Chapter 2
The Early History of Percutaneous Nephrolithotomy (PNL)

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Abstract The present chapter provides a detailed look into the early history of percutaneous nephrolithotomy (PNL), showing that many have contributed to the development of this procedure including the author, who has taken active part in it. PNL has become an integral part of urology since more than 30 years, quickly expanding during the 1980s, but was not widely accepted until the 1970s. Many other urologists have contributed to this technique, reinventing it many times, and of course, the beneficial effects of the introduction of new instruments, accessories, technologies, and devices are evident.

A look into the early history of percutaneous nephrolithotomy (PNL) shows that many have contributed to the development of this procedure, which has become an integral part of urology since more than 30 years.

2.1 The Beginning

2.1.1 Percutaneous Nephrostomy

Percutaneous nephrostomy was not widely accepted until the 1970s [1]. There are many hints on early percutaneous procedures in the old urological literature of different countries. Simple puncture of the kidney from the flank was performed, e.g., by Hillier in 1865 [2], and described as a frequently performed procedure for instance by Küster [3]. J. Israel and W. Israel mentioned percutaneous nephrostomy

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drainage in 1925 in their German textbook "Chirurgie der Niere und des Harnleiters." They used the technique of trocar puncture of hydronephrotic kidneys from the flank and introduction of a tube for drainage in the second half of the nineteenth century [4]. They quote Schede to have performed this procedure around 1880 [5].

The technique of percutaneous nephrostomy was described again 150 years later by the American urologist Goodwin in 1955 [6], although remaining relatively disregarded and in the hands of the radiologists. Percutaneous nephrostomy under ultrasound control was performed in 1974 by Pedersen [7]. In the author's experience, the introduction of ultrasound into clinical routine in the early 1980s had an important impact on percutaneous procedures in Europe. In many countries where urologists had direct access to ultrasound, they took the puncture away from the radiologists' hands, and the whole procedure was then performed by the urologist alone. Since 1980 the author established all his percutaneous accesses under combined ultrasound and fluoroscopic control himself and has taught his coworkers accordingly [8]. Especially in North America, urologists have only very limited experience in establishing an autonomous percutaneous access [9, 10] and sometimes invent complicated or not well-accepted endourological techniques to bypass the problem that radiologist governs this step of PNL [11–13].

2.1.2 Percutaneous Stone Removal

The credit for the first stone extraction through a previously established nephrostomy tract is given to Rupel and Brown in 1941 [14], but Chester Allen described this procedure already in 1935 [15], and the early literature in various countries will probably show further descriptions of this procedure.

An operatively established access was used to remove larger stones by disintegration with an electrohydraulic lithotrite in 1970 by Sachse [16], and the same results were achieved with an ultrasound lithotrite that was originally designed for the disintegration of bladder stones by Rathert in Aachen, Germany [17], and by Kurth in Mainz, Germany [18].

An essential publication by Fernström (radiologist) and Johansson (urologist) reported on three successful cases of primary percutaneous nephrostomy, subsequent tract dilatation for several days, and stone extraction under fluoroscopic control [19]. Their first case was done in 1974, and they concluded that the technique was suitable for stones up to 15 mm in diameter. But they did not realize the full potential of percutaneous stone removal: in a later publication in 1982 [20] with 33 patients treated in that manner they still stated: "… *the canal is ready for instrumentation after 8 days and the stone is removed after 10–12 days. The patient can be discharged 17 days after the performance of the percutaneous nephrostomy*." and "*Calculi greater than 20 mm are not suitable for percutaneous nephrolithotomy because of the excessive degree of dilatation which would be required*." At that time one session stone removal with ultrasound or electrohydraulic disintegration had already become routine for several urologists. Nowadays it is especially the stone above 20 mm in diameter which is regarded as the standard indication for percutaneous nephrolithotomy. This was only possible by putting all the pieces of the puzzle together in the right way (Fig. 2.1).

