ANALYSIS OF HAIR FROM CHEMOTHERAPY PATIENTS

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ABSTRACT

In forensic science, hair analysis is a useful technique that yields important evidence for criminal investigations. Patients undergoing chemotherapy frequently show noticeable alterations in the chemistry and morphology of their hair, which can be used to identify those who have received cancer treatment. The purpose of this study was to look at the possibilities of hair analysis in forensic science, particularly in the identification of people undergoing chemotherapy. Hair samples from 97 chemotherapy patients, divided into various age groups and treatment stages, were analysed for morphological changes in this study. The findings revealed a common continuous medullary pattern in individuals of all ages receiving chemotherapy, including in the first and second stages. Fragmented patterns were sometimes seen, but discontinuous patterns were less frequent. Thin cuticle patterns were more common in second-stage chemotherapy patients, according to cuticle research. This study shows how hair analysis can be used to identify patients receiving chemotherapy, which is useful for forensic investigations. The results serve as evidence in criminal investigations and aid in the creation of new techniques for human identification.

KEY WORDS: Forensic science, hair, investigations, identification, evidence

1. INTRODUCTION

The tiny, thread-like strands that protrude from the skin of mammals, including humans and some other creatures are known as hair. Unquestionably, human hair serves as a significant piece of evidence in the majority of crimes. Hair has a lot of relevance in forensic investigations since it is the most frequent and significant sort of evidence found at crime scenes. The unique quality of hair is that it can be quickly transferred if there was any physical contact. It is simpler to connect a suspect to a victim or a victim to a crime scene when hair is found there. There are several criminologists interested in hair analysis. The prevalent mind set is stated by Sydney Smith (1) who writes that "if a definite answer is required as to whether a certain sample of hair is that of a certain individual, the investigator is strongly advised to refuse to go further than to State that the hair is similar." Without a doubt, the current state of knowledge substantially supports such statements.

Other sorts of evidence might not always be able to address questions, but a hair analysis may. Analysing hair samples can reveal poisonous remnants even decades after the poison has left the body if someone has been poisoned. To exclude and identify suspects in crimes, hair analysis is commonly employed. Investigators usually take hair samples from crime sites for additional examination since they can be used as important pieces of evidence to help solve the case.

1.1 HISTORY OF HAIR

It is a protein filament or slender fibrous outgrowths from the skin known as hairs that have a variety of microscopic features, including shape, colour, and root appearance. Forensic scientists can identify the age, gender, and race of the person who shed the hair by varying these features. Additionally, they are able to identify the bodily part from whence the hair came. DNA can be extracted from hair and utilized in analyses to assist identify potential criminal suspects.

In the late 1800s, investigators realized the value of using hair analysis as tracing evidence in criminal cases. France produced one of the earliest forensic science reports utilizing the scientific examination of hair in 1857. This introduces the concept of hair and fibre analysis, and as microscopic hair examination became known, the area quickly developed in the early 20th century. The principles and practice of medical jurisprudence, a historical treatise on forensic science written by Alfred Swaine Taylor and Thomson Stevenson, was published in 1883. The chapter on employing hair in forensic investigation contained illustrations of human hair under magnification.

The French forensic scientist Victor Balthazard and Marcelle Lambert wrote "Le Poil de l'Homme et des Animaux" (the hair of the man and animals) in 1910, which was a thorough examination of hair. This publication contains numerous microscopic examinations of hairs from the majority of animals. A study of hair and wools belonging to the mammalian group of animals, including a special examination of human hair, was both published in 1931 by Professor John Glaister (1937). He rose to prominence and became a well-known source of data on hair analysis. In 1934, Dr. Sydney Smith used the comparison microscope for the first time to compare hair taken from a crime scene with hair from a suspect or victim (1).

John Hick published "Microscopy of Hair: A Pragmatic Guide and Manual" in 1977, laying the foundation for the forensic examiner to use hair as evidence. This treatise established the value of hair and fibre analysis in the realm of a criminal investigation. These works established the precision and reliability of hair analysis in forensic science. Since the turn of the century, forensic hair analysis has been a significant factor in court cases. The academic and scientific communities had to accept hair analysis as a legitimate scientific discipline. The murder of Duchesse de Praslin in 1847 saw the earliest examination of a criminal case.

The basic tenet of forensic science is that "Every contact leaves a trace," which is found or discovered by investigation. Doctor Edmond Locard, a French scientist, is often referred to as the "Sherlock Holmes of France" and was a pioneer in the field. Dr. Locard found that people unknowingly pick up and move little amounts of hair, fibre, dust, and other trace materials all the time. These materials exchanges, according to Dr. Edmond Locard, were crucial for analysing a crime scene. This became known as the Locard's Exchange Principle, and from the early 1900s to the present, it served as the cornerstone of forensic science.

1855 - Because hair is frequently shed and quickly spread from one person to another, it is a clear source of trace evidence in many crime scenes. In 1855, forensic hair analysis was used for the first time in connection with John Browning's murder trial (2).

Even though hair has a simple structure, social interaction depends heavily on it. Hair is composed of keratin, a rigid protein. A hair follicle holds each hair firmly to the skin. The hair bulb forms the root of the hair follicle. The hair shaft is formed in the hair bulb by the division and proliferation of living cells. Blood vessels nourish the cells in the hair bulb and deliver hormones that change the structure and growth of hair according to the stage of life.

Hair is the natural part of look but additionally, hair can provide protection by, for example, preventing our scalp from being exposed to the sun's rays. Dust, perspiration, and other particles

are kept out of our eyes by eyelashes and brows. Even our nose and ear hairs function as a barrier against bacteria and other foreign items. When it's chilly outside, body hair stands up to keep the air that has been warmed by the body near to the body, acting as a warming layer of air.

1.2 DIFFERENT TYPES OF HAIR

Except for a few areas, such as the palms of our hands or the soles of our feet, our whole body is covered in hair. The body's “vellus” hairs, often known as peach fuzz, are shorter and thinner than "terminal" hairs, which are longer and thicker. Your head hair, facial hair, eyelashes, eyebrows, pubic hair, chest hair, and belly hair are all examples of terminal hairs.

Each person’s percentage of each hair type differs, and it also depends on their age and sex. Vellus hair is prevalent on children’s bodies, for example. Women have terminal hair on roughly 30% of their body's surface compared to men who have terminal hair on 90% of their body.

There are mainly three types of hair:

1.Lanugo hair: - When a foetus is inside the uterus, it is covered in soft, fine hair called lanugo (womb). While they are growing, it keeps them warm and aids in protecting them. When they are born, some infants have lanugo covering their bodies, especially if they were delivered prematurely**. (FIG 1.1)**

2. Vellus hair: - Vellus hair is a type of hair that forms on the majority of a person's body throughout childhood. It is short, thin, light-coloured, and hardly detectable**. (FIG 1.2)**

3.Terminal hair: - The thick, coarse hair that makes up your eyelashes and eyebrows and grows on your scalp is known as terminal hair. **(FIG 1.3)** Following puberty, terminal hair may also start to grow on your pubic region (abdomen), armpits, chest, and belly. About 30% of your body is covered in terminal hair when you are a girl. In persons who are born as males, it covers 90% of your body's surface.

