In 1951, Lortat-Jacob, Robert and Pettinari, started to perform the *regulated resection* of the liver by ligating the hepatic vessels at the hilum and the hepatic vein at the vena cava, the hepatic dissection continued with blunt dissection through the liver substance[35-37].

In 1951, Wangenstein reported total liver resection to the right of the falciform ligament[38].

In 1958, Lin utilized the fingers to fracture the liver, hence arose the expression of *finger fracture*[19-20].

In 1959, Quattlebaum proposed a liver dissection to reach the intraparenchymal vessels with the handle of a knife or with the closed scissors[39].

In 1961, Tung performed under hypothemia at 30°C the first right hepatic lobectomy where the blood vessels were ligated intraparenchymally by using the finger-fracture technique and utilizing a preliminary Pringle maneuver. By 1962, Tung and Quang had performed 82 resections of various hepatic segments.

Tab. I
Comparative segmentation of the liver according to Couinaud and Ton-That-Tung:

COUINAUD		TON-THAT-TUNG	
SECTORS	SEGMENTS	SEGMENTS	SUBSEGMENTS
DORSAL	I	DORSAL	
LEFT LATERAL	II	LATERAL	II-III
LEFT PARAMEDIAN	III-IV	MEDIAN	IV
RIGHT PARAMEDIAN	V-VIII	ANTERIOR	V-VIII
RIGHT LATERAL	VI-VII	POSTERIOR	VI-VII

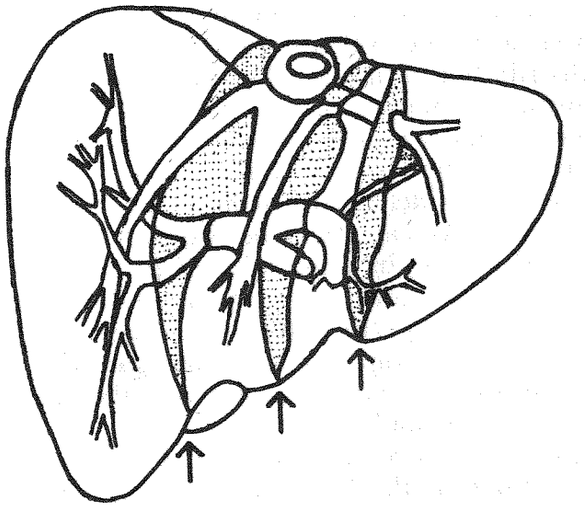

Fig. 5: Goldsmith-Woodburne liver division by paralobar planes.

Contrary to other surgeons, Tung and Quang believed that clamping the porta hepatis by the Pringle maneuver ensured less intraoperative bleeding, probably due to a sphincter-like action of the junction of the hepatic vein and Inferior vena cava[18-27]. Bauer et Al. in 1932, Walker and Attwood, in 1960, showed that reflux along the hepatic branches of the inferior vena cava (IVC) is negligible[40-41]. Bismuth (1964) proposed a method that combines the technique of Lortat-Jacob and Tung. He first clamp the blood and biliary vessels destinated to the part of the liver that have to be resected, than observe the change of color on the surface of the liver and finally by following such a plane he ligates the hepatic veins and the glissonian elements through the parenchyma[42].

In 1964, Dermileau was the first European to use the Hanoi technique; also the first to attach the term *digitoclasia* to the finger fracture technique[43]. This term further developped the

misunderstanding already started by Lin and Quattelbaum of allegedly violating the liver without respecting the intraparenchymal distribution of the vascular and biliary pedicles. Based on this misunderstanding, polemics have evolved defining the vietnamese technique as *atypical* as compared to that of Lortat-Jacob which is definited *typical* or *regular.*

The resection is definited typical when the pedicles are recognized and atypical when the pedicles are not formally recognized. However, the Tung technique is based on a detailed knowledge of the intraparenchymal bile-vascular distribution; in this latter method the pedicles are progressively isolated, ligated and excised, from which a well organized preplanned exeresis of the liver can be carried out. How then can one speak of an atypical resection?

Except for the contribution of Couinaud, little was said about minor resections of the liver, such as segmentectomy and subsegmentectomy until Tung (1962).

These resections have been shown to be difficult to execute by the regular method which may take a longer time to perform, may require multiple transfusions, and may not permit the recognition of the intraparenchyimal abnormality of the pedicles.

Champeau, in 1964, stated that *by passing in the heart of the hepatic parenchyma, one can remove many parts of the liver and by respecting its anatomy, one can save time and blood*[44-45]. Certainly, the transparenchimal method is the method of choice for the emergency surgery of the liver, a technique used frequently by the Americans during the Vietnamese war.

