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ZONOGRAPHIC DIAGNOSIS OF DISEASES OF THE INTERVETEBRAL  
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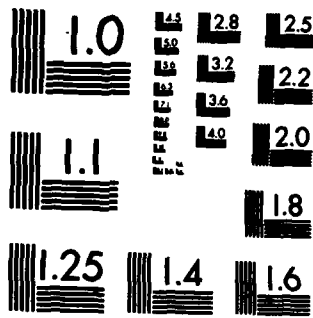
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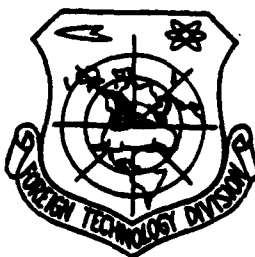
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ZONOGRAPHIC DIAGNOSIS OF DISEASES OF THE  
INTERVETEBRAL DISK IN THE LIGHT  
OF OUR OWN EXPERIMENTS

by

Stanislaw Bryc and Janusz Zlomaniec



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ZONOGRAPHIC DIAGNOSIS OF DISEASES OF THE INTERVERTEBRAL DISK  
IN THE LIGHT OF OUR OWN EXPERIMENTS

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From daily observations, it results that pathologic changes in the intervertebral cartilage and the syndromes of ischias (sciatica) are very frequent diseases and appear relatively in an early period of life. It is to be emphasized that the degenerative process, increasing with age, causes disk-root incompatibility at a typical level for cases of prolapse of the nucleus pulposus which is, as is well known, a more serious consequence of disk disease. This level (L4-L5 and L5-S1) is the place at which prolapse appears in a large percentage of cases. In the literature this percentage is estimated at 90-97% [6,9].

For many years the plain radiograph of the vertebral column in two standard projections has been used, making possible the detection and determination of the degree of pathologic changes of the intervertebral cartilage. The correctness of diagnosis and the accurate definition of the degree of pathologic changes established by planigraphic examinations including zonography are very important. It was introduced here a year ago and the purpose of the report is to give results obtained by us.

The examinations were carried out on 56 persons of different ages (31 women and 25 men) with various clinical indications. The segment of the vertebral column, suspected of pathological changes, was exposed in the course of a myelography to plain radiographic, planigraphic and comparative zonographic examination. The mentioned group of examinees was selected from a large group of patients in whom various diseases of the vertebral column or of the spinal cord were detected. The discussed group of persons had operative

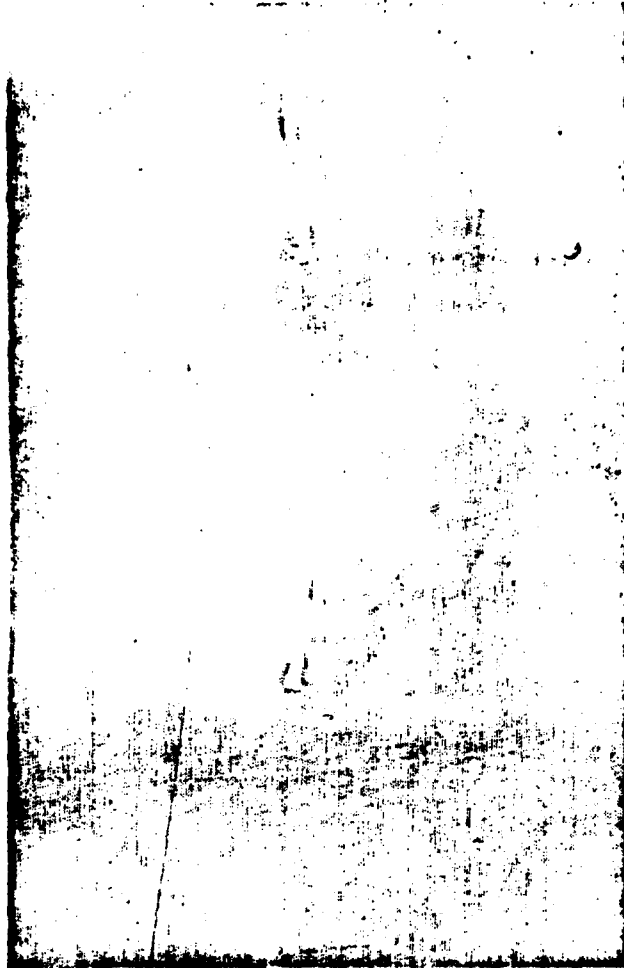


Figure 1. Lateral zonograph makes visible the calcifications in the area of three disks developed after a suffered injury. Plain radiograph revealed only calcification in the Th10-Th11 disk.