Fig 1.1 Lanugo Hair

Fig 1.2 Vellus Hair

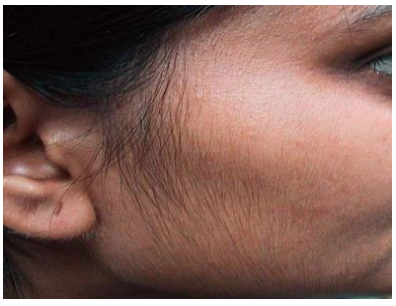


Fig 1.3 Terminal Hair

1.3 The structure of hair

Keratin, a fibrous, helicoidal protein (formed like a helix) that is a component of the skin and all of its appendages, makes up 95% of the hair (body hair, nails, etc.). Because keratin is not soluble in water when it is generated by keratinocytes, the hair is impermeable and protected. The hair contains 18 different amino acids, including arginine, proline, threonine, and leucine. Cysteine, a type of sulfurated amino acid that is particularly abundant in keratin, creates disulfide connections between molecules, giving the whole structure more rigidity and resilience. (**FIG 1.4)**

The living component of hair, the follicle, is found beneath the skin, while the completely keratinized, non-living hair shaft is found above the skin's surface. Between the dermo epidermal junction and the area of the hair bulge is the arrector pili muscle. Sebaceous glands and, in some places, apocrine glands open into the follicle above the arrector pili muscle's insertion.

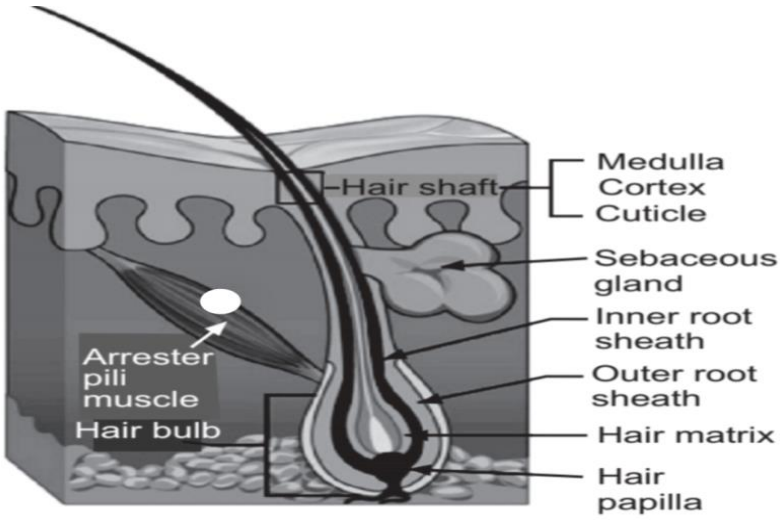


Fig 1.4 Structure of Hair

The structure of hair is composed of three primary parts:

1. Cuticle: - a delicate outer layer of protection that also serves as a vital source of nutrition for the growth of hair. Approximately 60 micrometres long and 6 micrometres wide, it is highly keratinized and made up of scale-like cells that are piled one on top of the other.

2. Medulla: - The innermost layer of the hair shaft, known as the "medulla," is made up of an amorphous, soft, greasy substance. If it is filled with air, it appears white when lit by light that is reflected off of it and black when lit by light that is transmitted through it. If the structure is filled

with mounting medium or similar clear substance, transmitted light makes it appear transparent or clear, but reflected light makes it almost undetectable.

3. Cortex: - The major component of the hair, the cortex, is made up of lengthy keratin chains that give the hair its elasticity, suppleness, and resilience. Intercellular cement, which is a lipid- and protein-rich, holds the cortex's cells together. The microfibrils, microfibrils, and protofibrils that make up each cell are organized into bundles that run parallel to the direction of the hair's length. Melanin is also present in the hair cortex. Melanin, the pigment responsible for the color of the hair, is produced by specialized cells called melanocytes. The melanocytes, which are located close to the hair bulb, inject pigments into the keratinocytes of the newly formed hair shaft. The color remains throughout the entire hair cycle, from the beginning when the hair is born to the end when it falls out.

On average, humans have 100,000 hair follicles on their scalp out of about 5 million total on their bodies (The scalp has about 130 hair follicles per square centimetres). This is equivalent to 300–500 hair shafts per square centimetre. Throughout their existence, follicles can produce roughly 20 individual hairs. 1 About 100 strands of hair fall out each day on average. Race and hair color both influence hair density. Africans have medium density and the slowest growing hair, while Asians have the lowest density and the fastest growing hair. The average growth rate and the highest hair density are found in Caucasians. Natural hair varies in density, thickness, and colour.

1.4 THE HAIR GROWTH CYCLE

About.3 to.4 millimetres per day, or 6 inches, of hair is added to the scalp each year. Unlike other mammals, humans do not exhibit seasonal or cyclical patterns in the development and shedding of their hair. At any given moment, a random sample of hairs will be in one of the three phases of growth and shedding: anagen, catagen, or telogen..

1. Anagen

The hair development cycle's anagen is the growth stage. Anagen is the hair cycle's active phase. The cells in the hair root are multiplying quickly. The club hair, which is a hair that has stopped growing or is no longer in the anagen phase, is eventually forced up the follicle and out by the newly created hair. During these phases, approximately 1 centimetres of hair develops every 28 days. During this active phase, scalp hair grows for two to six years. Because their active phase of growth is short, some people find it difficult to grow their hair over a certain length. On the other side, those with really long hair have a long active growth period.

The hair on the arms, legs, eyelashes, and brows is quite short and actively growing. The reason why the hair on the arms, legs, eyelashes, and eyebrows is so much shorter than the hair on the scalp is because it has an extremely brief active growth period, lasting only 30 to 45 days.

2. Catagen

This is transition phase. About 3% of all hairs are always in the catagen phase, which is a transitional state. This stage takes two to three weeks to finish. As growth stops, the outer root sheath shrinks and attaches to the hair root. As the name implies, this is the growth of a club hair.

3. Telogen

This is the resting phase. Between 6% and 8% of all hairs are typically in the telogen phase, which is the resting stage. This stage lasts approximately 100 days for scalp hair and longer for eyebrow, eyelid, arm, and leg hair. At this point, the club hair is fully formed and the hair follicle is totally at rest. When a hair is plucked out at this point, a solid, hard, dry, white substance will be evident at the root. Telogen hair loss often occurs in the range of 25 to 100 hairs every day.

4. Exogen

The shedding stage is now. To put it simply, the exogen phase of hair growth is a part of or an extension of the telogen stage. During the exogen phase, hair falls out of the scalp, usually with the help of washing and combing. Losing 50 to 100 hairs per day is normal during the exogenous phase. During the exogen period, which can last two to five months, new hairs are growing in the follicles as the old ones fall out.

