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A Study on the Analysis of Brain Cancer Medical Imaging Using Digital Image Processing Technique and Treatment Using Alternative Methods

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Abstract

Background/Objectives: Glioma is a serious brain tumor affecting the nervous system and is often found only after symptoms such as headache, vomiting, seizures and cerebral neuropathy appear.

Methods/Statistical analysis: In medical image analysis, digital image processing is a process to diagnose a disease or prediction of survival rate of patient or so on using medical images like MRI, CT scan, PET scan, X-ray or ultrasound using machine learning algorithms. In this paper an overview over digital image processing, machine learning is discussed and we propose a comparison study between state-of-the-art supervised deep learning algorithms.

Findings: We discuss about Glioma tumor and its severity. In this paper we present medical image processing techniques are helpful in glioma tumor diagnosis and overall survival time prediction for glioma patients. Furthermore, we present an overall introduction about digital image processing, history, tasks and architecture; machine learning, deep learning and its classification. Later on we discuss about medical images used for brain tumor detection, we describe about MRI, CT scans, ultrasound, X-ray and PET scans. We investigate about open data sets which is also known as public data sets. We present the cancer imaging archive (TCIA), the whole brain atlas (TWBT) and about brain tumor segmentation challenges (BraTS) which are public brain tumor datasets available free on internet for researchers.

Improvements/Applications: we explore about traditional Korean medicine and traditional Indian medicine ayurveda which are alternative therapies and also known as pseudoscience.

***Keywords*:** Glioma, supervised learning, machine learning, deep learning, digital image processing, Ayurveda, Korean medicine.

1. Introduction

Glioma is a severe brain tumor which starts in the glial cells in brain. It affects the cerebral nervous system. The symptoms of glioma tumor are headaches, vomiting, seizures and cranial nerve disorders [1]. The glioma tumor has been divided in total four grades by world health organization (WHO). WHO grade I, biologically benign gliomas are comparatively low risked tumor and can be removed using surgery. WHO grade II, low grade gliomas are well differentiated but not anaplastic and in the habit of reoccurrence after surgery so it should be listed in malignant category. WHO grade III-IV, high-grade gliomas are malignant with undifferentiated and dysplasia, and have a worse prognosis [2].

In medical science, early diagnosis of glioma tumor can lead to the high survival time rate for a brain tumor patient [3]. Medical image processing provides platform to diagnose such tumors using deep learning algorithms. This survey paper is a cumulative survey between the supervised learning algorithms accuracy rate for diagnosis of glioma brain tumor and overall survival time for glioma patients.

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The structure of this paper is as follows. In section 2, we describe a medical image analysis system for brain tumors using machine learning. We explain about medical imaging and public data sets for brain tumor. In section 3 we explain about state of the art supervised learning approaches for glioma brain tumor diagnosis and for overall survival time of patient. In section 4 we explain about Korean traditional medicine and about Indian traditional medicine. Our conclusion is reported in section 5.

2. Application of Machine Learning

Machine learning (ML) is the research of algorithms that improves its working efficiency through experiences. ML is the subset of Artificial intelligence (AI). ML algorithms create mathematical models using sample data known as training data in order to make decisions and prediction for some certain problems without being explicitly programmed [4]. We have presented public data for brain tumor like TCIA [5], the whole brain atlas [6] and BraTS [7] in this paper.

2.1. *Data Sets for Machine Learning*

In medical image processing data is collection of various medical images like CT-scans, PET scans, ultrasound, mammography, neuroimaging are some of the example. Data are available in both public and private domains. Practice on various deep learning and a machine learning problems using dataset enhances researcher's knowledge and expertise. Public data has public access for all the researchers globally, while private data sets need to get permission before use [8]. These data sets are huge in size for this reason high frequency internet and big storage devices to store datasets are mandatory. After storing data on device we can practice deep learning and machine learning techniques on these data sets using deep learning tools. There are number of open source deep learning tools are available online some of them are pyTorch, Theano, Tensorflow, Keras, Sparkflow, mxNET, Scala and so on which works on python language.

In this research paper we discuss about the public data sets available on internet for brain tumor. The cancer imaging archive (TCIA), it is an open source database for researchers to research on medical images for cancer. This database is funded by National Cancer Institute (NCI), US and managed by University of Arkansas for Medical Sciences. Collections of majority of data in TCIA are CT-scans, MRIs and nuclear medicine images stored in DICOM format [9].