verification establishing the injury of intervertebral disk most frequently of the character of a hernia of the nucleus pulposus. The thickness of the layers of segments on the zonographs was 1.9 cm at an  $8^\circ$  angle inclination. Frontal, lateral, right and left oblique projections were used, depending upon the lateralization of the painful syndrome. In oblique projections, various inclinations of the lamp were used which fluctuated between  $15^\circ$  and  $45^\circ$ . In many persons, dynamic examinations were performed in lateral and oblique projections. The depth of the segment was determined as a function of the level of the examined segment of the vertebral column. The results

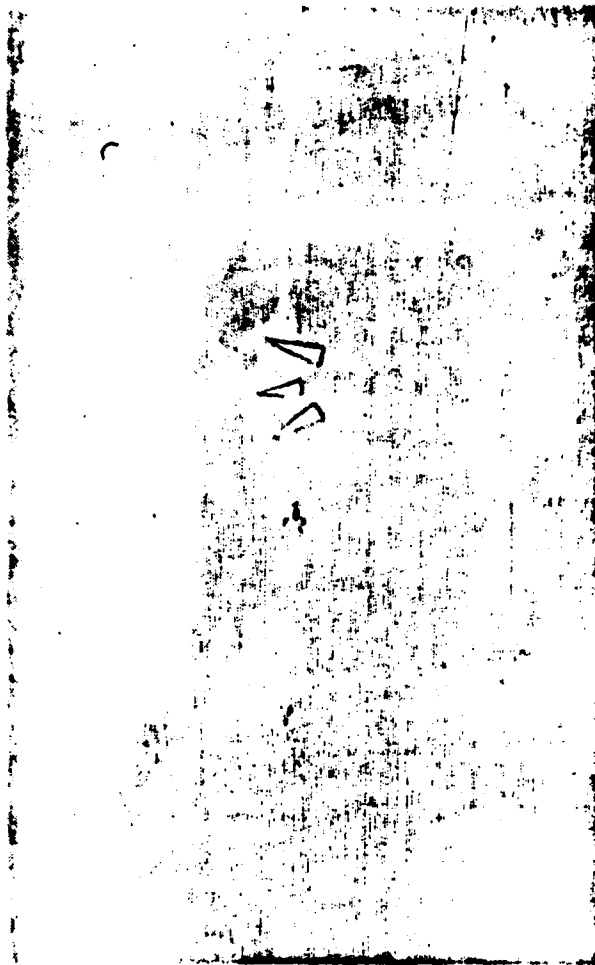


Figure 2. Structure of the intervertebral space L4-L5 with beaklike twin extensions of the posterior edges of the bodies and buckling of the anterior outline of the contrast band. Hernia of cartilage with secondary bony degenerative changes.

of the examinations were compared to data obtained during operations.

From the analysis of the material, it appears that the photographs of the deep layers play an essential role in the manifestation of many calcifications of the intervertebral disks which are not recognizable on plain radiographs owing to their concealment by the shadows of neighboring tissues, their extensions and weak shadow saturation (Figure 1). LOMBARDI [4] attributes an essential value