IDENTIFICATION AND EXAMINATION OF HAIR EVIDENCE;

Humans lose 100 head hairs on average per day, and as hair is easily transferred during physical contact, it is frequently used as forensic evidence to establish connections between individuals (for example, a suspect and a victim), as well as people and a crime scene. In severe crimes like sexual assault, homicide, and aggravated assault when physical contact is likely to have taken place, such associative evidence is very helpful. Armed robberies, which are less likely to have entailed physical contact, usually entail gathering clothing or other objects that may have picked up hair that may be used to identify perpetrators.

If a hair is examined under a microscope, it can be determined whether it was cut off violently, has an illness, or has been treated artificially, like with hair colour. A tool called a comparison

microscope is used by forensic analysts to compare known hair samples and unidentified samples to determine whether they have any similarities and might have originated from the same source.

One of the most frequently conveyed trace evidences is hair. They can be a significant piece of evidence connecting people to crime sites.

Questioned hair collection:

1. Take a picture of the hair in place, along with any substrate it may have.

2. Put on a fresh pair of latex or nitrile gloves.

3. If hairs are visible, you should gather and bind them right away to reduce the possibility that they will fall out when the object is moved (see step 5 for collection and packaging of hair). The item should then be collected if it can be carried in its entirety so that the laboratory can check it for more hairs or other traces of evidence.

4. Prepare proper packaging that is big enough for the object once the hair has been collected (see step 5), and label it with your name, the case number, the exhibit number, the date, a synopsis, and additional identifying details. Place the object into the container with care.

5. The method described below should be used to harvest hairs from a substrate:

(a) To catch any hairs that are visible, carefully extract the hair from the substrate using tweezers that are clean or disposable. Be careful not to damage or crush the hair when you are removing it. Place the recovered hair on a fresh piece of paper or a Post-it® note, being careful not to wrinkle it in the fold. Because the glue holds the hairs lightly, post-it notes are helpful for gathering hairs. Place the folded paper in an envelope labeled with your name, case number, date, exhibit number, and a brief description.

(b) Vacuuming or using tape to lift items can also be used to retrieve questioned hairs from surfaces (especially if the hairs are not visible).

1) Make a tape lifter by winding the tape back on itself around the tape roll with the sticky side out in order to tape-lift an object using transparent packing or book tape. Roll the tape over the object until it is completely covered. Use a second piece of tape if the first one becomes too clogged with particles. Cut the tape off the roll and place it adhesive side down on a fresh page protector or piece of clear plastic. A properly labelled envelope or container can be used to hold the sheet protector or plastic sheet.

2) Find a filter unit that fits onto the nozzle of a vacuum hose that may be purchased from evidence collecting companies in order to suction an object. Continue vacuuming the object, then store the filter (with the trace evidence on it) in a suitable container with the required labels.

6. Use evidence tape to close the container. Date and initial the cassette.

7. Until you can take it to the lab, keep the object in a safe place, such your car or a closed evidence van.

The head and pubic hairs are frequently the only human hairs that can be matched to known hairs.Beard hairs, however, can be appropriate for comparison (check with your laboratory). It is advised to gather 25 pulled hairs and 25 combed/naturally shed hairs from different parts of the head (and beard, if present) or pubic region when gathering known hairs for comparison. Pull 25 hairs from different areas of the scalp or pubic area while wearing clean, new, unworn latex or nitrile gloves (you can even ask the suspect or person of interest to do this themselves). Place these in an evidence or pharmaceutical fold, then place the fold inside an envelope and properly mark it**.**

Most common methods of collection of hair sample are: -

1. Visual collection: On some surfaces, threads and hairs are visible to the unaided eye. The sample can be taken from the surface and placed onto a clean piece of paper that can be folded and wrapped in a paper envelope using clean forceps and paper (i.e., tracing paper).

2. Tape lifting: Trace tapes are available for gathering fibre evidence and trace hair. After covering the likely sample area with the tape, it is taken out and packaged.

3. Vacuuming: Any evidence is collected in a filtered trap that is attached to the vacuum after the suspected sample areas are vacuumed. These samples are wrapped in spotless trace paper before being sent to the lab. Vacuuming is the least preferable collection method since it increases the risk of cross-contamination if the equipment is not sufficiently cleaned between uses.

1.5 MICROSCOPY

In addition to macroscopic examinations, microscopic examinations of hair play a significant role in forensic investigations. However, using a microscope, students can examine and learn about the features of a hair fibre or strand, such as the colour, scales, and medulla pattern.

A comparison microscope, which consists of two compound light microscopes joined by an optical bridge, enables the user to study two hair samples simultaneously, one known and one unknown. The first step in the multi-phase examination process is for the analyst to determine whether the unidentified hair is made of animal or human hair

Prior to using a compound microscope, hair is often first examined under a stereo microscope (both mounted and unmounted). This is due to the fact that a stereo microscope has been demonstrated to be particularly suitable for seeing the everlasting features of hair, such as colour, shape, texture, and length. Students will be able to observe the hair structure as a strand that might appear to contain microscopic fibres or fragments on its surface using a stereo microscope. The stereo microscope will display the colour of the hair strand in addition to its shape (twisted, for example), as well as any surface debris. Students will also be able to distinguish the thickness of various strands while looking at various hair kinds.

1.6 ABNORMALITIES IN HAIR STRUCTURE:

A hair shaft defect is any structural abnormality of the hair shaft. Some hair shaft flaws are simple to spot with the naked eye, while others can need microscopic inspection (tracheoscopy). Defects in the hair shaft could lead to no obvious abnormalities of the hair, losing hair (alopecia), Hair that is rough or wavy, Uncombable hair occurs when hair bundles are disorganized and grow in all directions without being able to be combed into order, reduced tensile strength in the hair shafts is a sign of fragile hair. Determine if the hair is abnormally fragile by gently pulling on numerous hair shafts. Defects in the hair shaft may result from external trauma or a genetic anomaly. Hair shaft damage from the outside. The most frequent reason for increased hair fragility is recurrent physical damage. It could be because of: a lot of grooming, braiding resistance, or a tight ponytail, heat coming from a hairdryer chemical damage could be brought on by lotions for perming, straighteners, dyes, and also chemical treatments.

Numerous medications have been shown to disrupt the hair cycle, leading to hair loss. Anagen follicles can be affected by drugs in one of two ways: I by precipitating a sudden termination of mitotic activity in rapidly dividing hair matrix cells (anagen effluvium); or (ii) by putting the follicles into an early state of rest (telogen effluvium). When medicine is administered for anagen effluvium, hair loss often starts within days to weeks, however, when a drug is administered for telogen effluvium, hair loss normally starts 2 to 4 months following the start of treatment. An important side effect of antineoplastic drugs, which causes acute damage to rapidly proliferating hair matrix cells, is anagen effluvium. Anticoagulants, retinol (vitamin A) and its derivatives,

interferons, and antihyperlipidemic medications are only a few of the medications that may cause telogen effluvium. (4) After discontinuing treatment, drug-induced hair loss is typically reversible. Alopecia is a condition that is influenced by both genetic predisposition and the medicine being used. In patients who receive the recommended dosages, some medications cause hair loss in the majority of cases, while other medications only sometimes cause aberrant hair growth. Drug use may be connected to both hirsutism and hypertrichosis. The hair loss in telogen effluvium, however, starts 2 to 4 months after the start of treatment. Antineoplastic drugs, which cause acute damage to rapidly dividing hair matrix cells, are known to produce anagen effluvium. Numerous medications, including anticoagulants, retinol (vitamin A) and its derivatives, interferons, and antihyperlipidemic medications, may result in telogen effluvium. Usually, drug-induced hair loss can be reversed if treatment is stopped. Alopecia prevalence and severity are influenced by the medication as well as genetic predisposition. When given in the proper dosages, some medications cause hair loss in the majority of patients, whilst other medications only sometimes cause aberrant hair growth. Drug use may be connected to hypertrichosis and hirsutism. The most prevalent drugs to blame for hirsutism development.