Fig. 2.1 The puzzle of PNL history [6, 14, 16, 17, 18, 19, 23, 42]

Between 1976 and 1979 the author, the radiologist Rolf Günther and the urologist Gerd Hutschenreiter contributed to the further development of the PNL technique. Initially the radiologist did the puncture, but when ultrasound became available, the whole procedure became urologic. Our first report of a case treated by percutaneous ultrasound lithotripsy [21] was followed by presentations with increasing patient numbers and refinement of the technique at the 1979 annual meeting of the European Intrarenal Surgery Society in Bern and the meeting of the German Urological Society in the same year [22]. Our 1980 presentation at the 75th American Urological Association (AUA) annual meeting in San Francisco was the basis for the manuscript on PNL that was submitted to the Journal of Urology at that AUA meeting. It was accepted with minor modifications. Dr. Scott, who was at that time the editor of the Journal, disliked some concluding remarks in the last three paragraphs of the discussion: "*With a set of instruments currently being developed, we expect to reduce the time for the whole procedure to two ambulant sessions for dilation and a one-week hospital stay for stone removal… Percutaneous stone manipulation as a deliberate alternative to open surgery has to compete with the techniques for operative stone removal established over the past 100 years. Its specific place among the various techniques of stone therapy will be defined on the basis of further experience.*" We respected his comment "*The Journal of Urology is not a*

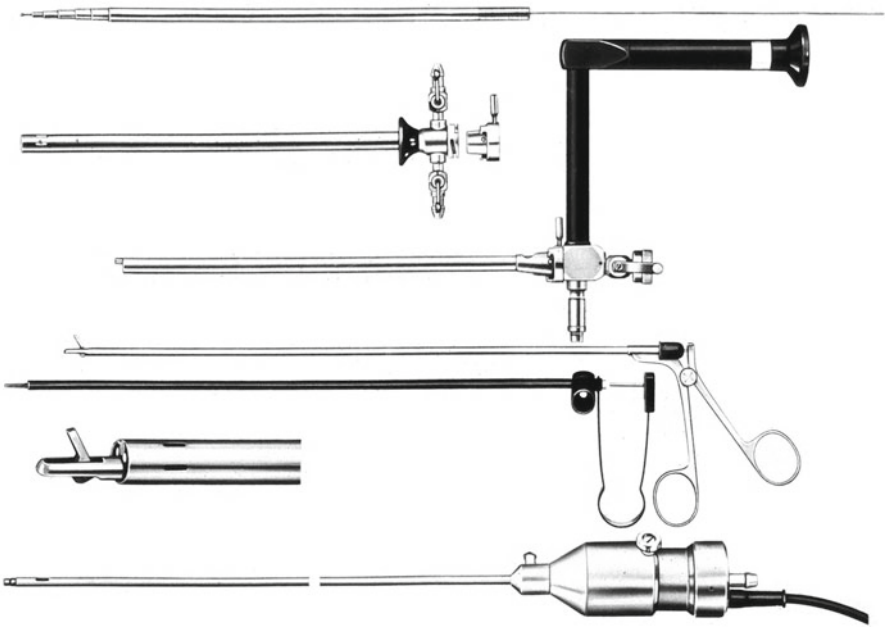

Fig. 2.2 The PNL instruments

medicine man's paper" by slightly changing these statements, but without changing our ideas [23].

At the time of the presentation at the AUA meeting in May 1980, the telescope dilators designed by the author and produced by Karl Storz were already in use [24]. These dilators were the first instruments purposely built for percutaneous stone removal. They were developed as a consequence of the problems met with serial plastic or metallic dilators initially used and developed as part of a set of instruments (Fig. 2.2) to establish a large, straight nephrostomy tract with minimal bleeding in one session and to allow a complete one session procedure. Percutaneous stone removal in one session is of course desirable for the patient, but it was not easy to achieve. Clayman et al. in their report on 100 cases in 1984 succeeded in only 31 % of their patients [25]. In the authors' initial series published in 1983, the one-session stone-free rate was also only 60 % [26].

Fragmentation of large stones was obtained with an electrohydraulic system [25] or preferably with an ultrasound lithotrite, as the latter caused no harm to tissue [27].

