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Short Articles

AN EARLY ACCOUNT OF BLOOD PRESSURE MEASUREMENT BY JOSEPH STRUTHIUS (1510-1568)

by

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DURING THE eighteenth century in the cathedral of the Polish city of Poznań a memorial stone could be seen with the inscription:

> Josephus Struthius Posnaniensis
> Philosophiae et medicinae doctor.
> Librorum graecorum latinus in-
> terpres publicus olim stipen
> dio senatus veneti artis medicae
> Patavii professor. Artis sphyg-
> micae per tot saecula abolitae
> novus restorator, postea sere-
> nissimi principis Sigismondi Augusti re-
> gis Poloniae medicus obiit a.D. 1568,
> aetatis suae 58.

By the time Bugiel wrote his thesis on Joseph Struthius (1510–1568) in 1901, from which the quotation is taken,[1] there was no longer any trace of the stone.

Struthius came from a well-to-do family called Strus, his father being a comb manufacturer.[2] Joseph, born in Poznań (at one time Posen), was the second of three sons. According to Eloy,[3] he latinized his name to Struthius which, taken from the Greek, means sparrow. He was twice married and, as far as is known, left no heirs.[4]

In 1527 Struthius went to the University of Cracow where he obtained the two parts of a degree in liberal arts in 1529 and 1531 respectively.[5] The university, founded in 1364 by Casimir the Great, had four faculties;[6] while those of theology, philosophy and jurisprudence were well established, that of medicine had only been fully developed by Struthius's time. Like so many Poles, including Copernicus, who went to Italy to continue their studies, Struthius went to Padua in 1532, where he was promoted to Doctor of Medicine and Philosophy on 26 October 1535.[7] Among his

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[1] V. Bugiel, *Un célèbre médecin polonais au XVI^e siècle, Joseph Struthius (1510-1568). Contribution à l'histoire de la médecine à l'époque de la Renaissance*, Paris, G. Steinheil, 1901, p. 7.

[2] Ibid., p. 10.

[3] N. F. J. Eloy, *Dictionnaire historique de la médecine ancienne et moderne etc.*, Mons, Hoyois, 1778, vol. 4, p. 331.

[4] Bugiel, op. cit., note 1 above, pp. 34, 36.

[5] Ibid., p. 15

[6] Ibid., p. 11.

[7] Ibid., p. 27

sponsors was Francesco Frigimelica (1491–1558), professor of the theory and practice of medicine, who, on 5 December 1537, granted Vesalius the insignia of the Faculty.[8] Just as Vesalius took over the chair of surgery and anatomy the day following his promotion, so Struthius was appointed "explicator extraordinarius medicinae theoreticae" immediately after obtaining his doctorate, thus becoming professor at the University of Padua at the age of twenty-five. It is noteworthy that Struthius and Vesalius were both at Padua from 1537 to 1542, when Vesalius left the city (except for a brief return in 1543).[9] During that time Struthius translated six of Galen's works into Latin; these were published in Venice between 1535 and 1540.[10]

Struthius returned to his native Poznań in 1545,[11] but soon afterwards was summoned to Cracow to attend Isabella, daughter of King Sigismund I and wife of John Zapolya, King of Hungary.[12] Struthius was then called to the gravely ill Sultan Sulaiman II at Constantinople. Declining an invitation to go to Madrid to King Philip II of Spain, Struthius preferred to settle in Poland, where he became physician to King Sigismund II (1548–1572). In 1557 Struthius was elected Burgomaster of Poznań. He died of the plague in 1568.[13]

Struthius's fame rests on his studies of the pulse. A passage in his *Sphygmicae artis iam mille ducentos annos perditae & desideratae Libri V*[14] of 1555 appears to report the first attempt at a quantitative estimation of what is now called blood pressure. Writing about pulses of different strengths he stated:[15]

> But in [the case of] a weak pulse not even the skin of the patient's hand can be raised, let alone the pulp of the physician's fingers. For the artery supports and lifts heavier or lighter loads in proportion to the strength of its forces: which is clearly observed if you place adjacent to the arteries upon the outside of the skin some leaf, or membrane, or linen, or small scrap of cloth, or some other similar thing. For you will see whatever you have placed on top move and be raised together with the artery below it. But if again you should place [another load] upon it as big as the previous one, the movement of both will now be much more indistinct: if, however, you should add a third it will be much more indistinct still: likewise, if you should add a fourth and a fifth, in the end you will eventually see the movements of the objects, which you have placed [upon the artery], arrested. But if the pulse should be stronger it will support the weight of more objects, if less strong, of fewer: if it should actually not be strong at all, it will not support the weight of any object. But if it is weak, it is so far from being able to raise a weight placed upon the outside of the skin that it can not even move the skin itself from its position.