The texture of hair can alter due to several factors, both natural and artificial. These are the primary explanations:

Hormone: Some women's hair grows thicker, fuller, and glossier during pregnancy as a result of elevated hormone levels Unfortunately, not everyone experiences that kind of impact. There are more reasons why hormones can alter hair structure. Hair texture changes, brittleness, and coarseness can all be caused by thyroid issues. Hair can be impacted by insulin and androgen alterations.

Medicine: Hair is known to be impacted by medication, particularly chemotherapy. Chemotherapy can also impact hair since it targets cells that proliferate quickly, which usually results in hair loss. However, when their hair grew back following therapy, some cancer patients saw a significant change in texture. Beta-blockers, antidepressants, blood pressure medications, acne treatments, and painkillers are additional medications that can impact hair and hair structure. On the good side, hair typically returns to its original form when you stop taking such kinds of drugs.

Diet: Changes in food can have an impact on how strong, brittle, healthy, dry, etc. hair is, even though they typically won't make hair curly or straight. Healtcriteriare is aided by nutrients like iron, zinc, biotin, vitamin E, and omega fatty acids. Salmon, spinach, eggs, avocado, and other foods are healthy for your hair.

The antidepressant can also cause hair abnormalities. Telogen effluvium is the term used to describe the sort of hair loss that antidepressants typically induce. Telogen effluvium happens when your body is under stress, whether it be from childbirth, an illness, surgery, mental stress, inadequate nutrition, or medication. This stress causes your hair follicles to enter the resting stage (the telogen phase) earlier than they normally would. There is diffuse hair loss over the entire scalp as a result of the increased number of hair follicles in this resting period.

Chemical Treatments: Altering the texture of hair with color or bleach. One of the types of medication is called chemotherapy. That causes serious issues in hair. This treatment is taken by patients who have cancer.When aberrant cells in a portion of the body divide uncontrollably, it can lead to cancer. Treatment options include chemotherapy, radiation therapy, and surgery. Strong chemicals are used in chemotherapy, a medical treatment, to destroy your body's quickly growing cells. Because cancer cells divide and proliferate far more fast than typical body cells, chemotherapy is the most common treatment for cancer. Chemotherapy medications come in a wide variety. Chemotherapy drugs can be used alone or in combination to treat a number of cancers. Cancer patients may receive chemotherapy in a number of circumstances, such as:

To treat cancer without additional therapies. Chemotherapy may be the primary or sole treatment for cancer.

To eradicate cancer cells that remain undetected following previous treatments. After previous treatments, including surgery, chemotherapy can be used to eliminate any cancer cells that may still be present in the body.

To get you ready for additional treatments. A tumour can be reduced by chemotherapy so that additional therapies, such as radiation and surgery, are feasible. Neo adjuvant treatment is the term used by physicians.

To reduce symptoms and indications.Chemotherapy may help alleviate the signs and symptoms of cancer by killing some cancer cells. Physicians use the term palliative chemotherapy. Not just on the scalp, but all over your body as well, chemotherapy may result in hair loss. Your pubic, armpit, arm, and other body hair might also lose its hair from time to time. Certain chemotherapy medications are more prone than others to result in hair loss, and varying doses can result in anything from mild thinning to total baldness. Chemical treatments such as straightening and dying also cause shaft abnormalities. For treating frizzy hair, chemical straightening becomes more and more common. The cortex of the hair fiber can be penetrated by keratin in hair care products,

enhancing the mechanical qualities of damaged fibers and encouraging a surface coating that water diffusion through the hair fibers is prevented or reduced.

In chemotherapy patients, after the chemotherapy treatment, the hair shows different textures and the hair becomes finer when compared to before. (5) After chemotherapy the hair becomes curlier in texture than the hair had before. It also shows different color too. It then maybe a darker or lighter shade than the original hair. Chemotherapy is a type of chemical drug treatment designed to kill the body's rapidly proliferating cells. It is usually used to treat cancer because cancer cells proliferate and develop more quickly than other cells.So that affects the hair and it makes the hair thinner, more delicate, e, and the color difference.

1.7 FORENSIC SIGNIFICANCE OF HAIR

Hair is a type of class evidence that so many signs in forensic investigation. Considering that it can link a victim to a crime scene. Hair can be transferred from one person to another, indirectly, or directly. An example of an indirect transfer is when someone sheds hairs into their clothes, then spreads those hairs to another person. A lot of information can be gleaned from crime scene hairs by forensic scientists. The details include the part of the body the hair originated from, the person's race, gender, and whether the hair was shed naturally or was plucked off against one's will. Hair evidence can provide details about a person's race as well as whether or not the hair has had chemical treatment, been cut or removed in a certain way, or been chemically treated. Hair evidence, together with genetic data like blood type or DNA, can also reveal where on the body something was located. Additionally, hair testing can help can help figure either the subject was poisoned or under the influence of drugs. Hair contains many substances that are kept since there is no active metabolism there, making it a window into a person's history of drug usage.

Numerous locations on a person's body can yield hair evidence, albeit certain hairs are more significant than others. Hair from the head and vaginal area produces the most evidence due to its unique properties. Even though a person can be recognized at a crime scene by their facial, chest, and underarm hairs, forensic experts rarely examine them. The victim's age, sex, gender, and other details must be known if a certain crime scene has occurred too to gather important evidence from the scene. The investigation process and other factors would make it clear whether the victim is a child, adult, middle-aged person, or old person.

Finding biological evidence, such as hair, is useful in a criminal investigation because it can be used to define the breadth of the crime scene, link a suspect to a weapon or the crime scene, support witness testimony, or even connect various crime scene locations.

2. MATERIALS AND METHODOLOGY

2.1 MOTIVATION

The researcher started this project because hair samples are thought of as a tool for identifying specific people during a crime scene investigation. Additionally, hair samples are admissible as evidence in court. In forensic investigations, hair is an essential piece of evidence. Because hairs can be transferred by physical touch, their presence can be used to connect a suspect to a victim or a suspect/victim to a crime scene. The types of hair detected, together with their quality and quantity, all have an impact on how valuable they are as evidence in a criminal case. The general morphology of a hair helps identify the region of the body from where it originates. Length, form, size, color, stiffness, curliness, and microscopic appearance all contribute to body area. Identification of bodily regions is also influenced by pigmentation and medullar appearance. After doing chemical treatments on hair, there are certain changes in hair structure. Like that, after the treatment of chemotherapy there is also chance in changes in the structure of hair. If identify any change in the structure hair then it is easy to identify that the hair is from a chemotherapy patient. This research study and findings can be helpful for the law enforcement in crime and criminal investigation.