2.1.3 Prone or Supine?

The prone position was the classic position described for percutaneous nephrostomy. For many years the author did not use cystoscopy with retrograde ureteral

catheterization before the nephrostomy puncture [24]. Thus it was not necessary to turn the patient from the supine-cystoscopy-position to the prone-nephrostomy-position. Bolsters underneath the abdomen were not used because we felt that they pushed the kidney cephalad instead of exposing it. Thus breathing of the patient was unimpeded, and the anesthetists had no problems with control of the patient as they used epidural anesthesia and could communicate with the patient during the whole procedure.

Experience with a supine percutaneous access was gained with patients that required emergency drainage of a kidney that got obstructed after open surgery. It was easy to do but did not change our PNL procedure.

2.2 The Progress

Many others have contributed to the development of percutaneous nephrolithotomy: Clayman and coworkers were the first to describe the use of angioplasty balloon dilatation catheters for tract dilatation as another alternative to the sequential dilatation with plastic dilators in 1983 [28]. This group published an experience with 100 cases in 1984 [25].

The term endourology was coined by Smith et al. in 1979 [29] when they described the possible future application of percutaneous nephrostomy. Nowadays stone therapy is only a minor aspect of this continuously developing field.

The use of PNL quickly expanded. After personal experience with PNL since 1980, Marberger and collaborators designed a purposely built nephroscope and ultrasound lithotrite for percutaneous use together with the Richard Wolf GmbH, Knittlingen, Germany [30], and Korth with Olympus Winter und Ibe, Hamburg, Germany [31]. Clayman and Castaneda-Zuniga were the first to publish a book on almost every aspect of percutaneous renal surgery [32]. Wickham, who had learned about the technique of PNL during his visits to the Department of Urology at the University of Mainz and the author's presentation at the meeting of the European Intrarenal Surgery Society in Bern in 1979, was probably the first person to reintroduce a pelvic stone into the kidney to demonstrate the ease of the procedure to the patient and the first to try not to insert a nephrostomy after a percutaneous procedure, as no bleeding from the tract was observed (Wickham, personal communication). But he was also the one who realized the potential of PNL and organized the first world meeting on this topic [33]. One-session PNL was initiated by the design of telescopic dilators [24] which are still very popular after 30 years [34]. Also the Amplatz dilators and sheath became widespread access instruments [35]. Segura and coworkers were the first to publish a series of 1,000 procedures [36]. Many other urologists have contributed to this technique and they, like Clayman and collaborators in 1984 [25], reported in the early 1980s that PNL had replaced 90 % or more of their surgical procedures for renal stone removal. But at that time, minimally invasive PNL was being continuously replaced by a noninvasive technique, namely, extracorporeal shock wave lithotripsy (ESWL) [37, 38]. The worldwide