Struthius seems to have conceived this idea as a result of his observations of the effects of compressing the artery, described in the passage immediately preceding that quoted above. It reads:

> A compressing application [of the fingers] checks and restrains the movement of the artery from completing the performance and sometimes arrests it altogether. When the artery does not

[8] C. D. O'Malley, *Andreas Vesalius of Brussels 1514–1564*, Berkeley and Los Angeles, University of California Press, 1964, p. 77 and p. 430, ref. 14.
[9] Ibid., pp. 110, 197.
[10] Bugiel, op. cit., note 1 above, pp. 39–41.
[11] Ibid., p. 27.
[12] Ibid., p. 32.
[13] Ibid., p. 36.
[14] Josephus Struthius, *Sphygmicae artis iam mille ducentos annos perditae & desideratae Libri V*, Basle, Oporinus, 1555.
[15] Ibid., p. 103.

> bear the weight of the fingers, the movement is suppressed and a deceptive quiet necessarily appears to you as a result of the arresting of the movement; evidently the artery is believed to be at rest as long as it remains in [the same] position. But it remains quiet for a longer time since it is forcibly prevented from rising up (during compression by the application [of the fingers]). But perhaps you will say that by its own movement the artery thrusts back the skin and pulp of the physician's fingers and stretches or raises itself up to the point where it finishes its movement: and only is quiet at the position of the pulp of the fingers when it has finished its movement. We shall reply to this that it is not true except when the artery is endowed with a strong movement, with which we shall deal in the following chapter.

Haller was aware of Struthius's publication and also stated that this approach has not been taken up by more recent writers.[16] In a chapter entitled 'Other distinctions of pulses' he wrote:

> The remaining distinctions of pulses do not allow accurate measurement in the same way. Perhaps it was possible from Struthius' counsel to determine the strength of the pulse by a weight placed upon it, because it would certainly be more raised by a powerful impulse of the heart than by a smaller one: no recent writers, however, have made any experiment.

A further short reference to Struthius's idea is contained in Haller's *Bibliotheca medicinae practicae*,[17] viz. that Struthius defined a strong pulse by the weight which it supports.

Vierordt,[18] calling him Struth, quoted one of the passages mentioned above as the first intimation of an attempt to examine the human pulse by a method other than just palpation. However, he did not realize that it was also a forerunner of pressure measurement. According to Bugiel,[19] part of this passage contains the idea of the sphygmograph, at least in principle, though there was a long way yet to go to the construction of a recording instrument.

Struthius's description of the hard (*durus*) and strong (*vehemens*) pulse as well as the discussion of the causes predictably follow Galen. He wrote:

> The hard and strong pulses have really a great deal in common, since they each produce a violent beat, that is, disturb the touch, but they are distinguished from each other by the symptom, that is, the special state. For the symptom of the strong pulse is that it supports the compressing application [of the fingers] and in this disturbs the touch, which the Greeks call ἀντιβατικὸν πληγῆς, that is, resisting the beat. On the other hand, the symptom of the hard pulse is pressure or pressing against the touch, the Greeks call it θλιπτικὸν, that is, pressing. For all hard. things press: strong ones do not press unless they have at the same time an added hardness.[20]

Similarly Galen: "The hard [pulse] you will feel indeed strike just as stone or wood, which is overcome by pressure unless it is also strong: by contrast, you will perceive

[16] Albrecht von Haller, *Elementa physiologiae corporis humani*, Lausanne, Sigismund d'Arnay, 1760, vol. 2, p. 268.

[17] Albrecht von Haller, *Bibliotheca medicinae practicae*, Basle, Schweighauser, 1776, vol. 2, pp. 49, 50.

[18] Karl Vierordt, 'Die bildliche Darstellung des menschlichen Arterienpulses', *Arch. physiol. Heilk.*, 1854, 13: 284–287. *Die Lehre vom Arterienpuls in gesunden und kranken Zuständen gegründet auf eine neue Methode der bildlichen Darstellung des menschlichen Pulses*, Braunschweig, Vieweg, 1855, pp. 24, 163 ff.

[19] Bugiel, op. cit., note 1 above, p. 61.

