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Moiré Topography: From Takasaki Till Present Day

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1. Introduction

The introduction of the Moiré phenomenon in scientific studies occurred in 1874, when Raylegh compared the overlapping of two equal gratings (Ikeda & Terada, 1981).

Since Takasaki (Takasaki, 1970) proposed Moiré topography (MT) for the analysis of the surface of the human body, other authors have published studies with the objective to explain, improve and apply the method in individuals with different characteristics, as well as using other possible techniques that involve MT (Adler et al., 1984, Breque et al., 2004, Castro, 2007, Drerup, 1981, Hertz, 2005, Kim & al., 2004, Kim et al., 2001, Lino & Fabbro, 2004, Porto et al., 2007, Rössler et al., 2006, Yeras et al., 2003). Takasaki himself also seemed to be concerned with the evolution of the technique and its several clinical applications (Takasaki, 1973, 1982, 1976), after his first publication in 1970.

To this day however, few devices are commercially available on the market for the evaluation of the topography of the human body – although the advantages of MT are well recognized as a diagnostic and prophylactic tool, especially for postural deviations of the vertebral column. Perhaps, this limited use of MT is due to a lack of knowledge about the physical phenomenon of Moiré and, consequently, its potential clinical applications.

This Chapter therefore aims to present a literature review regarding the main characteristics of the Moiré phenomenon, and its use as a topographical method for clinical diagnosis of postural deviations.

2. Materials and methods

This research survey was divided in two phases in order to form the body of analysis for this study. In the first phase, a search of studies related to MT was performed from the sources PubMed, Science Direct and Academic Google. Also, the tool of Multiple Search was used from the website of the Library Irmão José Ótão of the Pontifical Catholic University of Rio Grande do Sul, Brazil (PUCRS, Brazil). This tool allows multiple searches to be carried out with only one command from several available sources of information in the Library of PUCRS. It can retrieve at once complete scientific articles from electronic databases, such as Proquest, Ebsco, Biological Abstracts and Scielo. In addition to this, some works were acquired by means of direct contact with authors via e-mail. The second phase consisted of a literature survey based on the list of references of each paper found in phase one.

The search and selection criterion of the articles for this study was performed through the use of key words in Portuguese and English, including: Moiré, Moiré topography, Shadow Moiré and Moiré Technique. Physics text books and article review were also consulted to clarify the concepts in Optics.

All scientific papers obtained through the literature search were submitted to the technique of Scanning (GOODMAN, 1976 apud (Kleiman, 1989)), consisting of a superficial reading of articles with the intention of better selecting useful works for the study. Some articles published prior to 1980, although not up to date in terms of scientific discoveries, were still considered because of their importance for the characterization of the state-of-the-art of MT. These were obtained through the Commutation Service, available from the homepage of the Library Irmão José Ótão of PUCRS.

A content analysis, adapted from the proposal of Bardin (Bardin, 2000) and having been used in other studies (Porto, 2003), was applied to the selected material. The characteristics of the analysis adopted were: 1) the description of the Moiré phenomenon and the origin of the technique name; 2) the evaluation techniques based on this physical phenomenon, including instruments used, calibration of these equipment, analysis of the image and the care required in the performance of MT application; 3) areas of clinical use.

This study approached the subject according to the following topics: physical principle of Moiré; techniques based on the Moiré phenomenon; calibration of the equipment for MT; analysis of the topograms (Moiré pictures); application of the method; and the care needed in applying MT.

3. Results and discussion

3.1 The physical principle

According to Oster (Oster, 1988), the Moiré phenomenon - also called, standard or fringes of Moiré - occurs when one set of curves is overlapped over another set of curves, forming a completely new set. This overlapping of the gratings (or curves) must be less than an angle of 45° in order to generate interference. This interference formed by the intersection of the lines of gratings is what will characterize the standard of Moiré (Bartl et al., 2001, Drerup, 1981, Dzielinski et al., 1990, Oster, 1988).

The phenomenon can also be generated when there is a small difference in the thickness and distance between the lines of the grating (or reticulum), also with the use of circular forms of the standards of Moiré.

Depending on the technique used, however, it is possible that the two gratings created for the generation of the Moiré phenomenon are not both in reality a physical object. This occurs with the method Shadow Moiré Technique (SMT), Figure 1, in which the shade of the projected grating on the analysis surface functions as the second grating (Breque et al., 2004, Oster, 1988). Likewise, it occurs in the Projection Moiré Technique (PMT), Figure 2, in which the first grating is projected on the analysis surface and the optic phenomenon is generated subsequently when the image is processed by software (Mínguez et al., 2007). Moreover, these techniques seem to be the two main ones for the evaluation of human body surfaces, which has also been pointed out by Lim, Kim and Chung (Lim et al., 1989).