2.2 NEED OF THE STUDY

Hair is one of the most significant evidence types in forensic investigations. It is essential in legal and forensic systems. The literature review demonstrates that all individuals have a diversity of morphological features and that each human has unique hair properties. Unique medullary patterns, such as thick or thin cuticles, can be seen in some people. The study's main objective is to describe and evaluate a hair sample by looking at the morphological variances found in samples taken from various groups using the following criteriaa

2.3 GEOGRAPHICAL COVERAGE:

The study area is Alappuzha, it is the smallest district in Kerala, India. Because of its vast system of canals and waterways, Alappuzha is known as the "Venice of the East" and is a location of exceptional natural beauty. Alappuzha's name, which translates to "the land between the sea and the network of rivers pouring into it," was given to the region based on its geographic location and natural qualities. Kerala's Alleppey district is its tiniest. Location of Alappuzha: 9.54°N 76.40°E The typical altitude is 1 metre (3.3 ft) Alappuzha has a total area of 1,414 square kilometres (546 square miles) and is bordered by Vembanad Lake, which has an area of 2,195 square kilometres

(847 square miles), where six major rivers converge to form the district's 80 km of coastline. The 82 km of shoreline in the region is uninterrupted.Alappuzha district has 2,127,789 residents, which is nearly equivalent to the population of Namibi or the US state of New Mexico, according to the 2011 census. This places it at position 216 in India (out of a total of 640). [Reference needed] 1,504 people live in the district for every square kilometre (3,900 for every square mile). Its population grew by 0.88% between 2001 and 2011 as a whole. Alappuzha has a literacy rate of 95.72 percent and a sex ratio of 1100 females for every 1000 males. The population is made up of 9.46% Scheduled Castes and 0.31% Scheduled Tribes, respectively.

2.4 RESEARCH DESIGN

Human hair samples are one of the primary sources used in the forensic analysis of crime scenes. These samples frequently offer important information that helps in the identification of a suspect or victim. The purpose of the current study is to analyze the morphology of hair in chemotherapy patients. The sample is mainly collected from persons who have received the first and second stages of chemotherapy treatment. Using the medulla, medulla pattern, and cuticle thickness, among other parameters, the morphology of hair is meant to be investigated. A total of 97 samples were acquired for this study.

2.5 UNIVERSE, SAMPLE SIZE AND SAMPLING TECHNIQUES.

A total of 97 pieces of hair were gathered.47 hair samples were collected from first-stage chemotherapy patients and 50 hair samples is collected from second-stage chemotherapy patients respectively. Nail Polish process and mounting technique are used.

2.6 TOOLS OF DATA COLLECTION

In this study the researcher has taken experimental method and observatory method. Here a total of 97 samples out of which 47 were taken from first stage chemotherapy patients and 50 samples from second stage chemotherapy patients to find cuticle and medullary pattern. For collecting the sample materials use are tweezers, zip lock bags, sanitizer, scissors, microscope (10x and 40x), glycerine, glass slides, transparent nail polish. Graphs, tables and diagrams are used whenever necessary.

2.7 METHODOLOGY

A total of 97 individual head hair samples, 47 head hair samples (25 males and 22 females) from first-stage chemotherapy patients, and 50 (27males and 23females) from second-stage chemotherapy patients were collected using the methods described below. The participants were

instructed to sit comfortably while collecting hair pieces with hair tweezers from various sides of the head and packing each piece individually in a zip bag. Each time you remove hair with a tweezer, clean it with alcohol. Individuals name, age, gender were also noted. Each person's gathered hair was mounted on a glass slide by adding one drop of glycerine and covering the sample with a cover slip. Each hair strand is laid out on a glass slide for analysis, and transparent nail polish was applied on the top. At 10x and 40x magnification under a compound microscope, all observations were recorded.

2.8 DATA ANALYSIS

For the present study ninety-seven samples collected from Chemotherapy patients of different age groups. Fourty seven hair sample is from first phase chemotherapy patients and 50 from second phase chemotherapy patients and the collection procedure is described above. The following measurements were looked at for each hair sample:

(a)Type of medulla: - Each hair was examined to determine whether it included a medulla, and if so, the medulla was classified as one of the following:

1. Continuous
2. Discontinuous
3. Piecemeal
4. No pattern

(b)Cuticle thickness: - The cuticle's relative thickness is defined as the distance between its outer margin and the cortex (Forensic human hair examination guidelines, 2005). This is typically categorised as Thick, Medium, or Thin.

(c) Cuticle margin: - At the inner cuticle margin, the cuticle and cortex seem to be separated by a border (Nataraja Moorthy T et. al, 2015). It contains:

a) Distinct

b) Indistinct

c) Varied

If there is a cuticle, take a note of its outside boundary. Among them are:

a) Flat

b) Smooth

c) Cracked and

d) Serrated

3. DATA ANALYSIS & INTERPRETATION

According to morphological analysis, the study of hair is crucial to forensic science because hairs can be transferred through physical contact and their existence might link a suspect to a victim or a crime scene. In the current study, it was discovered that different age groups of chemotherapy patients had distinct hair cuticle patterns and medulla structures.

AGE	MEDULLA				CUTICLE	
	CONTINUOUS	**DISCONTINUOUS**	**FRAGMENTED**	**ABSENT**	**THIN**	**THICK**
40-50 yrs	14(70%)	03(15%)	03(3%)	0	04(20%)	16(80%)
50-60 yrs	05 (55.56%)	04(54.44%)	0	0	04(44.44%)	05(55.55%
60-70yrs	06(85.72%)	0	01(14.28%)	0	0	07(100%)
70-80 yrs	11(100%)	0	0	0	08(72.72%)	03(27.27%
TOTAL	36	07	04	0	16	31

. TABLE 3.1 MEDULLA AND CUTICLE OF FIRST STAGE CHEMOTHERAPY PATIENT HAIR.

In table 3.1 showing the medulla structure and cuticle of first chemotherapy patient hair. In this out of 20 sample from the age group 40-50, 14 shows continuous medulla,3 shows discontinuous medulla, 3 show fragmented medulla is seen. From 50-60, 5 shows continuous medulla,4 discontinuous, no fragmented and all hair have medulla. From 60-70, 6 continuous, no discontinuous, one fragment and all sample have medulla in that age group.in age group 70-80, 11

samples are collected and all the 11 samples are continuous. Total sample of 47, 36 are continuous, 7discontinuous,4 fragmented.

In first stage chemotherapy patients of 40-50 age group 14 sample were analyzed and it contains 4 hair samples with thin cuticle and 16 samples have thick cuticle. In case of 50-60 years people, out of 9 samples 4 analysed as thin cuticle and 5 thick medulla. In age group of 60-70 years, the total 7 samples are thick. From age group 70-80 years, 8 shows thin cuticle and 3 shows thick cuticle.