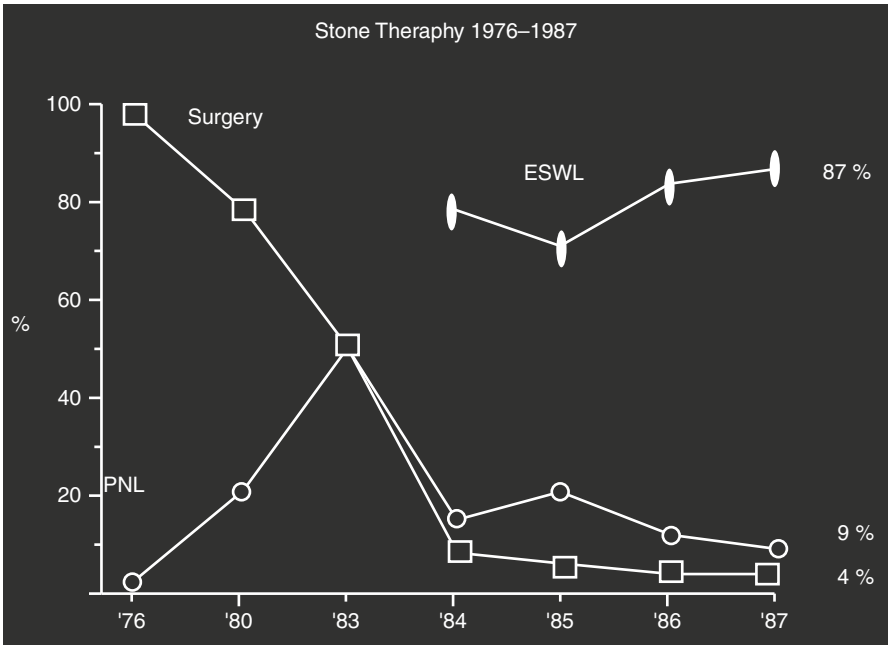

Fig. 2.3 Frequency of stone therapy from 1976 to 1987 in the Department of Urology, University Clinic, Mainz, Germany

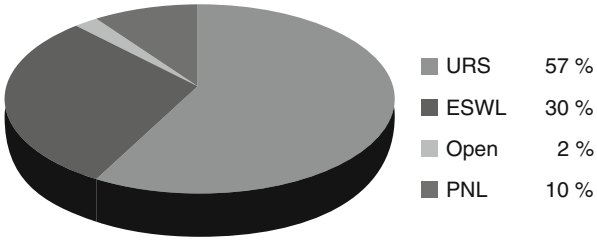

Fig. 2.4 Frequency of stone therapy from 2007 to 2008 in the Department of Urology, University Clinic, Mannheim, Germany

fourth extracorporeal lithotripter was installed in 1983 at the Department of Urology at Mainz University Clinic in Germany, where the author worked until 1987. ESWL immediately reduced the frequency of PNL to approximately 10 % (Fig. 2.3), because all the small stones that could have been removed by percutaneous extraction were now shocked. Today PNL ranges in this 10 % level in most of the affluent countries, as data from the authors department in Mannheim show (Fig. 2.4). The situation is different in countries where there are still a lot of big stones as in India, as shown by the statistics from Muljibhai Patel Urological Hospital, India (Fig. 2.5). With the enormously high PNL working load in his country and several thousands of cases having been treated in his department, Dr. Desai has somehow reinvented PNL [39, 40] and has of course already a positive experience with the supine position [41].

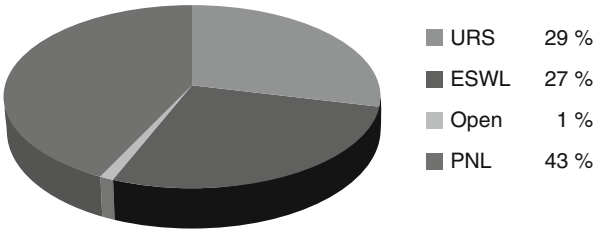

Fig. 2.5 Frequency of stone therapy from 2007 to 2008 in the Muljibhai Patel Urological Hospital, Nadiad Gujarat, India (courtesy of Dr. Mahesh Desai)