In 1975, Starzl introduced the term *trisegmentectomy* to replace the old term of extended right or left lobectomy used by other authors[46]. Right trisegmentectomy includes posterior, anterior and medial segments of Tung or right paramedian and lateral sector and IV segment of Couinaud. Left trisegmentectomy includes lateral, medial and anterior segments of Tung or, left and right paramedian and left lateral sectors of Couinaud.

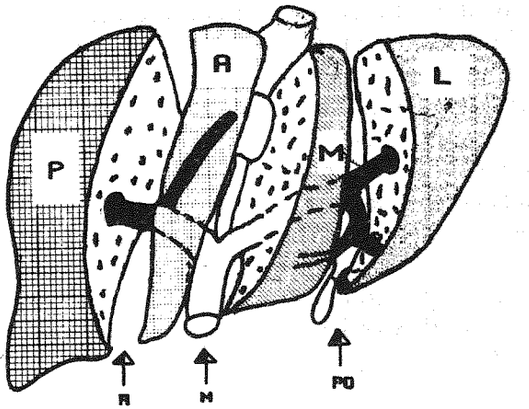

Fig. 6: Hepatic segments: P = posterior, A = anterior, M = medial, L = lateral, R = right rissure, M = median rissure, P0 = porto umbilical rissure.
Division based on ramirications Or secondary branches Or the glissonian pedicles (-) described by Giordani et al.

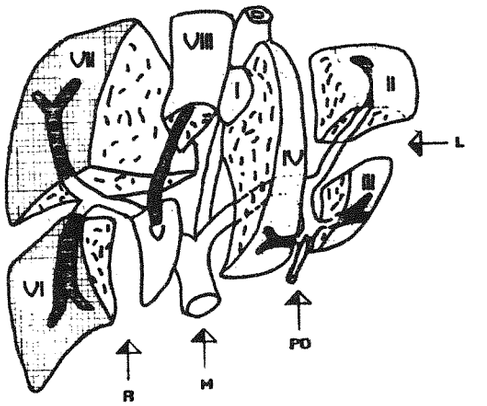

Fig. 7: Subsegments Or the liver: I=caudate, II=lateral dorsal, III = lateral ventral, IV = medial, V = ventral anterior, VI = ventral posterior, VII = dorsal posterior, VIII = dorsal anterior, R = right fissure, M = median fissure, P0 = porto umbilical fissure, L = leit fissure. Division based on ramirication of the tertiary glissonian pedicle (-) described by Giordani et al.

Recently some Authors[47] have proposed an hepatic anatomic division based on the glissonian pedicle ramification. Primary right and left glissonian pedicle, divides the liver in right and left sectors; secondary glissonian branches give rise to segments and tertiary glissonian branches supply the subsegments equivalent to 2-8 segments of Couinaud (Fig. 6, 7). We feel that a world-wide agreement on the surgical anatomical therminology and exeresis of the liver should be reached, to better comunicate among ourselves. Afterall over the years the better understanding of intrahepatic anatomy and physiology has greatly improved the pre and post-operative care decreasing the morbidity and mortality of liver resections even down to 0% in some series[46, 48,49].

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Articoli/*Articles*

INFLUENZE BIZANTINE NELLE STRUTTURE SANITARIE DEI SECOLI V-IX IN ROMA

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SUMMARY

Medical and welfare centers (xenodochia, diaconiae), were built in Rome in the early Middle Age under the byzantine influence. The byzantine influence played a very important rôle in organizing these welfare institutions as well as in promoting cultural, ethical and religious patterns in order to provide treatments and aids for the poor and sick people.

Il problema dell'influsso esercitato dal mondo bizantino in Italia è molto vasto e coinvolge l'evoluzione e la crescita della cultura e della civiltà nella penisola[1]. La questione appare, quindi, di grande importanza.

La città di Roma - nel periodo che in questa sede verrà analizzato, e che va dal V al IX secolo, dalla cosiddetta *caduta dell'impero romano d'Occidente*, quindi, alla piena epoca carolingia - vive il suo rapporto con l'impero bizantino attraverso vicissitudini e intermittenze, ma sempre in maniera intensa[2]. In un secolo e mezzo, i rapporti fra Roma e Bisanzio furono caratterizzati da tensioni di carattere dottrinale, politico e amministrativo.

Tuttavia *il legame con l'impero, modellò il pensiero politico e la cultura della città*[3]. Questo era un legame forte, che lasciò

Parole chiave/*key words*: Rome - Byzantine influence - philanthropìa - xenodochia - - diaconiae