The whole brain atlas (TWBT), this data sets includes medicine, neurosciences, medical physics, biomedical technology, neuroimaging and cognitive neuroscience. This dataset is an information resource for medical imaging of the central nervous system. It integrates clinical information with MRI, CT-scans and X-Ray, nuclear medicines. This repository is working under care of Harvard Medical School, American Academy of Neurology, Brigham and Women's Hospital, Department of Radiology, Countway Library of Medicine in United States. This dataset is publicly available since 1995 [10].

Brain Tumor Segmentation (BraTS) Dataset always focused in the evaluation of the state-of-the-art approaches of BraTs techniques using multimodal scan [11]. Every year numerous segmentation techniques add on in the list of state-of-the-art approaches via BRATS challenges. A segmentation technique focuses on appearance, shape and histology of tumors in MRI. In BraTS19's challenge is focused on predicting a patient's overall survival time by using machine learning approaches [12]. Some of the other popular free open source datasets websites for brain tumor are kaggle.com, radiopaedia.org, datasetlist.com, pathmind.com, aylward.org, github.com and so on.

2.2. *Supervised Machine Learning*

Supervised machine learning (SML) is a deep learning approach in which labeled data (LD) is used to train a machine to perform regression or classification. As shown in [Figure 1], Labeled data are the sets of classified modules which are used to train a machine to perform certain tasks. Trained machine compare new data with old data (labeled data) to produce predicted result. In other words, we can say that supervised learning is a predictive approach in which recognized data is categorized to compare with new data and provide accurate result in time.

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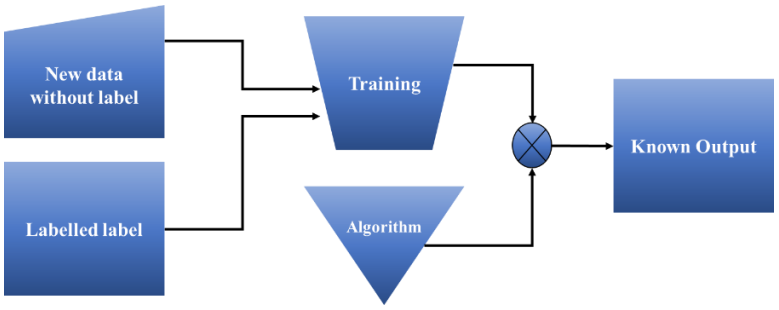

Figure 1. Supervised Learning

[Figure 2] describes Supervised Machine Learning Techniques. Supervised classification is labeling new data sets into a class which provides detailed information about new data sets using labeled data sets provided initially to machine. While supervised regression is predictive analysis used to predict continuous variables. Easiest example of regression is weather forecasting. Using past and present details about temperature, atmospheric pressure, wind, humidity, precipitation and volume of cloudiness, weather forecasting machine casts about present weather and weather for upcoming week or a month. And an image which has different fruits and classifying the name of fruit can be good example of supervised classification technique. For classification input data is not continuous while for regression machine takes continuous variable as data to generate continuous result.

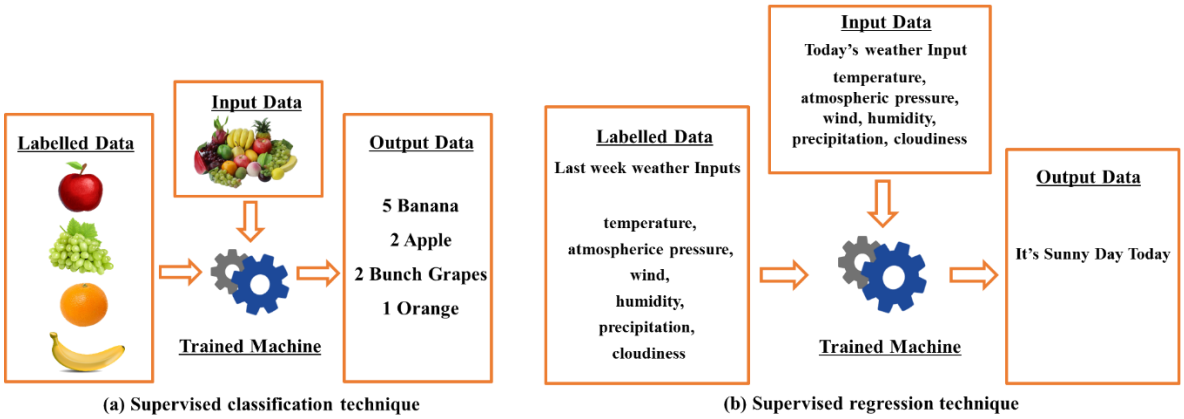

Figure 2. Supervised Machine Learning Techniques

Supervised learning technique is quick in providing predicted results. Some of the state-of-the-art supervised learning approaches are ANN, linear regression, support vector machine, logistic regression, random forest and K-nearest neighbor [13].

