NAILS AS BIOMARKER FOR HEAVY METAL DETECTION

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Abstract:The increasing exposure of heavy metals is a serious concern. This exposure is sometimes occupationally or may be due to dietary habits.Increased metal concentration leads to disorders in body. To study the effect of heavy metals on body, it is very important to use a biomarker to diagnose the body. There are so many biomarkers used by a researcher, like Blood, Urine, Hair, Nails, Teeth, and Bones etc. For choosing a biomarker we have to keep some important points in mind. This review is focused on using Nail as biomarker for studying heavy metal concentration in human beings. Nails are keratinous protein structure, which can be used as reliable biomarker for study of heavy metal concentration in body.

Keywords:**Heavy metals; Nails; Biomarker**

I.   INTRODUCTION

In last ten years heavy metals concentration and its increasing role in environmental contamination draws researchers attention towards itself. The increased metal contamination in our environment is due to industrialization, urbanization and use of fertilizers and pesticides. Due to this, there is increased metal content in the population which got continuously exposed to such environment.(Sisodia*et al*).The excess or deficiency of trace elements may cause chronic diseases including cancer, cardiovascular diseases and diabetes (Ka He). Nails and hair are metabolic end products that have heavy metal content incorporated in them from their growth process(Rashed*et al*). In protein structures like nails and hair trace elements are integrated easily as they have complex chemical nature. These are sulphur containing amino acids and fibrous proteins. (Tamas*et al*, mohmand*et al*). The analysis of biomarkers for analysis of trace elements is necessary as it gives a detail account of dietary and non-dietary exposure. The biomarkers which are commonly used are blood, hair, nail and urine samples. For some cases even bone samples are also used for detection of elements. (Ka He).In dead tissues like hair and nails, heavy metals are incorporated in them during growth process; therefore nail determination for heavy metal analysis may be able to provide reliable results. (Sisodia*et al*).

Why Nails as Biomarker

Small amounts of certain trace elements is essential for body, but after crossing the permissible limit they become toxic and may produce adverse impact on body.(Sisodia*et al*). Human hair and Nails are considered as attractive sample materials as they are easy to collect, store and transport unlike other body fluids which gets contaminated easily in absence of external conditions (Abdulrehman*et al*).These are metabolic end products that have heavy metal content incorporated in them from their growth process. (Rashed*et al*).Nails have high amount of fibrous proteins and these contain keratin as cystein Residues. In protein structures like nails and hair trace elements are integrated easily as they have complex chemical nature. These are sulphur containing amino acids and fibrous proteins. (Tamas*et al*, mohmand*et al*). On nail root there is always high influence of cell health status, as their growth takes time. The growth of nails is slow i.e. 1.2 mm per week for finger nails and 30-50% slower for toe nails. Toe nails can provide even a better analysis of heavy metals than finger nails as they take a longer duration to grow hence more exposure. These are like excretory products, which shows trace metal contents and reflect mineral metabolism in body (Abdulrehman*et al*).

II.   STRENGTHS FOR USING NAILS AS BIOMARKER FOR DETECTION OF HEAVY METALS

There are some advantages and disadvantages for using nail as Biomarker. Some advantages for using nails as biomarker are:

1) Nails are keratin rich proteins and incorporation of trace elements and minerals is quite high, so gives proper information without much problem to the donor.

2) Nails show long term intake and exposure in a single specimen.

3) Nails specimen is easy to collect, to store and to transport. This can be easily collected with the help of a stainless nail cutter and stored in a plastic zip lock bag. For transportation they don't require any chemical and other special

condition for preserving the sample. They can be easily transported in a box with coding and description on the Plastic bags as well as Box.

4) Collection, storage and shipping of Nails samples are always cost effective, making it much cheaper than other biomarkers.

III. LIMITATIONS

There are many limitations in using nails sample as the biomarker. Some of these are:

1) For some elements, response of nails as biomarkers is not well characterized. But, still some useful information can be extracted for these trace elements from nails.

2) Nails are usually cut down and hands are washed after a fix time due to hygiene practices, is also a limitation, but this can be sorted out as toenails take time to grow as well as they are not frequently washed.

3) Nails can become easily contaminated with nail polishes and some medications. These also can get contaminated with nail cutters used for taking samples. But we can overcome this limitation by using polar and non polar solvents as well as by using intense cleaning.

4) Sometimes nail specimens are collected in a very small amount, which is less then detection limit. For dealing with this limit, it is always advisable to collect more than required sample size.

IV. COLLECTION AND STORAGE

Collection: For collection, participants should be asked in advance not to cut their nails for two weeks or longer. Nails can be collected with the help of stainless nail cutter. Preferably toenails are collected for analysis.

Storage: After cutting the nails, these can be stored in plastic zip lock bag, with proper coding on them with permanent marker. It is noted that the nails are stored at room temperature under dry conditions until further analysis. Nails samples can be taken anywhere.