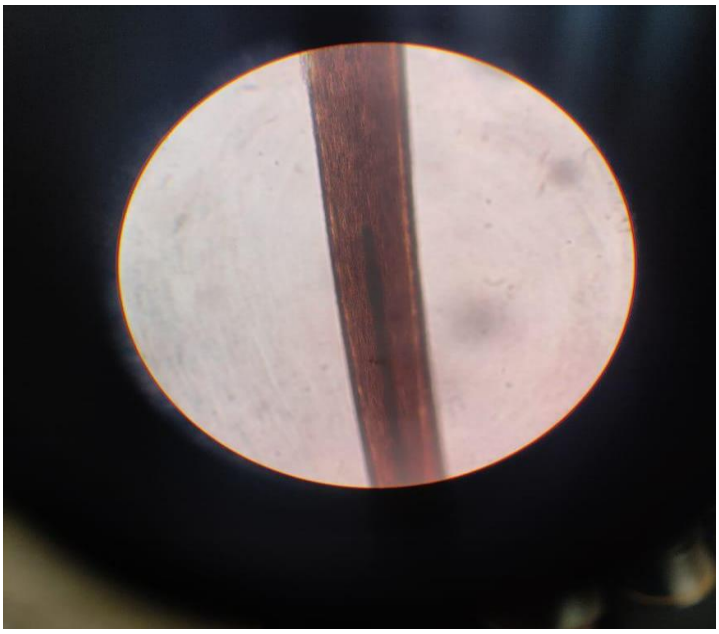


Fig 3.1 Thick medulla (first stage chemotherapy patient hair)

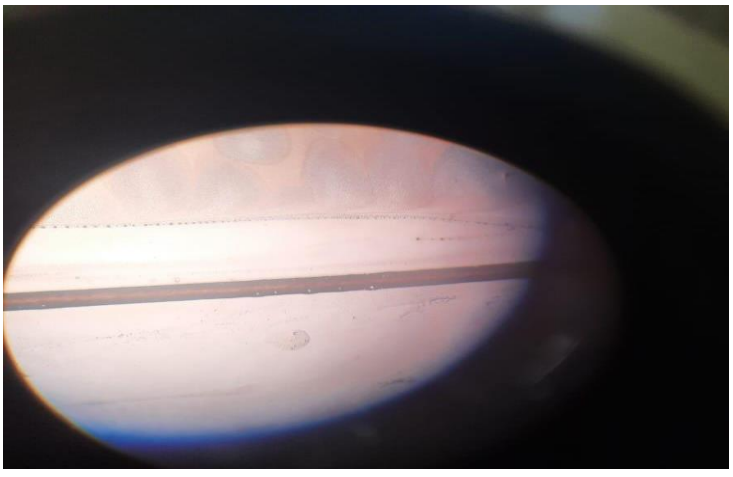


Fig 3.2 Thin Medulla

According to the analysis found that the medulla is present in all the samples. ie, in all 47 samples of first-stage chemotherapy patients receiving first-stage chemotherapy exhibit continuous, discontinuous, or fragmented medulla in all 47 samples. The continuous medullary pattern is common in all age categories. 20 samples were collected from the age category 40-50, in that 14 samples are having continuous medulla, 3 discontinuous and 3 fragmented. From 50-60, total 9 samples were collected and 5 contains continuous medulla and 4 discontinuous medullary patterns. In 70-80, total of 11 are collected and majority of it contains white hairs. All the 11 samples have continuous medulla.

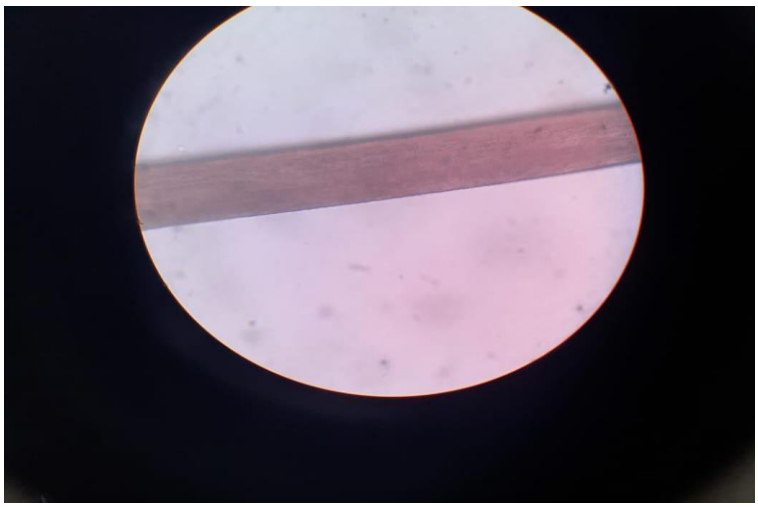


Fig. 3.3 Discontinuous medulla

Similar to this, it was discovered during the cuticle study that the samples indicated above also exhibit a difference in the cuticle pattern. In all age groups, both thick and thin cuticle patterns can be seen. In case of age categories 40-50; 50-60; and 60-70 the most common is thick cuticle pattern but in case of age group 70-80 the common cuticle pattern is thin. Thus, we can say that the common cuticle pattern is thick in hair of young first stage chemotherapy patients and Thin cuticle pattern is common in old aged people of first stage chemotherapy patients category.

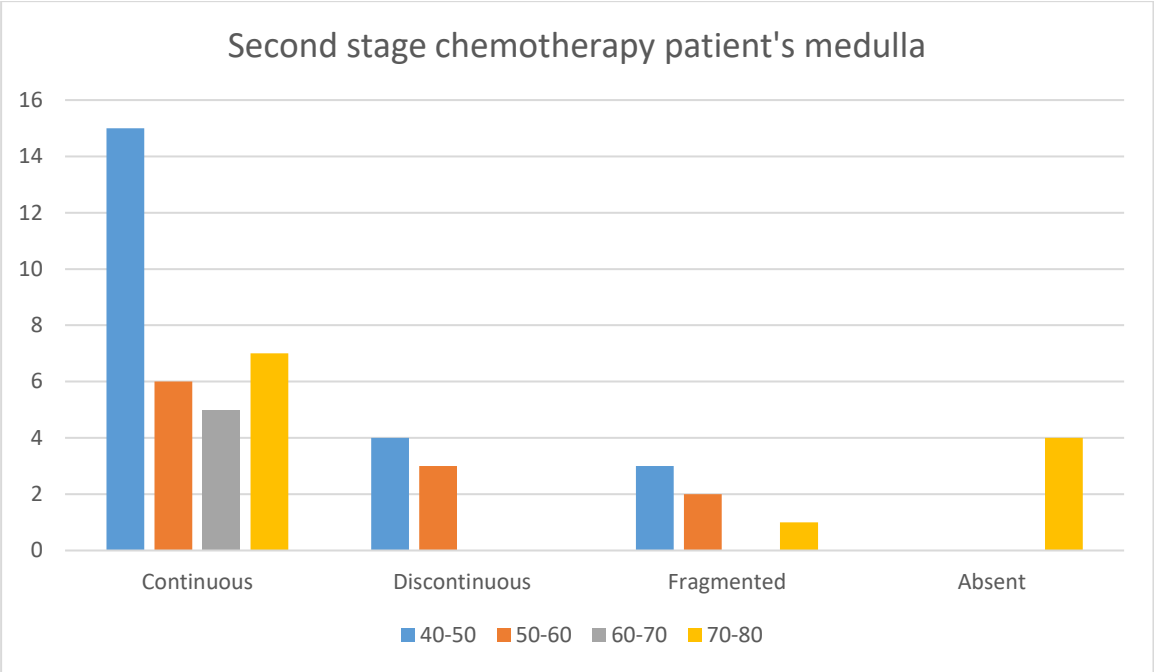
AGE	MEDULLA				CUTICLE	
	CONTINUOUS	DISCONTINUOUS	FRAGMENTAD	ABSENT	THIN	THICK
40-50 yrs	15(68.18%)	04(18.18%)	03(13.63%)	0	16(72.72 %)	06(27.27 %)