Application areas of supervised learning are bioinformatics, chem-informatics, database marketing, handwriting recognition, quantitative structure–activity relationship, learning to rank, information retrieval, information extraction, object recognition in computer vision, speech recognition spam detection, optical character recognition and pattern recognition [14].

3. Medical Image Classification for Brain Tumor

The uncontrolled occurrence of mass of unnatural cell growth in brain is known as brain tumor. There are two types of brain tumor cancerous and non-cancerous. Cancerous tumors are also known as malignant tumor and non-cancerous known as benign tumor [15]. Cancerous tumors further divided into primary tumors, which initiates within the brain and secondary tumors, which initiates from some other part of the body and end up affecting the brain. Growth rate of benign tumor is slower than malignant tumor and risk factor is high with malignant tumor as they grow aggressively and hard to detect at early stages. A symptom of brain tumor includes headaches, seizures, and problem with vision, mental changes, vomiting or migraines [15].

As shown in [Figure 3], Medical imaging is the procedure of making visual representation of inside of a body for

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clinical investigation and medical survey and analyzing the working of organs and tissues inside the body. There are several types of medical images used by radiologist to diagnose brain tumor. Some of the popular medical imagining techniques used for brain tumor has discussed in following paragraph [16].

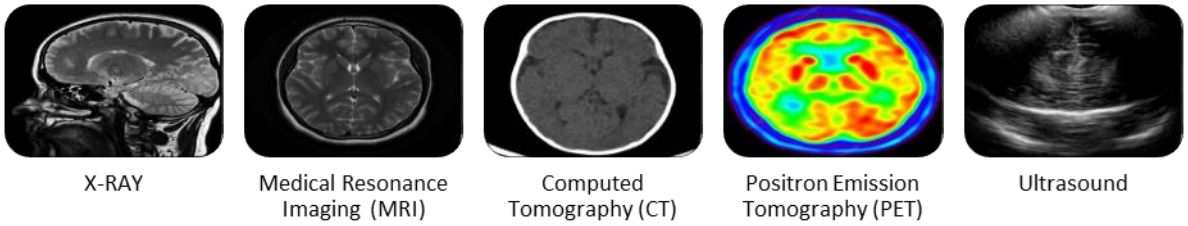

Figure 3. Medical Imagining Techniques used for Brain Tumor

Magnetic Resonance Imaging (MRI), MRI produces images of anatomy and physiological processes of the body. An MRI scanner produces strong magnetic fields, gradients and radio waves to produce images of human organs. As radiography uses x-rays to generate medical images, MRI differ from radiography by using magnetic waves to obtain the results. Medical use of MRI includes neuro-imaging, cardiovascular, musculoskeletal, liver and gastrointestinal and angiography [17]. Some of the medical imaging techniques dedicated for brain tumor diagnosis is MRI, radiography, CT scan, PET scan, nuclear medicine and ultrasound.

In MRI imaging technique a dye called contrast medium injected in patient body before scanning to get clear picture of state of the tumor [17]. MRI provides more detailed scan than CT-scans and are the preferred technique by the radiologists. To get clear version of scan the type of MRI used is gadolinium contrast media or MRI contrast media in which gadolinium liquid inserted by intravenous to gain optimum scanning result [18]. Another MRI approach to get cellular structure of the image is known as diffusion weighted imaging (DWI) [19] and to gain the knowledge of blood circulation in brain tissues perfusion imaging technique (PIT) has used under MRI [20]. A functional MRI (fMRI) shows the response of brain area which is responsible for movement and speech. During fMRI scanning patients are directed to do certain tasks so radiologist can observe their brain movements through the MRI machine [21]. Another MRI technique known as magnetic resonance spectroscopy (MRS) differentiate between dead brain cells and live brain cells and it shows the development of previous therapies so radiologist can decide future treatment for brain tumor using result of MRS [22].