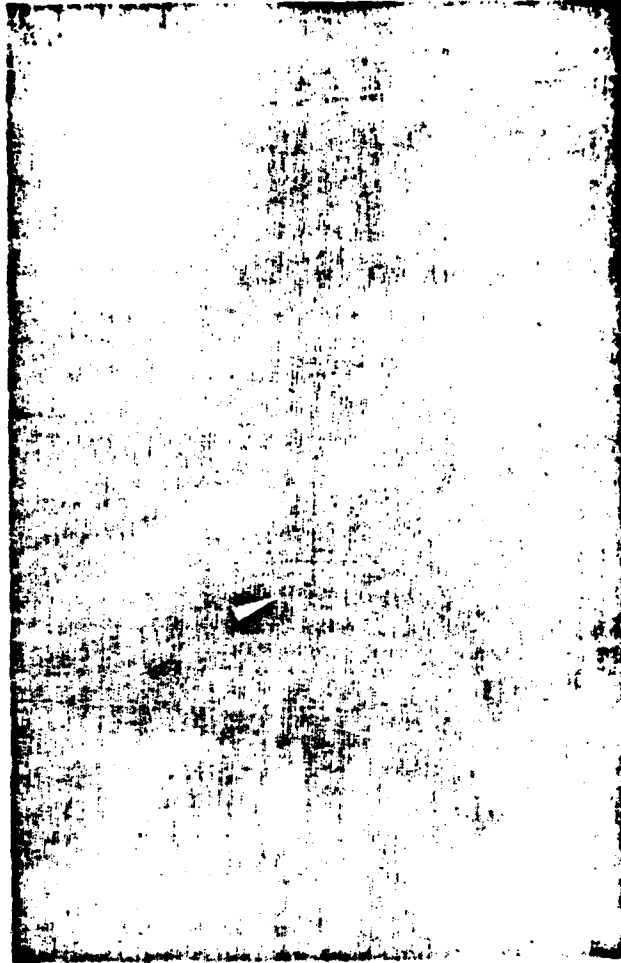


Figure 3. Amputation of the L4-L5 root on the right side, visible on the zonograph, but hardly perceptible on a plain radiograph.

to the diagnosis of calcifications, especially where they are located close in the area of a disk hernia directed toward the lumen of the vertebral canal. This calcification is accompanied by an inflammatory reaction as a component of the pain syndrome [4]. In children, this type of designated calcification occurs as calcinosis intervertebralis or discopathia calcificans and has to develop as a consequence of injuries of the disk blood vessels [10]. Post traumatic interruption of the fibrous ring with displacement of the nucleus pulposus into the vertebral canal also causes changes and calcium deposits.

Calcium deposit and flattening of numerous disks with subsequent

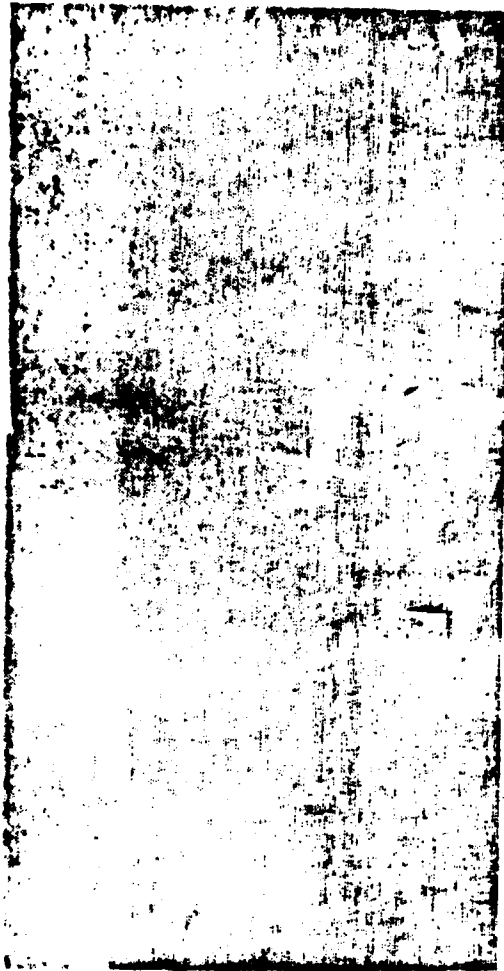


Figure 4. Oblique zonograph shows double-level (L3-L4, L4-L5) buckling of the anterior outline of the contrast band corresponding to the disk hernia.

narrowings of the intervertebral space takes place also in a disease called ochronosis alkaptonurica. In this disease the calcium is first deposited in the central part of the vertebra in the form of bands, after which the concretions of calcium fill out homogenously the flattened disk. On the other hand, the pigment (alkapton) located in the marginal part of the disk is invisible on the X-ray.

Degenerative changes of the disk lead to deformities of the bony borders of the bodies at the height of the intervertebral space. Similarly as to standard planigraphic examination, the zonograph makes