50-60 yrs	06(54.54%)	02(27.27%)	02(18.18%)	0	06(54.54 %)	05(45.45 %)
60-70 yrs	05(83.33%)	01(16.66%)	0	0	02(33.33 %)	04(66.66 %)
70-80 yrs	07(58.33%)	0	01(8.33%)	04(33.33 %)	08(72.72 %)	03(27.27 %)
TOTAL	33	07	06	04	32	18

TABLE 3.2 MEDULLA AND CUTICLE OF SECOND STAGE CHEMOTHERAPY PATIENTS.

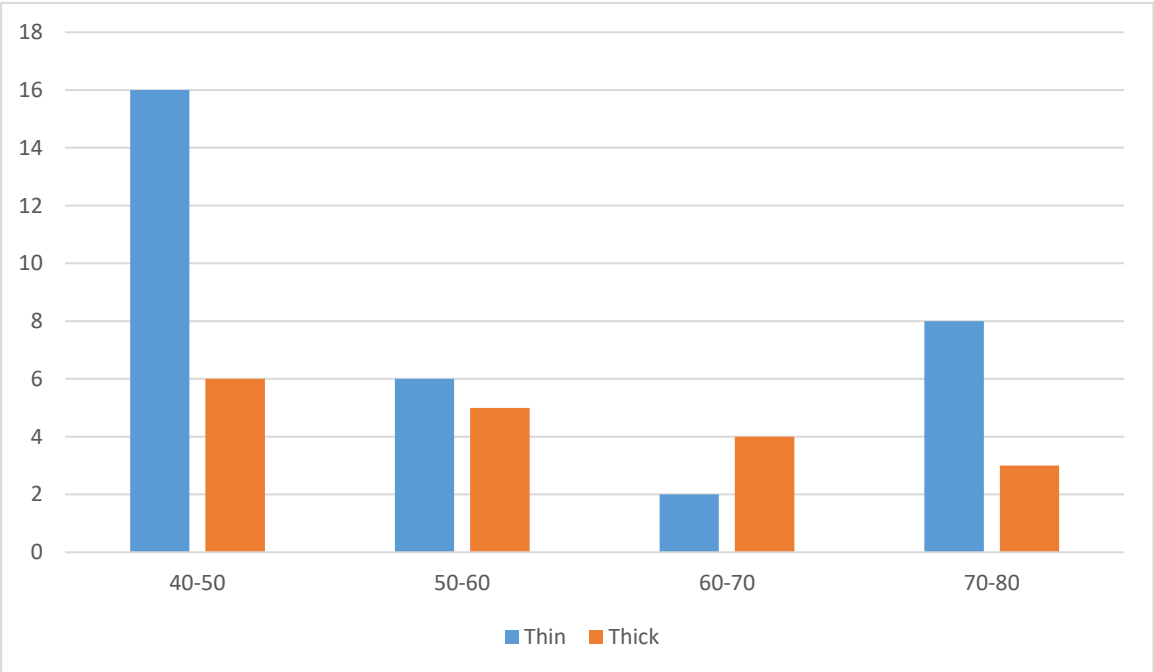
Table 3.2 showing the medulla and cuticle of second stage chemotherapy patients from total sample of 50 from different age groups. From the age group 40-50,22 samples are analysed. out of that 15 shows continuous medulla, 4 shows discontinuous and 3 fragmented. From the age 50 - 60 years 11samples are analysed from that 6 samples are seen as continuous, 2 discontinuous and 2 fragmented. In case of age group from 60-70, 5 samples are showing continuous and only 1 sample showed discontinuous medulla. From sample 70-80 years 7 shows continuous, one fragmented and 4 absent. Only this age show absent medulla.

The cuticle structure in age group 40-50 years having thin medulla in 16 samples and 6 samples shows thick medulla. From age group 50-60 years, the sample 6 contains thin and 5 contains thick medulla. From 60-70, out of 7 samples 2 shows thin cuticle and 4 contains thick cuticle. From 70 -80, 8 samples are thin and 3 samples shows thick cuticle.



GRAPH 3.1 SECOND STAGE CHEMOTHERAPY PATIENTS' MEDULLA.

In this graph 3.1 shows the continuous, discontinuous, fragmented and absent medulla of second stage chemotherapy patients.