Radiography is a medical imaging technique of radiology in which ionized or non-ionized radiation (like X-rays or Gamma rays) has used to find out the inside working of organs in human body. A medical use of radiography includes projection radiography (PR), computed tomography (CT), fluoroscopy and contrast radiography (CR) [3]. CT scan technique is used to penetrate the body using penetrating waves like x-rays or gamma rays are known as computed tomography. Brain CT scan is used to find out head injuries, reason of dizziness, brain bleeding, strokes in brain and for brain tumor diagnosis. Cross sectional images produced by CT scan can be reformatted on multiple planes. CT scan is painless procedure. It is non-invasive and produces accurate results for brain tumor and lesions. The major advantage of CT scan is that it can scan and produce images of soft tissue and blood vessels, bone at the same time. CT scan is the cost effective imaging tool and solves wide range of clinical problems. The most popular types of tomography are atom probe tomography, computed tomography, electron tomography, hydraulic tomography, magnetic induction tomography, microwave tomography, neutron tomography, positron emission tomography (PET), PET-computed tomography (PET-CT), quantum tomography (QT), ultrasound computer tomography (USCT), X-ray computed tomography and zeeman doppler imaging [23].

A part of nuclear medicine (NM) includes PET scanning. In PET scan radiotracers are injected to blood cells which has particle of radioactive material. Radiotracers travel to infected areas and gives energy in the form of gamma rays. The device which is used in producing nuclear medicine medical images is known as Gamma camera. PET scanning is capable to extract changes on cellular level using this advantage PET scanning is capable to diagnose disease comparably faster than other medical imaging techniques. PET scan is safe, accurate, non-invasive and painless procedure. Using PET scanning functioning of brain can be detecting and observed. In few cases PET scanning and SPECT (single photon emission computed tomography) scanning are function together to provide more accurate results to radiologist in diagnosing severe brain tumors and brain functioning. [24]

Ultrasound medical imaging produces 3D medical images. High frequency broadband sound waves are used to produce brain tumor and cerebrospinal fluid images using ultrasound whose bandwidth range goes in megahertz. Ultrasound has

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commonly used by radiologists in pregnancy to imaging the fetus brain and body growth. Ultrasound is safe for infants. Ultrasound is non-invasive technique and works on non-ionizing radiation technique. Other medical uses of ultrasound by organs are anesthesiology, angiology, cardiology, gastroenterology, gynecology, hemodynamic, otolaryngology, neonatology, ophthalmology, pulmonology, and urology [14]. Photoacoustic imaging (PI) or optoacoustic imaging, this model of ultrasound medical imaging is based on biomedical imaging technique in which Photoacoustic effects are used to produce medical images. Photoacoustic effects are non-ionizing laser pulses who trace the working of, biological tissues in human body. When radio frequency technique has been used at the place of non-ionizing laser technique, that concept is known as thermo acoustic imaging. General medical uses of PI are brain lesion detection, hemodynamic monitoring, and breast cancer diagnosis [25]. There are other approaches where ML, Deep Learning, SVM, Decision Tree played a vital role in classification and identification of diseases and conditions [46-55].

4. Overview of Korean Traditional Medicine and Indian Ayurveda and its Effects on Brain Tumor

In section 4.1 we studied about traditional Korean medicine history, traditional medicine techniques and its impact on brain tumor. In section 4.2 we studied about Indian ayurveda history, types and ayurveda effects on brain tumor. Section 4 has been provided history and an overview of alternative therapies effects on brain tumor.

In this section the traditional Korean medicine is presented with the effect of Korean medicine on brain tumor and a brief introduction of traditional Indian medicine Ayurveda is presented with its effects on brain tumor. Traditional Korean medicine is originated from the traditional Chinese medicine principle. There are three main methods to treat a disease in traditional Korean medicine treatment they are (a) herbal medicine treatment using plants and their parts, (b) acupuncture treatment using hot needles to stimulate blood circulation, and (c) moxibustion treatment using burning dried mugwort and applied on affected area of the diseased man [26]. There are some researches and proofs are available which shows about the treatment which is done in traditional Korean medicine to treat glioma tumor or brain tumor using herbal medicine technique and acupuncture technique. Another approach is traditional Indian medicine Ayurveda. Ayurveda is an alternative therapy or we can say pseudoscientific approach to diagnose, treatment and prevention from the diseases. The main eight components of Ayurveda are (a) *kayachikitsa*, general medicine; (b) *kaumara-bhrtya*, the branch of medicine concerned with the treatment of infants and children; (c) *salyatantra*, surgical technique; (d) *bhutavidya*, treatment of psychic disorders; (e) *agadatantral vishagara*, toxicology; (f) *rasyatantra*, rejuvenation; (g) *vajikaranatantra*, aphrodisiacs; (h) *shalakyatantra*, medicine ear, nose and throat ENT [27]. Ayurveda suggests that there are three doshas in every human body these are *Vatta*, *Pitta*, *Kapha* and their imbalance causes the severe diseases like tumor in body. Ayurveda describes practices to balance these tridosha using Ayurvedic practices and treatment of diseases like glioma tumor and other severe diseases using Ayurvedic practices [28].