visible the actual height of the neighboring vertebrae, in contrast to a plain radiograph which causes optical deformities of the adjoining disks. Among the 28 examinees, narrowing of the individual intervertebral space was established, but in eight persons multi-level narrowings were manifested. In 18 patients the narrowings were found in the posterior parts of the interspace, but in six persons in the anterior part. In agreement with the data from the literature [6,9], they most frequently appeared on the L4-L5 level (17 persons), and on the L5-S1 level (13 persons). In 34 cases, at the edges of the bodies osteophytes were formed in different ways. It is essential to individualize, from among the degenerative excrescences, the horizontal traction osteophytes, arising as a consequence to stresses and overstrains of insertions of disk fibrils to the external layers of bodies. They are situated about 3 mm below the basal cartilage of the body. Upon examination of the deep layers, in 12 cases fine osseous outgrowths were detected which were penetrating toward the lumen of intervertebral foramina, and were not visible on plain radiographs. This type of change is apparent on oblique zonographs by turning the body by 45°. This projection namely includes full dimensions of the intervertebral articulations and in this area shows the degenerative changes which often have an essential influence upon the compression of neural roots. Moreover, in 31 patients, congestion of the boundary lamina of vertebral bodies was found, a type of subcartilaginous sclerosis, frequently with an irregularity of the contours at the level of the narrow interspaces. Coexistence of spondylophytes of the posterior edges of the bodies suggested changes involving only one segment. Initial degenerative changes were observed on the disk with regular images on standard roentgenographs. The zonographs showed clear changes, both bony changes and also buckling of the disk into the frontal outline of the meningeal sac at the level of the intervertebral space (Figure 2).

As to the cause of the painful syndrome in ischias (sciatica), they are most frequently compressions of the disk hernia upon the roots. Therefore, the zonographs were evaluated with regard to making visible both the root changes and the deformations of the outlines of

of the meningeal sac. It was shown that the best images of pockets and roots are obtained for an oblique projection at 30°. Then, they are seen on the zonographs rather clearly, distinct from the images observed on plain radiographs. Zonographs created a possibility of evaluating the swellings and the distensions of the root due to inflammatory edematous changes which often accompany a disk hernia. And also the symptom of "root Musket" in the form of an interruption of its contour with widening of the shadow of the compression was established in 41 cases, in comparison with 33 found on plain radiographs. In 43 persons, displacement and downward pushing of the root was recognized most often in the direction of the vertebral canal which, as is well known, has a special meaning in the hernia diagnosis (Figure 3). Moreover, in 26 persons, complete amputation of the root and capsule was established, while its upward transportation was found in nine cases. On the zonographs, altogether, 35 pocket asymmetries were found in comparison with 27 cases recognized with survey radiographs. It has to be emphasized that, thanks to the zonographs, in five cases an erroneous diagnosis was avoided, while on plain radiographs, shadows projecting over other structures imitated amputation of pockets. In 45 cases, root changes coexisted with deformations of the meningeal sac, while in seven persons they were isolated. In distinction from the values of tomographic radiographs, zonography --giving a thicker segment--assures against the possibility that the contours of root structures go out from the film of the segment.

In seven persons, the contrast medium was shown at the level of the intervertebral space. In three, delayed partial flow of a small amount of the contrast medium was observed. It has to be recorded that root indentations of the contrast medium which create pathognomonic denticulation of the medium for prolapse of the nucleus pulposus, are subject to easy identification in the zonograph. This phenomenon, as is well known, permitted a diagnosis of the cause of the medium. Consequently, its value was increased in myelography and in radiculography. In these cases, the classical layer examination requires the preparation of many segments that often miss small

details which often have solid diagnostic value.

The demonstrated pathologic changes most often appeared at the level of the L4-L5 intervertebral space (23 persons), less frequently at L5-S1 (18 persons). On five patients, they were displaced at other levels. Of these, four were multi-leveled. The oblique zonographs showed especially clearly the posterior bulging of the vertebrae (Figure 4). In 50 examinees, deformation of the outline was shown in the medullary sac. From this, they were visible only on the zonographs in up to 12 cases, which makes 24%.

Prolapsus of the disk was operatively verified in 51 persons. In five of them, the pains were caused by pressure of the exostoses, by inflammatory swelling of the roots and by other irregularities of the soft parts which now and then coexist in degenerative disk processes.

Measurements of the width of the vertebral canal on zonographs showed wide medullary sacs in 16 cases and narrow ones in five persons. Of these, multilevel bulgings were visible which did not have signs of prolapse of the nucleus pulposus in three cases.

In seven cases, dynamic zonographs demonstrated the possibilities of frequent reposition of the hernia during myelography, depending upon the position of the subject. In these persons, increase of the dimensions of the hernia was established for maximum forward bending. Depending upon the direction of bending, the vertebral canal changes its shape and dimensions which has an effect upon the subarachnoid space. When bending forward the medulla comes close to the anterior wall of the canal--while the disk is displaced backwards. During backward bending, the medulla adheres to the posterior wall of the canal.