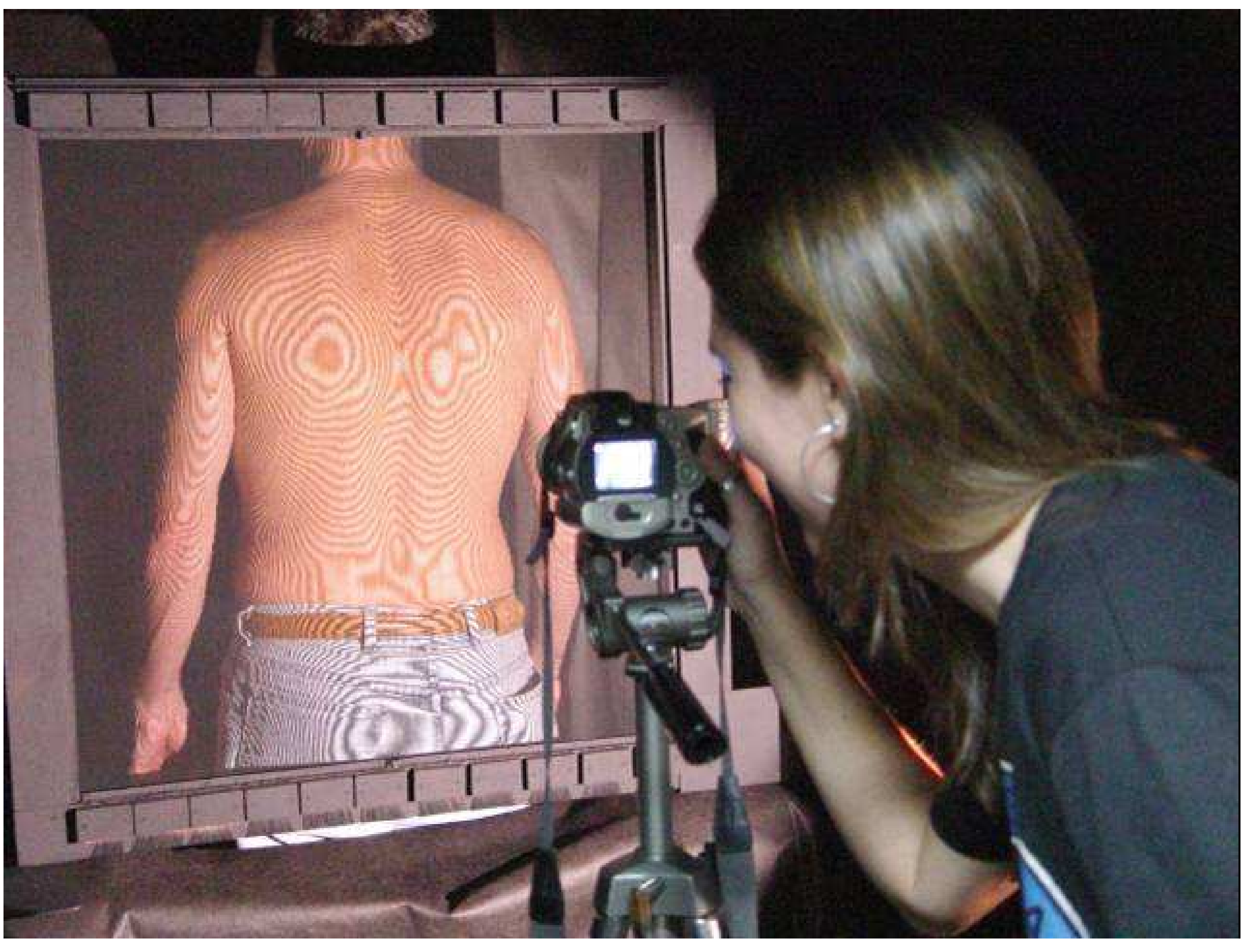

Fig. 1. Shadow Moiré Technique. *By the authors.*

Fig. 2. Projection Moiré Technique. From: www.miotec.com.br.

Moiré can be used to study the topography of surfaces, therefore the fringes of Moiré form the lines of contour - or the levels of curves - of the surface of the object under analysis (Breque et al., 2004, Yeras et al., 2003).

The word Moiré comes from a French terms meaning *wet* or *waved* and is related to an imported silk from China in which the fabric itself gives this peculiar appearance to the cloth (Bartl et al., 2001, Sciammarella, 1982). In Brazil, the fabric of this same appearance is called *Tafetá* or *Chamalote*. In accordance with the Textile Glossary, supplied by Hering company (Hering, 2004), Chamalote, which is made from a mix of camel hair and silk gives the same impression of the "waved" effect (Moiré).

3.2 The Moiré techniques

The Moiré techniques are a set of procedures based on the physical phenomenon of Moiré (Lino & Fabbro, 2004). They are stereometric methods of three-dimensional analysis of an object from a bidimensional image (Drerup, 1981, Kim et al., 2001). The Moiré techniques are: Moiré in plane, Shadow Moiré, Projection Moiré, Interferometry Moiré, Microscopical Moiré, Holographic Moiré and Interference Moiré (Rössler et al., 2006, Yeras et al., 2003). These techniques differ by the way the phenomenon of Moiré is generated and further used in the topographical analyses.