4.1. *Traditional Korean medicine (TKM) therapies and Brain Tumor*

Glioma tumors are commonly found in the central nervous system, occur primarily in areas of the brain, and affect it's function. The mortality rate by glioma tumor is around 81% [29]. Due to its high mortality rate the research on treating glioma using various techniques has been developing from decades around the globe. In Korea, doctors tried to treat glioma tumor using various traditional Korean medicine (TKM) therapies. TKM therapies are influenced by traditional Chinese medicine (TCM) therapies [4]. There are mainly three types of TKM therapies herbal medicine, acupuncture and moxibustion [30].

Herbal medicine or herbalism is the study of plants for purpose of creating health food to cure severe diseases like brain tumors and breast cancer. Roots, leaves, stem and sometimes whole plant has been used to prepare medical food and medicine to treat tumor patients. Korean Red Ginseng Extract (RG) is famous as a traditional health supplement in the Asian continent. It enhances the immunity of cancer patients. In this paper, RG has been observed to inhibit invasion, inflammation, and proliferation in several cancer cells [31].

Another TKM therapy is acupuncture in which needles has been used in stimulation of blood to treat severe diseases like blood clotting, acidity and so on. In a research it has been observed that acupuncture has positive effects on tumor patients. The treatment was conducted for four months continuously on 13 years old boy after brain tumor surgery. In the treatment it has been observed that acupuncture increased the cerebral blood flow (CBF) of the patient which reduces the probability of coma after brain tumor surgery and helps in the healing of tumor cells [32].

Moxibustion is TKM therapy that includes the burning of mugwort known as moxa which is a type of herb that improves the healing speed. The aim of moxibustion is to stimulate the flow of Qi, strengthening the blood and maintaining of general

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health. In a research it has been observed that moxibustion in supportive to reduce cancer fatigue. Total 22 studies were held on 1628 cancer patients and it has been observed that moxibustion is safe technique to reduce cancer fatigues like sensory fatigue, behavioral fatigue, and physical fatigues. There are no proven methods or researches that moxibustion heals glioma tumor but in researches it has been proved that it can reduce and heal the symptoms of brain tumor and its relative fatigues [32].

4.2. *Traditional Indian Medicine Ayurveda and Brain Tumor*

Ayurveda is a traditional Indian medicine (TIM) therapy from the ancient time. Ayurveda's origin can be found in Rigveda and Atharvaveda [27]. Ayurveda is known as alternative medicine and pseudoscientific medical treatment [33]. Ayurvedic therapies are mainly based on complex herbal compounds, minerals and metal substances mentioned in "Rasa Shastra". Modern medicine has undergone various technological advances for diagnosis and confirmation through the study of histopathology with light and electron microscopy. But in India in the past, it was necessary to rely entirely on a variety of clinical symptoms, according to Dosha's theory, through herbal remedies and various purifications of the body and mind. Contamination of prana (energy) assumed as a main cause of brain tumor. Brain tumor was very often referred with the mythological story of "Arbuda" [34].

During Vedic period (3000 to 5000 BC) "ARBUDA" was considered as a serpent like demon conquered by using Lord Indra (King of daites). Susruta description that because Arbuda is a lump, it has a profound meaning in relation to brain tumors [35]. Arbudas are gradually growing mass of large size, spherical, fixed position, usually not purulent, sometimes painful, and can occur on any part of the body. It can contain tissues and blood because of vitiation of "tridosa" [36].

Tridosha defines three basic energies that are believed to exist in the person's body. The three energies are acknowledged a vata, pitta, and kapha [37]. Each person has a completely unique stability for all three energies. Some people might be essential in one at the same time as others are a mixture of two or more.

There are two more concepts that support Ayurveda concepts for brain tumor. Mita Ahara-Vihara and Sapta Dhatu are discussed in Ayurveda for the proper expertise and treatment of brain tumor. The Mita-Ahara-vihara is about consuming balanced behavior, food and lifestyles [38].