Two-fold shadow projecting upon standard radiographs of the articular apophysis suggested a fallacious hernia diagnosis. In these circumstances, the zonographs prevented mistakes during myelographic examinations.

## DISCUSSION OF RESULTS

Generally, it can be concluded that zonography makes visible individual elements of the medullary sac. Due to relatively large dimensions, it covers the entire organ. Partial elimination of bony shadows projecting upon this area creates an additional factor permitting a better qualitative evaluation of the zonograph. Generally, incipient conditions of root compression are easier to visualize. Clearer visualization of details of the outline of the contrast medium during myelographic examinations not infrequently permits qualitative diagnosis of the cause while retaining the shadowing medium. This is especially essential in cases where disk hernia is suspected, where the displaced medium is higher or lower than the intervertebral space. It is well known that, in spite of the established differential criteria of the process, the intracanal shape of obstacle in the passage is frequently difficult to interpret [2]. Also now and then the position of prolapsed disk is close to an image which appears during a growing suprasclerotic displaced process on the anterior wall of the canal [7]. The number of myelographic images not typical for hernia is especially large in cases of disks in the region of the thoracic vertebral column [4]. RITTMAYER and coworkers [5] estimate the non-synonymous character of myelographic images at 10-20% of the examined cases.

Now and then, unfavorable relations of the projections of the lumbosacral joint may appear which create unfavorable conditions of visibility of the L5-S1 roots and especially of their sheaths. Moreover, the anatomical changes of this area appear rather general, and the number of pathological changes in this area is large. Similarly, the sheaths and roots at this level can be invisible in cases of anatomic variants of the medullary sac, both in the very wide and in the narrow sacs. In these cases, they can adhere either directly to the sac or they can be screened by the wide, intensively saturated coniform end.

Beyond this, in a wide medullary sac the invisibility of the extradural factors of the roots can cause difficulties in estimating

pressure. On the contrary, the concentric narrowing of the contrast medium at the level of the intervertebral space, as appears in cases of a narrow sac, does not prove the prolapse of the nucleus pulposus. In these special cases, the zonographs, made at a 30° angle, make visible the roots and the L5-S1 sheaths. From our observations, it results that 45° zonographs are already diagnostically useless because this projection causes mutual multiple deposit-spreading of the root shadows. This has an additional unfavorable effect on the projection of the intervertebral joints of the examined structure. It has to be remarked that the frontal projection generally makes clearly visible the L5-S1 sheaths. This problem was exhaustively elaborated by RABIN et al [1]. They emphasize that zonography allowed clear visualization of the lateral outline of the sac in bulged-out disks which coincides with our own observations. The zonographic technique lessens the contradiction between the standard radiographic images and the operative data. Not infrequently, it results from the practice that even correctly evaluated radiculographs do not exclude the prevalence of lateral hernias. In contrast to zonographs, on plain radiculographic radiographs, there are often screened sheaths and roots and also congenital irregularities of the medullary sac by reactive sclerotic changes of the bony structure of the vertebral column and especially by beaklike osteophytes which appear in degenerative changes.

Dynamic radiculo-zonography is of greater value for the estimation of the mobilities of bony structures. It creates possibilities of evaluation of the mobility of displaced disks, making visible the increase or decrease of its bulging, depending upon the position of the patient. The effect of position upon the results of myelographic examination is indeed emphasized in the literature [3,8].

Analysis of our cases shows the special value of zonographic technique in the evaluation of the                      of the shadowing medium in the medullary sac of the spinal cord. In contrast to tomography, it can be easily established with a layer projection of a segment which is due to include the examined structure. This technique supplements standard radiography and tomography and allows to increase the possibility of diagnosis. During the evaluation of individual tomographs,

some details are lost, resulting from the layer of the segment, especially those which are at the boundary. These structures can be made, therefore, only partially visible which leads consequently to an overestimation of small pathological changes. Zonography reproduces the entire given structure especially for changed volume relations and results in a full and informative spatial image. As to the cost of examination, it is markedly lower compared with tomography and the dose of ionizing radiation is reduced by 50%. Labor consumption and time consumption of the examination likewise speaks for the advantage of the presented zonographic technique.

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#### SUMMARY (from Russian)

##### SUMMARY

Using their own research material and data from literature the authors discussed the usefulness of zonographic technique in diagnosis of diseases of the intervertebral cartilage emphasizing the special usefulness of the above mentioned method in patients with pulposus nucleus prolapse.