In general, MT consists of a simple method and requires a camera, a light source and a grating. The images (topograms) are formed by the alternation of clear and dark fringes (Batouche & Benlamri, 1994, Batouche et al., 1996, Drerup, 1981, Kim et al., 2001), the dark ones being called fringes of Moiré (Rössler et al., 2006). The pattern created by these fringes on the surface of the object is used for further analysis.

The generation of the optic phenomenon will depend on the MT used. With SMT, for example, the shadow of the grating functions as the second grating (Breque et al., 2004, Oster, 1988). In this case, the shadow of the object under analysis is deformed by the form of its own surface (Rössler et al., 2006).

Therefore, the physical principle of SMT is: a source of light P illuminates at an oblique angle on the grating G and produces then an image on the surface S. An observer, called O, (or a camera, C) is placed in front of the grating. The shadows formed on the surface (the object) are either seen by the observer or captured by a camera. The results will look like a topographic map, which results from the Moiré optic process (Turner-Smith, 1997).

The positioning of the camera and the light source can vary. For example, the light source can be above the camera and both lined up exactly in the same plane (Hamra & Volpon, 1995). Also, the light source can be located a little in front of the camera and closer to the grating (Yeras et al., 2003). Other alternative methodologies for the application of Moiré topography are: a) positioning of the light source and camera side by side and at the same level, but maintaining the oblique incidence of light on the grid (Castro, 2007, Hertz et al., 2005, Hertz, 2005, Porto et al., 2007); b) to use a mobile light source (Lim et al., 1989); c) to replace the camera with a video camera (Turner-Smith, 1997, Yeras et al., 2003).

A lack of standardization in the Moiré technique for the topographical analysis of the human body is perceived. Few studies mention the measurements of distance left between the material employed during the technique (camera, source of light, grating, individual), as well as other important characteristics, such as: details of the reticulum (Castro, 2007, Hamra & Volpon, 1995, Hertz et al., 2005, Hertz, 2005, Kilpeäinen et al., 1996) and the calibration procedures used (Mínguez et al., 2007). This raises a concern given that replicability of measurement is compromised by a lack of information. The difficulty of standardizing measurement procedures in TM generates a need for even greater reliability on procedure definitions.

Another relevant aspect of the studies reviewed is that the equipment used for MT is of unknown origin in the majority of cases, meaning that it may or may not have been developed by the laboratory conducting the research. Noteworthy are the studies (Castro, 2007, Hamra & Volpon, 1995, Hertz et al., 2005, Hertz, 2005, Porto, 2008) that used TMS and stated that the grids were developed by the respective research groups, having also provided information regarding the methodology applied. In relation to grid design, it is common to find that it is made of wood (Castro, 2007, Hertz, 2005, Porto, 2008). Considering the distortion that can occur with this type of material due to tension of the nylon threads, Adair (Adair et al., 1977) proposed that the grid should be made from aluminum instead. Takasaki (Takasaki, 1973) also suggested that the grid size used for analysis of the whole human body should be 1.8 x 1.8 x 0.9 m^3. For analysis of the trunk, studies have shown that a square grid of 600mm is satisfactory (Castro, 2007, Hertz et al., 2005, Hertz, 2005, Porto, 2008).

Even in those studies where the equipment manufacturer was mentioned, the characteristics of the material employed for the MT were not always explained, as in the study by Mínguez et al. (Mínguez et al., 2007), which evaluated postural deviations due to scoliosis of the vertebral column.

The experimental design of MT can vary from one study to the next, depending on the type of MT employed. When using SMT, for example, a mobile grating can be adopted (Dzielinski et al., 1990) as opposed to a fixed one (Castro, 2007, Hamra & Volpon, 1995, Hertz et al., 2005, Hertz, 2005, Porto, 2008). The mobile grating can move horizontally in front of the object being studied.

In relation to the camera, the opening of the equipment must be sufficient to include in the field of vision both the grating and its shadow (Hamra & Volpon, 1995, Takasaki, 1973) and therefore, can make use of the camera optical zoom (Hertz, 2005, Porto, 2008). On the other hand, the shutter speed should preferably be less than 1/8 of a second to avoid the inevitable movement of the body. With such care, according to Takasaki (Takasaki, 1973), good contrast of the fringes can be ensured.

When looking at the light source it can be seen that the literature also does not present standard procedures for the application of TMS. Porto (Castro, 2007, Hertz et al., 2005, Porto, 2008) indicated using a 100W light bulb. Takasaki (Takasaki, 1973) suggested a 2-4kW Xenon lamp as being ideal, but notes that the 500W Iodine lamps have a good cost-benefit.