Ayurveda constantly gives same importance to Ahara and Vihara to keep correct health in addition to remedy diseases. Charaka Samhita has given Swastha Chatushka (Matrashitiyam) shows the significance of Vihara. The descriptionof Dinacharya, Ritucharya, Sadavritta and Nidra depicts the significance of Vihara in maintaining wholesome life style. To keep the health, Ayurveda laid many primary concepts like Dinacharya (diurnal regime), Ritucharya (seasonal regime). The concept of Apathya (unwholesome) and Pathya (healthful) is the peculiarity of Ayurveda to satisfy its aims and objectives. Charak had said that healthy food is one of the causes for the increase and well-being of humans whilst unwholesome meals are the root of all diseases including mind tumor [39]. Sushrut had further supported the truth with the aid of stating that food is the cause of vitality, strength, complexion and Ojus [40].

The basic and supporting units of the body are called Dhatu in Ayurveda [41]. In present day science, it is identified with tissues. There are seven key standards (components) that help the essential structure (and working) of the body. Brain tumor and its various humors are vitiated including distinctive Dhatus (Mamsa, Meda, Rakta, and so forth) [42]. Despite the fact that "Dosa" is vitiaed answer favorably for Arbuda's advancement, virtually every Ayurvedic message has given Kapha its most extreme meaning [43]. Susruta has referenced that because of abundance of Kapha, Arbuda doesn't fester, which is viewed as the normal and significant factor for any development in the body. Along these lines, it appears to be supported to propose that overabundance of vitiated Kapha in the body may be answerable for the precipitation of malignancy. Disturbance and injury may accelerate or enact the development of Arbuda. Where, for the development of outside genitalia, neighborhood utilization of certain bad tempered medications has been exhorted. As indicated by Susruta, injury is additionally viewed as another causative factor for the advancement of Mamsarbuda, while Vagbhata has depicted that at whatever point. This is exorbitant development of Mamsa Dhatu it might prompt different neurotic conditions, for example, Gandamala, Galaganda, Arbuda, Adhimamsa and Granthi. It shows that Mita Vihara and Mita Aihara most likely change nearby or methodical bio concoction factors including the hemodynamic prompting the inception of Arbuda. Arbuda can occur in any part or tissue of the body, according to Susuruta and likely no site is excluded, which can't offer ascent to Arbuda. This incorporate eye, nose, ear, buckle cavity independently, for example, Vartmarbuda (eye cover), Nasarbuda (Nose), Karnarbuda (ear), Mukharbuda (Buccal mucosa), Jalabuda and Galarbuda (Throat), Taluarbuda (Palate), Ostharbuda (Lip), Sirarbuda (Cerebrum or Tumors of head) [44].

Ayurvedic herbs are the absolute most generally utilized home grown prescriptions on the planet. Their across the board use and their wide-scope of utilizations are situated in rich history of viability recorded in age old writings and analyses. The

rundown of Ayurvedic prescriptions recommended to the patient is introduced here: Boswellia serrata, (Frankincense), Withania somnifera, (Ashwagandha), Curcuma longa, (Turmeric), Azadiratcha indica, (Neem) Tinospora cordifolia, (Guduchi) Amoora rohituka (Ruhtaka) Triphala (a blend of natural product powder of three unique plants: Terminalia chebula, Terminalia bellerica, and Emblica officinalis) Andrographis paniculata (Kalmegh) Nigella sativa (Kalonji) Indian White Cedar (Dysoxylum binectariferum Hook. f.) [45]

5. Conclusion

We discuss about Glioma tumor and its severity. In this paper we present medical image processing techniques are helpful in glioma tumor diagnosis and overall survival time prediction for glioma patients. Furthermore, we present an overall introduction about digital image processing, history, tasks and architecture; machine learning, deep learning and its classification. Later on we discuss about medical images used for brain tumor detection, we describe about MRI, CT scans, ultrasound, X-ray and PET scans. We investigate about open data sets which is also known as public data sets. We present the cancer imaging archive (TCIA), the whole brain atlas (TWBT) and about brain tumor segmentation challenges (BraTS) which are public brain tumor datasets available free on internet for researchers.

In this paper we explore about traditional Korean medicine and traditional Indian medicine ayurveda which are alternative therapies and also known as pseudoscience. In this paper we present its effects on brain tumor diagnosis and treatment.

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