[20] Struthius, op. cit., note 14 above, p. 110.

the strong pulse more endowed with strength when you press."[21] Another of Galen's descriptions is somewhat different: "The hard pulse is one in which the artery seems vigorous and rigid, as someone has said, and the underlying spirit is stretched, which results in the beat having a certain strength to rebound. The strong pulse is one which has a brisk movement as well as setting a violent beat in motion."[22]

Struthius attributed the hard pulse to the condition of the arteries, in turn due to certain defined external factors: "The hard pulse arises from the hardness of the artery. In fact, the hardness indicates either dryness, or congealing, or contraction through cold, or stretching."[23] As causes of the hard pulse he repeated those described by Galen, such as certain kinds of fever, marasmus, the effect of cold. The following passages may serve to illustrate how closely Struthius followed Galen:

> [Struthius:] Congealing or constriction through cold arises from improper and immoderate drinking of cold water, or cold washing, or from excessive use of cooling fruit, and other things which produce cold and thick phlegm which we usually call glassy.[24] [Galen:] Constriction through cold is brought about by untimely and immoderate drinking of cold water, or by similar baths, likewise by untimely or immoderate ingestion of cooling fruit; lastly from all those things which tend to produce much cold phlegm, which Praxagoras usually calls glassy juice.[25]

According to Galen, a hard pulse tends to be weak: "When it [the pulse] is associated with hardness, at the same time either a weak pulse is then present or one intermediate between weak and strong . . .".[26] This too is accepted by Struthius: "As we taught before, hard pulses are accompanied by smallness, also celerity and frequency."[27] Galen also wrote that abnormal fullness of blood vessels produced a hard pulse: "Therefore the swelling and the sensation of stretch will indicate just as much the fullness of the humours as of the spirits. . . . Therefore a swelling which arises with stretching will indicate greater fullness; but that without stretching, less [fullness]."[28] Apparently Struthius does not seem to have discussed fullness of blood vessels as a cause of a hard pulse. Distinguishing five primary varieties of the simple (i.e. regular and equal) pulse, he regarded the strong (*vehemens*) and weak (*debilis*) pulses to be due to the quality of strength (*qualitas virtutis*), whereas the soft (*mollis*) and hard (*durus*) pulses are the only varieties attributed to the condition of the artery (*qualitas arteriae*).

No further attempts appear to have been made at an indirect measurement of blood pressure in man until Hérisson described his "Sphygmomètre" in 1834.[29] It consisted of a graduated glass tube connected to a steel cup containing mercury and covered by a thin membrane. This was pressed on to the artery, and the strength

[21] *Galeni synopsis librorum suorum de pulsibus*, in Galen, *Opera omnia*, ed. by C. G. Kühn, Leipzig, Cnobloch, 1821–33, 20 vols. [in 22], vol. 9, p. 449.
[22] *Galeni definitiones medicae*, in ibid., vol. 19, pp. 405, 406.
[23] Struthius, op. cit., note 14 above, p. 298.
[24] Ibid.
[25] *Galeni de praesagitione ex pulsibus Liber I*, in op. cit., note 21 above, vol. 9, p. 248.
[26] Ibid., p. 247.
[27] Struthius, op. cit., note 14 above, p. 298.
[28] *Galeni de plenitudine liber*, in op. cit., note 21 above, vol. 7, pp. 568, 569.
[29] J. Hérisson, *Le Sphygmomètre instrument qui traduit à l'oeuil toute l'action des artères*, Paris, Chrochard, 1834.

of the pulse was determined by the amount of pressure required to produce the maximum rise of the mercury column in the glass tube during each pulse beat. An English translation with some suggested improvements was published in the following year.[30] A similar though modified instrument was described in 1850 by Chelius who also devised another method for the same purpose which was more akin to plethysmography.[31] All these attempts were rightly criticized by Vierordt (1854, 1855),[32] who was the first to publish a more truly quantitative method for investigating arterial pressure in man by determining the weight with which the artery had to be compressed in order to suppress pulsations. Struthius's work thus antedated these more elaborate techniques by some three centuries.

SUMMARY

In his book on the pulse published in 1555 Joseph Struthius (1510–1568) described a primitive method for measuring blood pressure by determining the number of objects which have to be placed on the skin over an artery in order to suppress its pulsations.

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[30] J. Hérisson, *The sphygmometer, an instrument which renders the action of the arteries apparent to the eye. . . . with an improvement of the instrument and prefatory remarks by the translator Dr. E. S. Blundell*, London, Longman, Rees, Orme, Brown, Green, & Longman, 1835.

[31] C Chelius, 'Beiträge zur Vervollständigung der physikalischen Diagnostik', *Prager Vjschr. prakt. Heilk.*, 1850, **26**: 92–111.

[32] Vierordt, op. cit., note 18 above.