The Moiré topogram depends on the position of the object behind the grating. Therefore, it is essential to standardize the position of the object to be analysed (Drerup, 1981, Hamra & Volpon, 1995). This care may be justified also by measuring the deviations presented, as with the notion of depth proposed by Takasaki (Takasaki, 1970). There was no standardization in this aspect found in the literature. Adair (Adair et al., 1977) proposed a protocol in which the individual stands upright, feet together, with buttocks close to the screen and shoulders parallel to the grid. This schematic can camouflage the problem that the posture of the person is being "arranged" by the evaluator (although the results of their study were really satisfactory for the detection of scoliosis in school children). Alternatively, another study [6,16,19,30] proposed that the person being evaluated should be in the standing position, feet apart naturally, and body as close to the grid as possible without touching it. The lack of methodological standardization in the application of TM hinders a better understanding of the deformities of the trunk including generating misinterpretation of results (Patias et al., 2010). For this reason, the determination of the Cobb angle is still the gold standard for diagnosis of scoliosis (Kotwicki et al., 2009).

By reviewing the scientific literature, it is apparent that some of the MT techniques are more used than others for the analysis of the human body surface. The SMT appears to be the best for evaluating deviations of the vertebral column and/or of the trunk (Adler et al., 1984, Castro, 2007, Hertz et al., 2005, Hertz, 2005, Takasaki, 1970, Uetake et al., 1998), which can be explained by the fact that SMT was the first MT employed for the topographical evaluation of human body.

Other areas of the human body have also been studied through the use of SMT, such as the arc plantar (Hamra & Volpon, 1995, Yeras et al., 2003), lower limbs (Yeras et al., 2003) and the scapular region (Chalupová, 2001).

In recent years, the Projection Moiré Technique has appeared more frequently in the scientific literature, especially in relation to postural evaluations (Kim & al., 2004, Kim et al., 2001, Mínguez et al., 2007). This can mainly be explained by the current technological evolution in the area of image processing, which also allows the use of the MT in more delicate and complex topographic areas of the human body, such as some bones, using the Interferometry Moiré Technique (Wood et al., 2001).

3.3 Calibration of the equipment

The procedure of calibration of the MT refers to the analysis of the surface of an object with a known geometry in order to prevent direct marks on the surface under evaluation from being made (Ortiz & Patterson, 2005). Moreover, it is possible to reconstruct the geometry of a known object from the generated fringes and to calculate the standard error of the instrument, which will give the accuracy of the equipment used during the performance of the technique (Hertz, 2005).

The calibration procedure of the SMT is described for Hertz (Hertz, 2005). She used a white cone (height = 30mm) made in TECNIL (nylon), with some ring marks, each one every 5mm of depth of the object (total of six marks). The cone was fixed on a wooden structure and placed behind the grating (reticulum) at a distance of 10mm. The image was captured with an optic resolution of 96x96pp and the camera optic zoom of 2x. After analysis of the images, standard error of the instrument was calculated (SE = 0.05136). According to the author, the results showed to be acceptable for a significance level of 5%. It was verified, by the calibration procedure that the distance in between each fringe was equivalent to 4.9mm.

A typical calibration of apparatus used for PMT was described by Mínguez et al. (Mínguez et al., 2007). According to these authors, two images obtained from the projected grating on a plane surface (without the object of analysis) are captured in two different positions with distance of 400mm in between them. These images are called *front grating* and *back grating*. Subsequently, the individual to be evaluated is placed in front of the plane surface, acting himself as the *back grating* (note that the 400mm distance is sufficient to fit a person between the two projected gratings). The idea is that, after the generation of the fringes of Moiré on the surface of the body of the individual, the previous projected grating serves as the basis for the calculations of the topograms.

Some authors, however, prefer to use a reference object by the side of the one being evaluated in order to calibrate the distances between the fringes. This object can be rectangular with known measurements (Ortiz & Patterson, 2005) or any another object of known geometry.

3.4 Analysis of the topograms

The medical analysis of the Moiré images is based on the symmetry of the fringes of both sides in different regions of the body (Batouche & Benlamri, 1994), as represented in Figures 3 and 4. Therefore, it is predominantly classified as a qualitative analysis (Adler et al., 1984).

As much as the quantitative parameters are important in the diagnosis of body asymmetries, there is no denying that the visual inspection of images provides information absolutely relevant for the evaluator and useful in the decision making process that follows. For example, Adair (Adair et al., 1977) tracked scoliosis in 1,132 school children in Ottawa, Canada. Benefitting from the advantage of the easy use of TMS, the author was able to photograph 40 children per hour, both boys and girls. When evidence of asymmetries in the back were detected, the children's spines were X-rayed to confirm the suspicion of scoliosis. The results showed that TMS identified 94% of the positive cases diagnosed by X-ray.