A proper questionnaire which includes age, gender, dietary habits, medication and working area is written. It will help in further data analysis. (Ka He)

V. DISCUSSION

Heavy metals occur naturally, as they are found in the earth's crust. Low levels of essential elements may cause deficiency diseases, metabolic disturbances and physiological disorders. (Abdulrehman*et al*). Nickel (Ni), Chromium (Cr) and Cobalt (Co) are essential elements, but required only in trace amounts, in high amount they may cause some serious problem to human body. (Nordberg *et al*, Nowak *et al*, Kuangfei*et al*, Rodushkin*et al*, Massadeh*et al*, Abdulrehman*et al*, Bukhari*et al*, Awadeen*et al*). Increased metal contamination in our environment is due to so many factors. Heavy metal contamination can occur from anthropogenic activities like smelting operations and mining and also from use of products having concentration of metal compound in them. Industry use of such products can also result in human population exposure. (Tchounwou*et al*). These may include urbanization, Industrialization, mining operation, increase use of vehicles and used of fertilizers and pesticides in high amount. (Mehra and Juneja).Poisoning from metals can be describes as "Silent epidemic" (Mielke*et al*). Undiagnosed cases are very high in the case of heavy metals toxicity. (Were et al). Some people are exposed and affected to it directly while some other are not. These can be categorized as high risk and low risk population. (Mehra and Juneja). Jobs related risk factors are always important as they sometime include chemical, physical and psychological factors. (Jacobsen *et al,* Wiltshire *et al*, Awadeen*et al*).As the trace elements in higher amount may cause harm to human body, it is necessary to determine the trace element content in body by using a biomarker. (Shen*et al*)The heavy metals get accumulated in Blood, Urine, Hair, Nails and Teeth. As Blood and urine gives only recent exposure, Hair and Nails can be used as biomarker as they provide a continuous record of trace elements. (Mehra and juneja).As hair and nails contain keratin, they play important role in diagnosis of drug exposure. They are able to accumulate and retain drugs which were exposed to body in past. (Shen*et al*)These can be used as biomarkers for detection as they show significant levels of elements as that of blood. (Nowak *et al*). Due to personal habits and religious customs, sometimes it is not possible to take hair sample for detection so nail as biomarker play an important role (Prags*tet al*, Engelhart*et al*, Shen*et al*)

It is very important to understand strength and weakness of measurement for trace element analysis as no single source of measurement is considered best for detection of trace elements. Human nails are proteins, which are rich in keratin. Incorporation of trace elements in nails is done by dietary intakes as well as exposure to trace elements. For e.g. Surma or kajal or kohl is used as eye cosmetic product. In South Asia it is widely used by women and children of different communities. It is high source of Lead, which ultimately leads to high amount of Lead in body (Ikegami *et al*). Nail samples can be stored for a long time. The time integrated measure of trace elements is shown in nails i.e. it shows the body intake of elements in a particular time. Toenails show a long exposure as they have longer growth rate. But sometimes nail growth rate depends on age, gender, metabolic rate and health condition. It also depends on Nail biting habit or Onychophagia. When a nail is formed, it comes out from the nail bed. Nails represent exposure and dietary intake of trace elements and body nutritional status from past few months or roughly a year (Ka He). Toenails can be used as biomarkers as these are non invasive, easy to collect and store and unlike hair samples less

external contamination is there. (Slotnick*et al*). Toenails are usually not on the receiving end for environmental contaminants. Moreover they get less contaminant from hair treatments, medication and shampooing. For removing of nail polishes there are chemicals available in laboratories and these chemicals usually don't affect the concentration of trace elements. Polar and non polar solvents are used for cleaning protocols. Toenails can be considered as reliable biomarker for the detection of trace elements in Body. (Garland *et al*, Krogh *et al*, Longnecker*et al*, Vinceti*et al*, Ka He, Rashed*et al*)

VI. CONCLUSION

Some studies show the analysis of toenails for detection of heavy metals give a reliable and long term biomarker. Different biomarkers can be considered suitable for different kind of clinical studies, But blood and urine represents only the recent exposure of the metals in body. Moreover collection of nails and hair is much easier than that of blood and urine. As the collection and storage does not require any other chemical or external source. It can be easily stored at room temperature. Although Hair is also formed of same keratin protein as that of nails and it shares the same advantages as that of nails but sometimes hair has undergone cosmetic procedures such as dying, bleaching, smoothening which may alter the trace element content in hair. Hence make it unsuitable for testing purpose. Out of fingernails and toenails, toenails are considered better biomarker for detection as they take longer time to grow out. As a result they provide long exposure and dietary intake of heavy metals. Hence they provide accurate information of monitoring heavy metals in body. These are suitable measure for detection of elements in polluted areas.

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