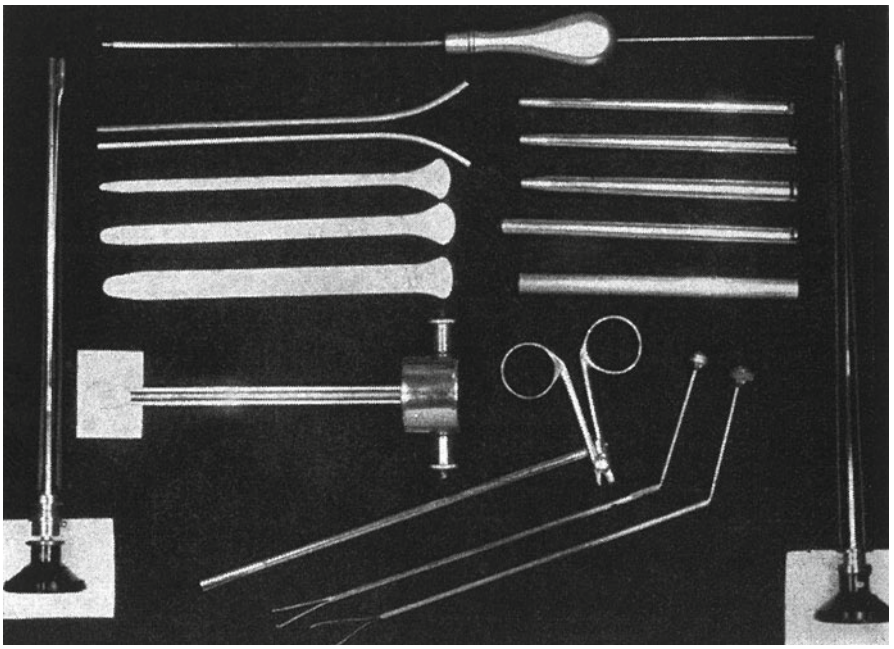

Fig. 2.6 Instruments designed for percutaneous pyeloscopy by H. von Rohr (Illustration 19. Preliminary pyeloscopic instruments. Above: Hemispherical polished puncture probe with a sort of withdrawn guiding stylet. Below on the left: Two half-sheathed guides. Below: Flat guides with increasing width to spread the half-sheathed guides. Below: Loop fixation to be inserted into the outer shaft with a tightening device, bearing the optic shaft or for the drilling shaft and space for a lamp-holder. On the right: Conical "third-pin" from I to III, below: cylindrical "third-pin" IV. Below: Outer tube with a lumen of 8 millimeters. Below: stone-crusher and grasping forceps. Left and right to the side: straight view telescope with a lamp holder and side view optics)

2.3 Conclusions

This brief look into the past of PNL might have missed some aspects, but like the future is difficult to predict, the past is difficult to "*re*-dict" In 1994 the author learned that the German urologist Heinrich von Rohr (1911–1978) had developed instruments (Fig. 2.6) for percutaneous endoscopic procedures and had designed an

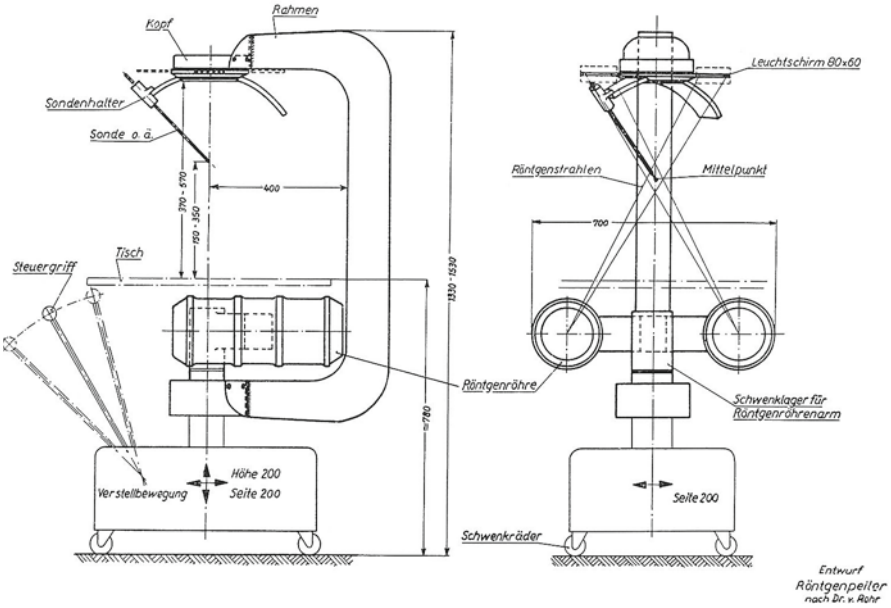

Fig. 2.7 X-ray localization and needle guide apparatus for percutaneous puncture of the renal collecting system designed by H. von Rohr (Illustration number 17, general construction drawing of the X-ray detector, Spring 1954, by Mr. Engineer Kretschmer of the German Federal Office for Material testing in Berlin-Dahlem)

X-ray apparatus (Fig. 2.7) to guide a puncture needle to the right place in the kidney. He had published studies on cadavers and animals in the East German Zeitschrift für Urologie und Nephrologie in 1958 [42]. At that time this periodical was probably only read in East Germany. We do not know why von Rohr never proceeded to clinical studies. But sometimes the right thoughts need the right time to become reality.

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