The qualitative medical evaluation of the produced topograms, based on visual inspection of the images, can be an extremely tiring task, especially when evaluating postural

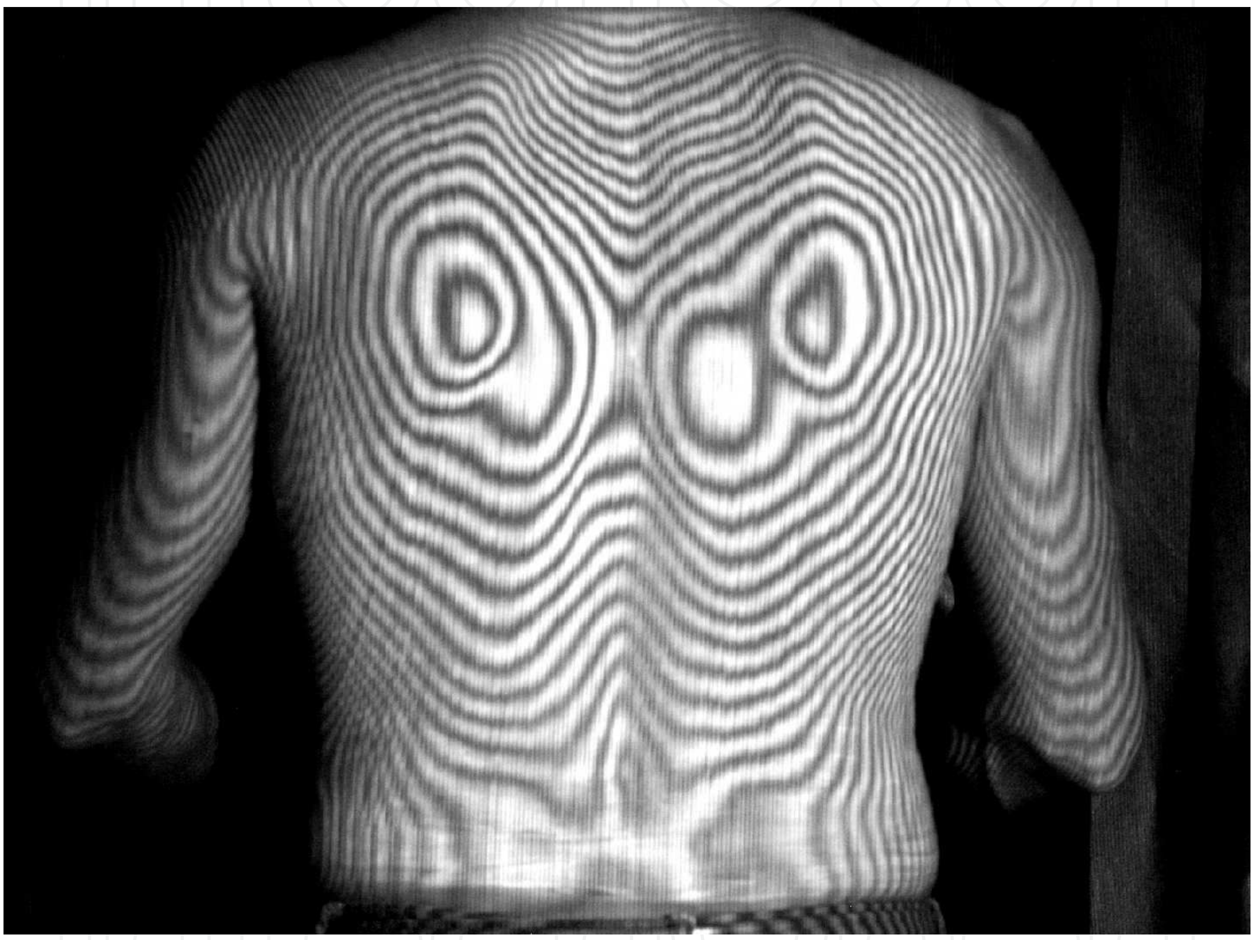

Fig. 3. Moiré topogram of an adult. *By the authors.*

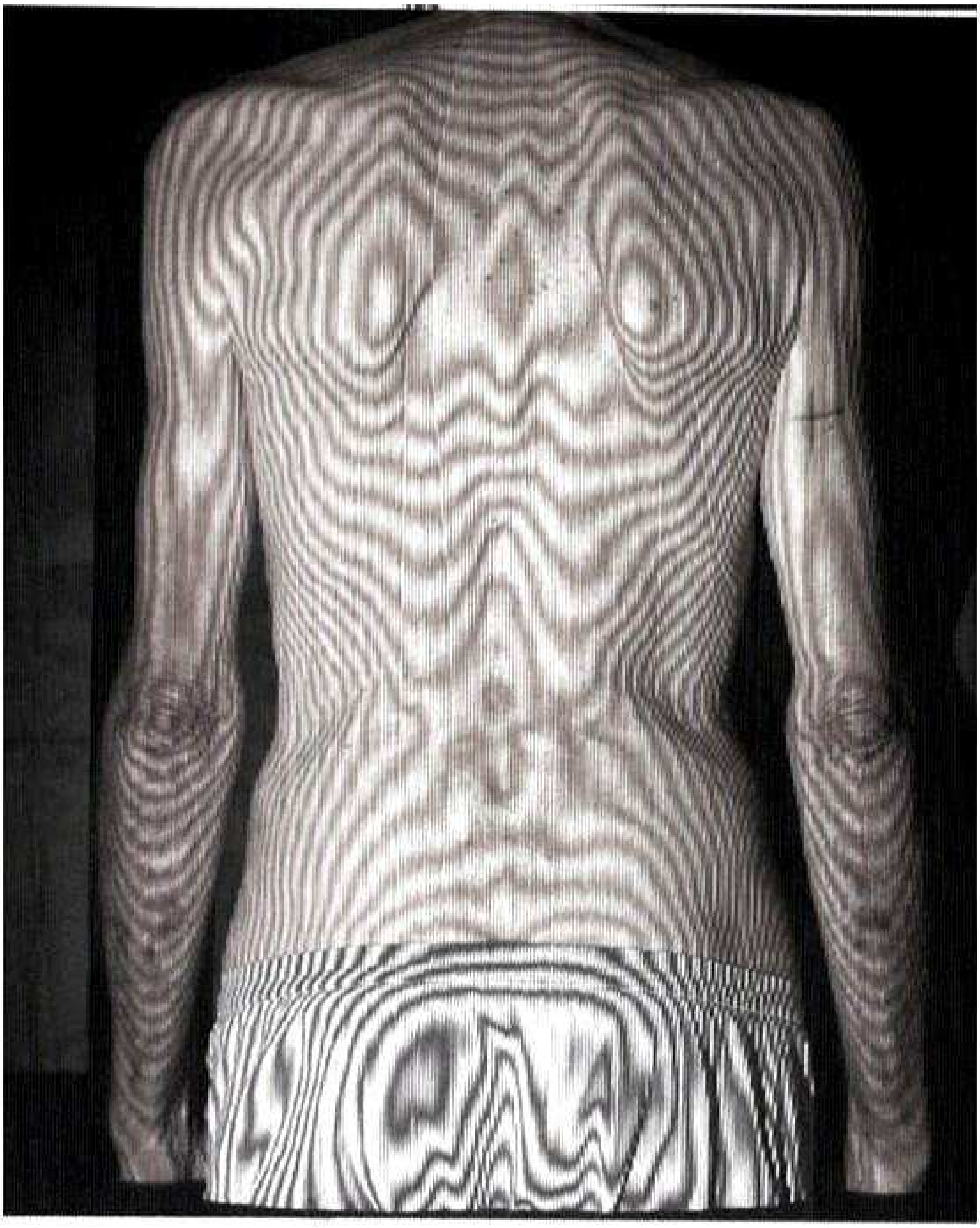

Fig. 4. Moiré topogram of an elderly person. *By the authors.*

deformities of a large number of people in a short period of time, as occurs in population studies (Porto, 2008) or when it is used to identify scoliosis in children at schools (Adler et al., 1984). Also, Kim et al. (Kim et al., 2001) and Kim et al. (Kim et al., 2006) believe that fatigue caused by the performance of many subjective evaluations can interfere with the judgment of the Moiré images. For this reason, these authors advocate the need for the automatization of the analysis procedure of the topograms captured from the back of individuals.

Having this in mind, Porto et al. (Porto, 2008), in a population study of postural evaluation of individuals of more than 60 years of age (Multidimensional Study of the Elderly Populations of Porto Alegre, Brazil), considered the use of a free software for analysis of the topograms. It did not detect deformities in the dorsal region of individuals automatically, but facilitated the evaluation by giving measurements of angular deviation and depth with more precision.

Photographs with 256 grey tones, ranging from 0 (black) to 255 (white), were captured on the back of each elderly individual. Porto et al. (Porto, 2008b) evaluated the lateral deviations of the thoracic column with the measurement of the joint angles formed (in degrees) and the characteristics of the concavities present, the unevenness of scapulas in the frontal plane with the measurement of angular deviations, in degrees, and hyperkyphosis thoracic. For this evaluation, the authors used a free software (Power Draw 2D Application Vector), which optimized the evaluation process of the images.

Previously, other authors (Castro, 2007, Hertz et al., 2005, Hertz, 2005) considered similar characteristics of the MT evaluation and tried to search for a numerical parameter for the evaluations of the volunteers. However, in these studies, they used more rudimentary instruments for the analysis of postural deviations, such as paper, pencil or pen and ruler.

The subject aspect of the MT is a limiting factor. According to Kim et al. (Kim et al., 2001), the numerical information of the asymmetry is useful in the evaluation of the deformity. Therefore, it is clear that the attempts of many authors in quantifying subjectively postural deviations are not the best option, although less expensive. These initiatives, however, show the concern of these scientists in improving this biomechanical evaluation. This might imply that an important limiting factor is the financial obstacle.