GRAPH 3.2 SECOND STAGE CHEMOTHERAPY PATIENT'S CUTICLE

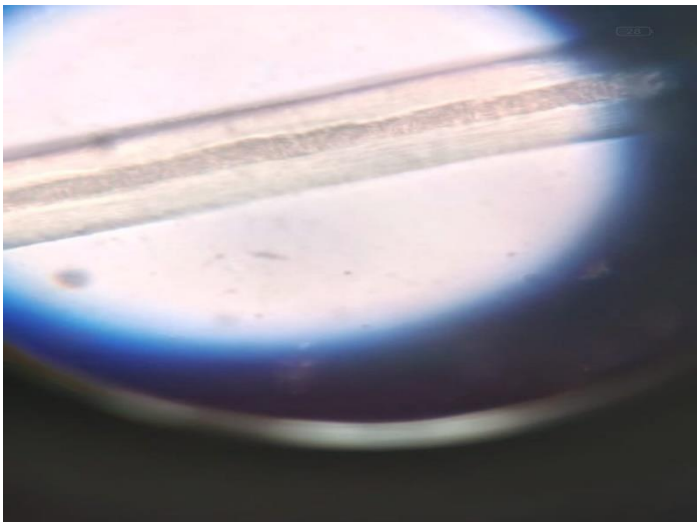


FIG 3.4 THICK MEDULLA

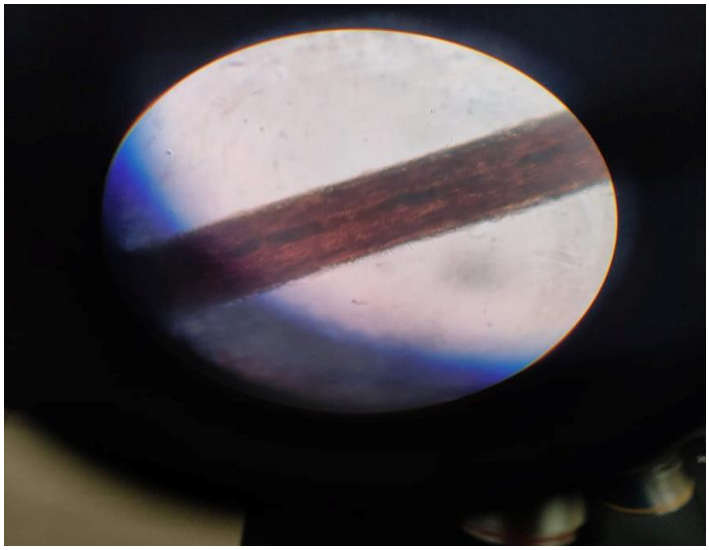


FIG 3.5 THICK CUTICLE

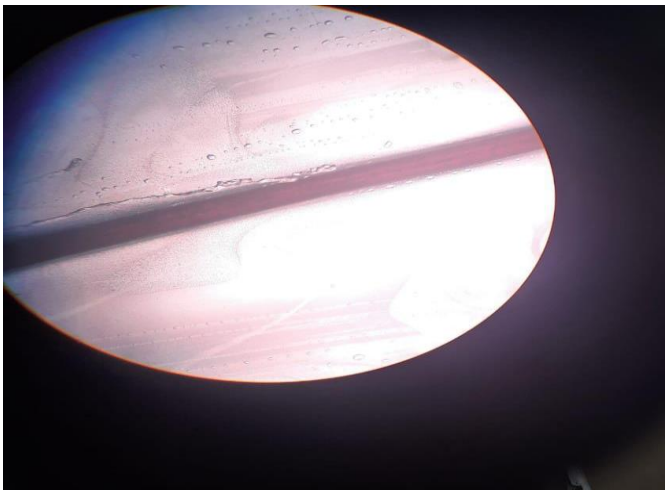


FIG 3.6 THIN CUTICLE

The continuous medulla is common in all the age groups. In age category 40-50, 4 samples show Discontinuous medulla, 3 fragmented medulla and 15 continuous in total of 22 samples. The medulla has a fragmented appearance in 40-50, 50-60, and 60-70.From 70-80 age categories doesn't show fragmented medulla in total sample of 11. Thus, we can say that in second stage of chemotherapy treatment the age category of person from 30-70 most commonly found "continuous medullary pattern".

The variance in the Cuticle pattern was discovered during the Cuticle analysis process to be present in the samples described above as well. With minor variations, the Thin Cuticle pattern can be seen in all age groups, but the Thick Cuticle form is quite rare. Age groups 40 to 80 frequently display a thin cuticle pattern. Thus, we can state that the "Thin Cuticle pattern" was the most frequently discovered Cuticle pattern in individuals receiving second-stage chemotherapy.

4. RESULT

During the examination that the Medulla was present in every single one of them. Most frequently seen in humans was a continuous medullary pattern. By categorising first stage chemotherapy patients into various age groups, the hair was analysed that a Continuous Medullary pattern appeared in all the age groups. Fragmented pattern is also seen in samples. In this out of 20 sample from the age group 40-50, 14 shows continuous medulla,3 shows discontinuous medulla, 3 show fragmented medulla is seen. From 50-60, 5 shows continuous medulla,4 discontinuous, no fragmented and all hair have medulla. From 60-70, 6 continuous, no discontinuous, one fragment and all sample have medulla in that age group.in age group 70-80, 11 samples are collected and all the 11 samples are continuous. Total sample of 47, 36 are continuous, 7discontinuous,4 fragmented. The Discontinuous pattern, however, was not as prevalent across all age groups. 'Continuous Medullary pattern was found in first stage chemotherapy patients,' it was validated from the final observation. It was discovered by cuticle analysis of hair from first-stage chemotherapy patients that the variance in cuticle pattern is also clearly present in the samples listed above. With minor differences, both thick and thin cuticle patterns can be seen throughout all age groups. In first stage chemotherapy patients of 40-50 age group 14 sample were analysed and it contains 4 hair samples with thin cuticle and 16 samples have thick cuticle. In case of 50-60 years people, out of 9 samples 4 analysed as thin cuticle and 5 thick medulla. In age group of 60-70 years, the total 7 samples are thick. From age group 70-80 years, 8 shows thin cuticle and 3 shows thick cuticle. Thick cuticle pattern observed in first-stage chemotherapy patients was corroborated by the final observation.

It became evident during the analysis procedure that the second stage of chemotherapy patients into various age groups it is also found that Continuous Medullary pattern appeared in all age groups. Not all age groups displayed a discontinuous pattern. As opposed to fragmented patterns, discontinuous patterns higher. the medulla and cuticle of second stage chemotherapy patients from total sample of 50 from different age groups. From the age group 40-50,22 samples are analysed. out of those 15 shows continuous medulla, 4 shows discontinuous and 3 fragmented. From the age 50 -60 years 11samples are analysed from that 6 samples are seen as continuous, 2 discontinuous and 2 fragmented. In case of age group from 60-70, 5 samples are showing continuous and only 1 sample showed discontinuous medulla. From sample 70-80 years 7 shows continuous, one fragmented and 4 absent. Only this age shows absent medulla. According to the observation, "Continuous Medullary pattern was detected in second phase chemotherapy patient's hair." Through the cuticle study of the aforementioned category, a greater prevalence of the thin

cuticle pattern may be seen across all age groups. The cuticle structure in age group 40-50 years having thin medulla in 16 samples and 6 samples shows thick medulla. From age group 50-60 years, the sample 6 contains thin and 5 contains thick medulla. From 60-70, out of 7 samples 2 shows thin cuticle and 4 contains thick cuticle. From 70 -80, 8 samples are thin and 3 samples shows thick cuticle. According to the final finding, "Thin Cuticle pattern was detected in second stage chemotherapy patients' hair."

5. CONCLUSION

The study about the chemotherapy patient's hair gives a clear conclusion about the medulla structure and cuticle thickness. Here two stages of chemotherapy patient's hair is collected. First-stage chemotherapy patients were divided into different age groups, and when the hair was analysed, it was discovered that a Continuous Medullary pattern was present in every age group. Additionally, samples display a fragmented pattern. However, the Discontinuous pattern was less common across all age groups. From the final observation, the statement "Continuous Medullary pattern was discovered in first stage chemotherapy patients" was confirmed. The variation in cuticle pattern was found to be evident in the samples mentioned above by cuticle analysis of hair from first-stage chemotherapy patients. All age groups exhibit both thick and thin cuticle patterns, with very small variations. The final observation confirmed the thick cuticle pattern seen in first-stage chemotherapy patients. The patients undergoing second-stage chemotherapy into different age groups additionally, it was discovered that all age groups displayed the Continuous Medullary pattern. Not every age group showed a discontinuous pattern. Discontinuous patterns are better than fragmented ones. "Continuous Medullary pattern was identified in second phase chemotherapy patients' hair," the finding states. A greater prevalence of the thin cuticle pattern may be noticed across all age groups, according to the cuticle study of the aforementioned category. "Thin Cuticle pattern was identified in second stage chemotherapy patient's hair," the final conclusion stated.

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