The automatization of the evaluation procedure for the Moiré images has many advantages, especially for the study of large number of people in short periods of time, when compared to the manual, visual and semi-automatic way. Kim et al. (Kim & al., 2004), for example, used a new technique of automatic detection of scoliosis during a study evaluating 1,200 topograms of young individuals. However, even with automatic detection of the fringes, there are serious problems related to ambiguous fringe patterns and to non-continuous fringes. According to Cline, Lorensen and Holik (Cline et al., 1984), non-continuous surfaces generate broken fringes which make subjective analysis very difficult. In this situation, errors of evaluation also occur when software is used to analyze topograms.

When evaluating the human body surface certain fringe patterns are perceived depending on the area studied. In this sense, according to Cline, Lorensen and Holik (Cline et al., 1984), the fringes become enclosed within the image plane when the surface is very inclined. This occurs, for example, in very thin individuals or those who present with thoracic kyphosis. Yet when the surfaces are very narrow, the breaks between the pixels prevent automatic construction of the image. Non-uniform surfaces with low reflectance might not generate clean fringe patterns. Other complex Moiré patterns that make the analysis of topograms difficult occur when individuals for evaluation are obese, according to Ruggerone and Austin (Ruggerone & Austin, 1986) and when they present with excess skin and hair.

3.5 Applications

The MT method has the advantages of being a non-invasive method and does not produce radiation, as occurs in X-ray exams (Ikeda & Terada, 1981, Yeras et al., 2003), does not require a highly trained professional for its application (Batouche & Benlamri, 1994, Ikeda & Terada, 1981, Yeras et al., 2003), allows the evaluation of many people in a short period of time (Ikeda & Terada, 1981, Yeras et al., 2003), is reproducible (Batouche & Benlamri, 1994, Ikeda & Terada, 1981), is low-cost (Batouche & Benlamri, 1994, Yeras et al., 2003), is able to substitute the use of an X-ray exam or to act as a complementary method in the diagnosis of disease (Hertz et al., 2005, Hertz, 2005, Yeras et al., 2003).

The MT method seems to be very efficient in the topographical analysis of an object that has irregular surfaces and that is not very rigid, such as a pile of sand, the surface of water or the human body (Takasaki, 1982). However, it is believed that MT is also a versatile method, being suitable for use for deflectometry and tension-deformation situations (Dzielinski et al., 1990).

The use of MT in the topographical analysis of the human body is possible because it is able to indirectly identify places with structural deformities under the skin through the form of the surface area (Chalupová, 2001). MT has, therefore, many possible applications and uses for health professionals in clinical evaluation of patients and for researchers and professors in their academic activities with students. These applications include: early detection of scoliosis (Pearsall et al., 1992, Takasaki, 1982, Yeras et al., 2003); the not-invasive reconstruction of the vertebral column based on the generated topograms (Dzielinski et al., 1990); the detection of other deformities of the vertebral column (hyperkyphosis, hyperlordosis, planar back, gibosity) in different planes (sagital, frontal and transverse) from only one image obtained from the back of an individual (Batouche & Benlamri, 1994, Castro, 2007, Hertz et al., 2005, Hertz, 2005); the evaluation of the foot sole (Hamra & Volpon, 1995, Yeras et al., 2003); the characterization of the palatal morphology (Kilpeäinen et al., 1996); the characterization of the form and the detection of abnormalities of the lower limbs (Yeras et al., 2003); the description of the scapular area and its symmetry in relation to the vertebral column and between both scapulas (Chalupová, 2001); the verification of the influence of sport activities in the morphology of the trunk (Uetake et al., 1998).

Japan was a pioneering country in the use of MT, and was first to use it for identifying scoliosis in school children. Currently, 11 city halls (of a total of 47, including Tokyo) use the SMT for this. According to Kim et al. (Kim et al., 2001), in 1977, the Japanese Minister of Education initiated a program for early identification of scoliosis in children and young individuals in Japanese schools. The detection of scoliosis in its early phase was done through physical evaluation, which is a non-reproducible and very subjective. Therefore, SMT became an alternative method, through the visualization of the asymmetry of the fringes of Moiré on the back of the individual, making it a very popular method.

Some researchers have applied SMT on a large-scale for the evaluation of postural deviations of children and young individuals, as did Adler, Csongradi and Bleck (Adler et al., 1984), Yeras, Peña and Junco (Yeras et al., 2003).

Adler, Csongradi and Bleck (Adler et al., 1984) evaluated 327 girls, in five of the eight public schools of Clara Saint, in California, United States, in order to identify early signs of scoliosis. The authors applied SMT and studied the asymmetry of the fringes, and also applied the clinical postural examination. Comparing the two methods, the authors found a low correlation (r=0.16), which they attributed to the method of Moiré employed in the evaluated schools.

Yeras, Peña and Junco (Yeras et al., 2003) evaluated 203 individuals between 10 and 15 years of age from a school in Havana, Cuba. The authors compared the evaluation of the fringes of SMT produced on the back of the individual and the same fringes that were recorded on a video. Moreover, they compared with the classical physical examination performed by doctors that include: complete physical examination, measurement of vertical alignment with the use of a pendulum and the flexion of the trunk for the detection of idiopathic scoliosis. The results showed that SMT was more precise than the physical examination and was very efficient in the detection of false-positives.

The MT method was also used to detect deformities of the trunk and column in the elderly, but the number of studies that applied this method in older individuals is minimal when compared to studies focusing on young individuals and children. The Aerospace Biomechanics Laboratory (NUBA, Microgravity Centre, School of Engineering, PUCRS, Brazil) together with the Institute of Geriatrics and Gerontology and the School of Physical Education of PUCRS evaluated the elderly population of a city in Rio Grande do Sul state, in a pioneering study (Porto, 2008).

The MT has presented a good correlation with the X-ray, becoming a reliable method for giving measurements, as shown by the studies of Daruwalla and Balasubramaniam (Daruwalla & Balasubramaniam, 1985), Ruggeroni and Austin(Ruggerone & Austin, 1986), and Kovac and Pecina (Kovac & Pecina, 1999).

3.6 Precautions

When an alternative method of medical evaluation is developed which prioritizes reduced costs, it is necessary that the new method proves to be a good substitute. Having this in mind, MT must have an excellent reproducibility when performed on the same patient many times. Statistically, the best way to validate a new method is by comparing it to the gold-standard one (Hulley et al., 2003).

Since publication in 1970 of the application of the Moiré phenomenon for human body surface analysis, some doubts have emerged regarding the ability to capture topograms with good fringe contrasts. These difficulties arise because of such factors as the size and depth of the surface not being able to show good fringe contrast (Takasaki, 1973).

There is a huge lack in the scientific literature of studies that have evaluated the accuracy of the MT when used on the human body. Daruwalla and Balasubramaniam (Daruwalla & Balasubramaniam, 1985) have evaluated the accuracy of MT applied on the back of young individuals and compared the results with the x-ray of each examined person. A total of 1,342 topograms of children from a school in Singapore were studied in 1982. The results of this study demonstrated that the accuracy of the curves was identified in 68% of thorax columns, in 54% of thorax-lumbar columns and in 15% of the lumbar region. The authors believe that the test that includes the flexion of the trunk provides more information and is a more economic method for large scale evaluation and that MT is a complementary method of diagnosis.

Standardization of the evaluation protocol and design of the experimental project must be pre-determined. This idea is corroborated by Ikeda and Terada (Ikeda & Terada, 1981). Drerup (Drerup, 1981) believes that a crucial aspect of the MT method is the position of the object, in this case the person. It is easy to notice in the scientific literature that there are more studies relating to MT application than those that focus on the accuracy of the method itself and the standardization of the measurements obtained.

One of the disadvantages of MT is that it is labor intensive when it comes to evaluation of the images. Some authors believe that the best solution would be the development of an automatic system for the analysis of the Moiré images (Batouche & Benlamri, 1994, Ikeda & Terada, 1981, Kim & al., 2004, Kim et al., 2001).

4. Conclusion

This chapter aimed to review aspects related to Moiré topography published in scientific journals from 1970 onwards, when this technique was first used for medical purposes. The method proved sufficiently versatile in its clinical applications and extremely useful as a complementary diagnostic technique. It is a time effective, low cost, user friendly method for evaluating body posture and deviations. It was noted, however, that there was a lack of studies in the literature reviewed evaluating the topography of the human body through MT, especially in the elderly population.

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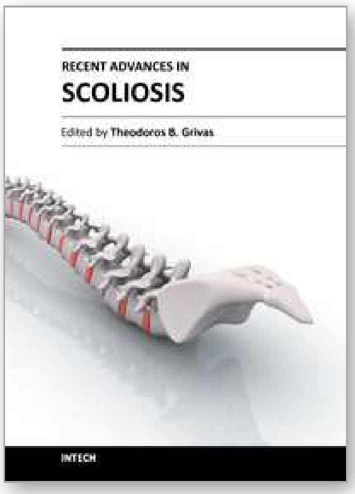

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This book contains information on recent advances in aetiology and pathogenesis of idiopathic scoliosis, for the assessment of this condition before treatment and during the follow-up, making a note of emerging technology and analytical techniques like virtual anatomy by 3-D MRI/CT, quantitative MRI and Moire Topography. Some new trends in conservative treatment and the long term outcome and complications of surgical treatment are described. Issues like health related quality of life, psychological aspects of scoliosis treatment and the very important "patient's perspective" are also discussed. Finally two chapters tapping the untreated early onset scoliosis and the congenital kyphoscoliosis due to hemivertebra are included. It must be emphasized that knowledgeable authors with their contributions share their experience and enthusiasm with peers interested in scoliosis.